FINAL CONTINUITY AND CHANGE AT A PU'UONE FISHPOND: ARCHAEOLOGICAL INVENTORY SURVEY LOKOEA FISHPOND KAWAILOA AHUPUA'A, WAIALUA DISTRICT, O'AHU ISLAND, HAWAI'I TMK (1) 6-2-003:002

Prepared for: Kamehameha Schools 567 South King Street, Suite 200 Honolulu, HI 96813

Prepared by: Christopher M. Monahan, Ph.D. Douglas W. Thurman, B.A. TCP Hawai'i, LLC 333 Aoloa Street, #303 Kailua, HI 96734

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Lower Anahulu River and Waialua Bay, 1842 or 1843, by Edwin Locke, showing Lokoea (B, red arrow) and 'Uko'a Fishpond (A); note connection (linear feature, green arrow) between the ponds (Sahlins 1992:174)



"Between the sandy stretch of Maeaea [Hale'iwa Beach Park] and the houses at Ukoa, on the seaward side, was the trail from Kamani to the place in front of the sluice gate of Lokoea, and on to Koolauloa," John Papa 'Ī'ī (translated by Mary Kawena Pukui) recollecting to around 1810 ('Ī'ī 1959:98)

"Ka make ana o Keawehunahala" (By M.N. Kaulua, *Nupepa Kuokoa*, April 15, 1876)

Kanikau la he Aloha, Nou o Keawehunahala, Kuu kane o na wai elua o ka aina, Mai ke kai Ehuehu o Puaena, Enaena ka maka o ke kanaka, I lokua mai e ke kai o Maeaea, Ea mao ole i ke kula o Lauhulu, E hoi ka uhane i Lokoea, E inu i ka wai kiaha o Maleka, Hoopiha'ku i ke kai o Kahala — e, Auwe ke kane ka mea'loha — e.

"The Death of Keawehunahala" (Maka'āinana and Kuleana Holder at Lokoea)

Here is a sorrow filled lament for you Keawehunahala, My beloved husband of the two fresh waters ['Uko'a and Lokoea] of the land, From the foam flecked sea of Pua'ena, Abundant tears of the people, Drenched with rain by the sea at Māeaea, (tears) rising unabated in the plain at Lauhulu, May the spirit return to Lokoea, To drink the glass of water from America, Fill up the ocean at Kāhala, O Sorrow, my husband, my beloved.

(Translated by Kumu Elizabeth Kahi Wight)

ACKNOWLEDGMENTS

In his classic 1982 essay on ethics in American Archaeology (The Golden Marshalltown: A Parable for the Archeology of the 1980s), Professor Kent V. Flannery opined that "Archeology is the only branch of anthropology where we kill our informants in the process of studying them." Lokoea is our "informant" in this case, and, while she is still very much alive, we did dig into her depths in a few places. Each excavation was carefully planned and conducted to answer specific questions; and we were not disappointed by these efforts. At all times, during our work at Lokoea, we were mindful of working in a respectful manner so as to minimize our archaeological footprint.

Mahalo nui loa to Kamehameha Schools, Land Assets Division, especially Jason Alapaki Jeremiah and Sean McNamara, for putting up with Chris Monahan's manic ramblings about every little thing we discovered at Lokoea. This modern-day pu'uhonua is truly a refuge from the hustle and bustle of nearby Hale'iwa, and we feel privileged to have had this opportunity. Extra thanks as well to Jason for agreeing to additional archaeological testing after we had an opportunity to discuss the results of the first draft of this study. We also thank the Mālama Loko Ea Foundation, including James Estores, Benson Lee, Jessica Casson and Sayo Costantino, for enlightening discussions and for allowing us to make a mess of their outdoor classroom with back-dirt piles, messed up grass, and dirty tarps. Mahalo as well to Kimi Apiki (Alu Like, Inc.) and Mahealani Matsuzaki (Land Legacy Educational Specialist, Kamehameha Schools) for their aloha. A special thanks goes to the caretaker, Tony, who always answers his phone with good cheer in spite of the fact that every time we call him, we're asking for something else yet again.

Doug Thurman conducted all the archaeological fieldwork with Monahan and produced most of the plan maps in this report. Malia Evans helped us out with a bit of fieldwork on one of our last days at Lokoea. Several experts in Hawaiian material culture, including Pat Kirch (University of California-Berkeley), David Shideler (Cultural Surveys Hawai'i), Kai Markell (Office of Hawaiian Affairs) and Susan Lebo (State Historic Preservation Division) looked at photographs of the wooden object recovered in excavation, and offered their professional opinions as to its possible function. Mahalo as well to Gail Murakami (International Archaeological Research Institute, Inc.) for the taxonomic identification of this object. Carol Wyban was kind enough to endure my prying questions about her years living at Lokoea.

A special appreciation is also in order to Kumu Elizabeth Kahi Wight (Kapi'olani Community College) for her expert translation and interpretation of Hawaiian language documents.

He 'onipa'a ka 'oiā'i'o! (Mary Kawena Pukui 1983:94)

ABSTRACT—EXECUTIVE SUMMARY

On behalf of the landowner, Kamehameha Schools, TCP Hawai'i conducted an Archaeological Inventory Survey of Lokoea in Haleiwa on Oahu's northshore. A pu'uone-type fishpond measuring approximately six acres in size, Lokoea is connected physically and metaphysically to 'Uko'a Fishpond, located about a mile to the north. We argue that Lokoea should be considered part of what we propose to call the 'Uko'a-Lokoea Fishpond Complex. Our primary research questions were: When was Lokoea first established as a pu'uone fishpond? What are its structural materials and methods, and what main functions do these structures serve? How have these structural features been modified over time? How does Lokoea fit into the larger cultural landscape of Kawailoa kai? And, what does Lokoea tell us about traditional Hawaiian landscape design and resource management?

We completed eight hand-excavated test units (TU-1 through TU-8). Excavation at Feature 1, the largest rock structure at Lokoea, demonstrated subsurface features indicating major structural failure and repair of the wall over time. We recovered a carved wooden artifact near the base of TU-1. Its form and inferred function, taxonomic identification, radiocarbon dating and stratigraphic context all suggest Feature 1 has been more or less completely rebuilt during the historic period. Archival evidence suggests the exterior of this wall was completely rebuilt after 1957. Excavation at Feature 2, the smaller wall connecting the central island to the east side of the property, demonstrated its core construction materials and methods differ from Feature 1 and appear to be a traditional style, even though we believe, based on our analysis of aerial imagery, that Feature 2 appears to post-date 1928. We recovered traditional Hawaiian artifacts in excavation near the base of a test unit (TU-5) on the central island, which, as far as we know, are the first such (in situ) finds at Lokoea. A wood charcoal sample from a subsurface fire place feature on the south side of the island (TU-6) was identified as Douglas fir, and we did not submit it for dating.

Although it is challenging due to the many instances of disturbance and rebuilding we documented, a large body of diverse information is consistent with the interpretation that Lokoea originated in pre-Contact times. The central island, which we have shown was originally constructed by infilling of sediments around and atop coral outcrops, seems to have at one time extended out further into the main fishpond where it connected with a smaller gated wall, the original Feature 2, that is no longer in the same position anymore. We have also demonstrated unequivocally that traditional Hawaiian artifacts are located in deep deposits under the island.

TCP Hawai'i evaluates Lokoea, in its entirety, including all seven of the archaeological features identified in this AIS report, as historically significant under criteria B, C, D and E. <u>Criterion B</u> applies because many ali'i, including Queen Lili'uokalani whose bath is adjacent to the pond, spent time at Lokoea. <u>Criterion C</u> applies because of the quality of much of the wall building and overall engineering of the entire system, which ingeniously walls off the 'Uko'a waterway from the south end of the wetland, thereby creating what we call Lokoea. <u>Criterion D</u> applies because of the wealth of potential archaeological data that still lies locked in the subsurface deposits of Lokoea. <u>Criterion E</u> applies because of Lokoea's ongoing role in the perpetuation of the cultural practice of fish-farming by Native Hawaiians.

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INTRODUCTION

TCP Hawai'i, LLC, conducted an Archaeological Inventory Survey (AIS) of Lokoea fishpond in Kawailoa Ahupua'a, Waialua District, O'ahu, TMK: (1) 6-2-003:002 (Figure 1 through Figure 3). The AIS was undertaken in support of a project to develop an Archaeological Site Preservation and Development Plan (hereafter, Preservation Plan) for Lokoea. The approximately 7.0-acre project area is adjacent to Kamehameha Highway and Jameson's By The Sea Restaurant in Hale'iwa.

The landowner and project proponent is Kamehameha Schools (KS). The AIS was designed to inform the Preservation Plan, which is being developed in collaboration with KS' non-profit partner organization Mālama Loko Ea Foundation (MLEF). This community group has begun restoration efforts at Lokoea, which is a pu'uone-type (inland, brackish) fishpond, including the raising of 'ama'ama (striped mullet), awa (milkfish), 'āholehole (Hawaiian flagtail) and others.¹ The pond is also frequented by native and endemic birds such as 'alae ke'oke'o (Hawaiian coot) and 'auku'u (black-crowned night heron). This report contains specific archaeological, historical and cultural information on Lokoea, in the context of other significant resources such as 'Uko'a fishpond and the wider cultural landscape of the muliwai (river mouth) of Anahulu Stream, Kawailoa Ahupua'a and Waialua Moku (District).

This report satisfies the general requirements of HRS Chapter 6E-42 and HAR Chapter 13-284; and specific details of HAR Chapter 13-276 governing the conduct and components of an AIS. Christopher M. Monahan, Ph.D., was the Principal Investigator for this project. He has 13 years of professional experience in Hawai'i, and another 15 years worldwide.

Lokoea (State Site # 50-80-04-233) is closely associated with 'Uko'a Fishpond (State Site # 50-80-04-236). Although approximately one mile apart, these cultural resources are physically connected by a stream channel that has likely always been present during the time of human occupation of this area. As such, there are significant metaphysical and spiritual connections between these wahi pana (legendary places), which are known in the historical literature as royal fishponds. For example, these ponds shared a mo'o named Laniwahine, who was their kia'i (guardian). Numerous ali'i, including Kakuhihewa, Ka'ahumanu and Lili'uokalani, had exclusive rights to Lokoea in the 19th century. Substantial modifications to the pond were later made by the Waialua Sugar Company and others in the 20th century.

In general, the objectives of the current AIS were to develop a spatial and temporal reconstruction of the evolution of Lokoea from ancient times to the present. Paleoenvironmental work at 'Uko'a (Athens 1993; Athens et al. 1995) suggests human settlement of the project area environs is at least 1,000 years old. McGerty and Spear (2000) obtained a radiocarbon date calibrated (2 sigma) to AD 1420–1530 from a subsurface cultural layer exposed in during archaeological excavation just south of the project near Lokoea Place. Subsurface testing during the current AIS fieldwork focused on identifying phases of fishpond modification; archival research included a consideration of evidence of habitation around the pond margins. Survey work at the ground surface focused on identifying and interpreting all features greater than 50 years in age. These data have been integrated into an overall picture of how human use and modification of Lokoea has changed through time.

An important component of this research was the translation and interpretation of Hawaiian language resources dealing specifically with Lokoea and 'Uko'a, including newspapers and Land Commission documents, in the context of more accessible and well-known information (e.g., McAllister 1933; Handy 1940; 'Ī'ī 1959; Handy and Handy 1972; Pukui 1983; Sterling and Summers 1978; Kamakau 1991, 1992; Sahlins 1992). Our overall approach was to treat the Hawaiian-language information and historical perspectives as a complementary component of the AIS, rather than as merely background information.

¹ Unless quoting from published material, in which case the original style is maintained, Hawaiian words are not italicized in TCP Hawai'i documents since Hawaiian is an official state language rather than a "foreign" language.



Figure 1. Project area location depicted on 1999 USGS Haleiwa quadrangle 7.5-minute series topographic map; the AIS project area is outlined in black; TMK is outlined in red



Figure 2. Project area location depicted on an aerial photograph (base map from ESRI ArcGIS); the AIS project area is outlined in black; TMK is outlined in red



Figure 3. TMK map of the project area and environs (base map from ESRI ArcGIS)

This integrated approach is an effort to ensure that the AIS will go above and beyond regulatory adequacy by addressing meaningful research objectives in a holistic way that expresses a Hawaiian sense of place about Lokoea.²

We have tried in this study to avoid including redundant, irrelevant and unnecessary information of a general nature that does not directly relate to Lokoea; thus, there is essentially no "filler" or cut-and-paste information in this report. We have tried to avoid archaeological jargon, as much as possible, so that this document can be useful to both the professional and non-professional reader. Finally, because this AIS report is a stepping stone to the companion Preservation Plan for Lokoea, some detailed archival research and analysis appears *only* in the Preservation Plan, where it is most relevant.

Environment

Topography and Terrain

The project area is located on a low-lying, nearly level coastal plain no more than about 1 m (3 ft) above sea level. Very small variations in elevation at Lokoea are important to its overall structure and function. Towards the mauka, or east, side of the pond near its north end, there is an elevated bluff, about 2 m (6 ft) high, of lithified coral reef. This natural landscape feature is an important part of the Lokoea landscape as a "high and dry" place to store materials, meet and get organized, observe the entire pond, etc. Towards the makai, or west, side the landscape rises gently up to the existing Kamehameha Highway, which is aligned along the natural "back beach" berm of Jaucas sand that protects much of the coastal plain from ordinary high-water events (such as full moon tides), but not necessarily major storms.

Geology and Soils

A major constraint on the size and shape of the Lokoea basin is the hard rock geology that can still be observed in the eastern margins of the pond. Along this side of Lokoea, a lithified coral reef (sometimes called limestone) representing a high sea stand rests conformably over a weathered pāhoehoe flow (Figure 4 and Figure 5). This lithified coral likely represents the Waimānalo Sea Stand dating to approximately 120,000 years before present, an interglacial period when sea levels in Hawai'i were approximately 7.5 m (24.8 ft) above current levels (Macdonald et al. 1983; Ziegler 2002).

Prior studies of 'Uko'a Fishpond are relevant to the geology of Lokoea. In their paleoenvironmental investigation of 'Uko'a Fishpond, Athens et al (1995), citing several prior studies (Macdonald and Abbott 1970; Rosenau et al. 1971; Stearns 1978; Hirata and Associates 1988) in addition to their direct observations, discuss the basic geology and geochronology of the 'Uko'a Fishpond basin. They conclude that the entire basin, which includes Lokoea, is essentially a Holocene phenomenon, meaning it has been in place and largely unchanged from a hard-rock structural perspective for the last 8,000 years or so, long before anyone ever stepped foot on Oahu. For our purposes, this means that the current topography and terrain, which is a major factor in determining Lokoea's hydrological regime (i.e., the way water moves across the land, where it comes from and where it goes) has not fundamentally changed throughout the time of human use of this landscape, which is not to say that the *sources* and *amount* of water have not been altered, because it is clear that the system once had substantially more water in it than it does today.

Information on soils and any direct quotes come from Foote et al. (1972) (Figure 6). The immediate pond margins are surrounded by Tropaquets, described as "poorly-drained soils periodically flooded by irrigation in order to grow crops that thrive in water"... "used for production of taro, rice, and watercress on flooded paddies." The makai side of the pond, along the Kamehameha Highway, is characterized by Jaucas sands, which are "very deep, excessively drained, very rapidly permeable soils on vegetated beach areas along the sea coast, which formed in calcareous sand deposits."

² Lokoea can also be spelled Loko Ea (or sometimes even Loko'ea). The Lokoea spelling is used throughout this report—unless quoting from published material—since this is how it appears in historical documents such as Land Commission records and Hawaiian-language newspapers.



Figure 4. Illustrating the hard rock geology of Lokoea in its eastern margins, view north; tall grass (left background) is the waterway to 'Uko'a; Wyban (1992:18) identified the natural feature in the foreground as a "ko'a (shrine)"



Figure 5. Illustrating the hard rock geology (lithified coral reef atop weathered pāhoehoe) along the eastern margin of the pond, view ENE; this is a small cave (designated the "north cave" or Feature 6 in the current study)



Figure 6. Soil survey data for the project area and environs (base map from ESRI ArcGIS)

Various types of silty clays are found around the rest of the pond. Because these soils are relatively impermeable, firm and consolidated, they provide physical constraints on the lateral movement of Lokoea's water. These silty clays along the south and southeast sides of the pond create natural boundaries to this fundamentally marshy area which, when stressed with too much water, more easily punches through the Jaucas sand to the west and flows into the ocean, rather than connecting with the Anahulu Stream to the south.

Fauna

Lokoea is currently home to numerous native species and a few aliens, as well as several visitors, as summarized in the lists below. Staff of MLEF provided currently-observed fish, other aquatic life and birds at Lokoea.³

Native fish and other aquatics currently observed (MLEF staff)

- 'A'ama, a type of crab (*Grapsus grapsus tenuicrustatus*)
- Āhole or Hawaiian flagtail (*Kuhlia sandvicensis*), also noted āholehole used to describe the young stage (Wyban [1992] uses the common name "silver perch" for āholehole)
- 'Ama'ama or mullet (*Mugil cephalus*)
- Awa or milkfish (*Chanos chanos*)
- Kākū or barracudas (*Sphyraenidae* spp.)
- Manini, a type of surgeonfish (*Acanthurus triostegus*)
- Moi or threadfish (*Polydactylus sexfilis*)
- 'O'opu, a general name for various types of goby
- 'Ōpae, a general name for various types of shrimp
- Palani, a type of surgeonfish (A. dussumieri)
- Pualu (sometimes spelled puwalu) or a type of surgeonfish (*Acanthurus xanthopterus* or *A. mata*)
- Ulua or jacks (*Caranx* spp.), also noted pāpio (or pāpiopio), used to describe the young stage of growth of this fish

Invasive fish and other aquatics currently observed (MLEF staff)

- Tilapia (indeterminate species);
- Tō'au or blacktail snapper (*Lutjanus fulvus*)
- Samoan crab (*Scylla serrata*)

Native birds currently observed at Lokoea⁴

- Auku'u or black-crowned night heron (*Nycticorax nycticorax hoactli*)
- 'Alae ke'oke'o (alternatively, 'alae kea) or Hawaiian coot (*Fulica alai*)

Flora

Leaving aside the various grasses and weedy plants and landscaped varieties, there are some plants at Lokoea that have probably been there from historic times. These include the hau (*Hibiscus tiliace*) thicket on the southwest margin of the pond and some on the central island and a couple of milo (*Thespesia populnea*) trees near the top of Lokoea Stream (incidentally, according to James Estores, one of his tutu used to jump off one of these milo trees into the Lokoea Stream to swim). There are many coconut palms (*Cocus nucifera*) and some date palms (*Phoenix* spp.) planted around the shoreline of the main pond and the Keiki pond—all of these appear to post-date 1960 or so. There is a large ironwood tree (*Casuarina*)

³ One of the more interesting residents of Lokoea was—until quite recently—a large barracuda named "Mele" in the waterway to 'Uko'a that MLEF staff pointed out to us. She recently died and will be missed by the staff.

⁴ Wyban (1992) also noted the presence of 'Alae 'ula or Hawaiian mudhen (*Gallinula chloropus sandvicensis*) in the 1980s

spp.) near the mouth of Lokoea Stream, just before the bridge along Kamehameha Highway. There are at least two types of marsh grass growing in the main pond and the waterway to 'Uko'a—incidentally, both of these, if left unchecked and not cut back, soon expand and fill in the pond wherever they are left to their own devices. Bougainvillea (*Nyctaginaceae bougainvillea*) grows along a portion of the lithified coral bluff along the northeast side of the pond. The MLEF staff is also actively planting various native species around the central island including ti (kī) (*Cordyline fruticosa*) and others.

Hydrology

There is abundant anecdotal evidence that, prior to the construction of the pump station at 'Uko'a by the Waialua Sugar Company—which appears on maps at least as early as 1906—the water throughout the entire Lokoea-'Uko'a system was substantially higher. Based on visual inspection of the oldest constructed features at Lokoea (the long rock wall on the makai side designated Feature 1 and the smaller rock wall on the mauka side designated Feature 2), estimates of 2–3 feet higher seem reasonable but could have been a bit more. Feature 2, in particular, has a distinctive line of lichen growth that is currently well above today's high water mark, but seems to evidence a time when the water was generally much higher.

Wyban (1992) has discussed this specific issue at length in her memoir about Lokoea, and recounts oral history from the early to middle 20th century that suggests children used to jump off the bridge at Lokoea Stream into the water, which is now rarely more than about a foot deep (Figure 7).

According to James Estores, in 1994, the spring at 'Uko'a was capped—instead of letting it continue to flow down into Lokoea—by the Waialua Sugar Company when it ceased operations.



Figure 7. Lokoea Stream outlet under the bridge along Kamehameha Highway; historical accounts (Wyban 1992:8) describe children jumping from the bridge into the stream—which these days is rarely deeper than about a foot—in the middle 20th century, indicating there used to be a few to several more feet of water in this stream system; view west

RESEARCH OBJECTIVES AND PREDICTED FINDS

This study was primarily focused on developing a spatial and temporal reconstruction of the evolution of Lokoea (State Site # 50-80-04-233) from its original, natural condition prior to the arrival of the first humans—at which time it was likely an intertidal marsh, or muliwai, of either the Anahulu Stream delta and/or Waialua Bay; to the time of its initial modification as a functional fishpond by Kānaka Maoli in pre-Contact times [dated sediment cores from nearby 'Uko'a Fishpond (State Site # 50-80-04-236) suggest initial human settlement of the area approximately 1,000 years ago (Athens 1993; Athens et al. 1995)]; to the time of Kamehameha's conquest of O'ahu around 1804, when it is likely that Lokoea underwent substantial additional modification as Kamehameha's favored chiefs and their 'ohana (mā) were awarded prime lowlands in this area (Kirch 1992; Sahlins 1992); and, later modifications associated with the commercial sugar industry (including the Waialua Sugar Company) and more recent commercial development.

Prior to the fieldwork, and based on limited background research, we anticipated identifying subsurface sediments and stratigraphy indicative of earlier phases of pond development that could be radiocarbon dated by obtaining and testing short-lived wood charcoal from discrete subsurface features. We also knew that surface features dating from later episodes of pond development would be encountered, including plantation and more modern features. A main research objective was to synthesize all available evidence—archaeological, cultural and historical—to reconstruct this dynamic picture and to demonstrate how the subsurface and surface features relate to each other.

Some specific questions we also wanted to address included whether the margins or boundaries of Lokoea were ever defined by rock walls, or whether the pond edges have always been defined (as they are today) by marsh or soil banks.

METHODS

This section describes the methods of archival research, fieldwork, post-field activities including laboratory analysis, and consultation for this project.

Archival Research

In addition to resources provided by KS—as described in more detail directly below—other materials for this project, including archaeological reports and other books, journal articles, historic maps and aerial photographs, Hawaiian newspapers, and Land Commission documents, were obtained at the following specific archival repositories:

- SHPD/ DLNR Library;
- UH-Mānoa Library website (http://magis.manoa.hawaii.edu/maps/digital/quads.htmlUH);
- UH-Mānoa, The Oceania Digital Library website (http://evols.library.manoa.hawaii.edu/ handle/10524/18844);
- OHA Papakilo database (http://papakilodatabase.com/main/index.php);
- Land Survey Division at the State Department of Accounting and General Services (DAGS) website (http://ags.hawaii.gov/survey/);
- Hawai'i State Archives;
- Ulukau website (Hawaiian language newspaper archives) (http://nupepa.org/);
- USGS website (http://geonames.usgs.gov/pls/topomaps/f?p=262:1:981281919519692).

KS provided numerous historic maps and aerial photographs, selected information on land use and tenants during the middle to late 20th century, and Land Commission data.

Translation and interpretation of Hawaiian language documents was provided by Associate Professor of Hawaiian Language and Literature Elizabeth Kahikahealani Wight, M.A. (Kapi'olani Community College). Kumu Wight primarily worked with two types of documents provided by Monahan: (1) Land Commission records for approximately 20 kuleana holders in the immediate vicinity of Lokoea; and (2) Hawaiian language newspaper excerpts based on key word searches (and all conceivable spelling variations) including Ihukoko, Kamani, Laniwahine (and Laniwai), Le'epoko, Lokoea, Māeaea, Pua'ena, Puhi'ula and 'Uko'a. Most of these are places names with obvious relevance to the project area. Some of these (including Ihukoko and Le'epoko) are mentioned in passing by 19th century writers such as Kamakau and 'Ī'ī. In general, only the most relevant results are reported here. We do not spend a lot of time systematically reporting negative findings regarding our searches of Hawaiian language documents. We do not claim to have exhausted all efforts regarding this topic, which, in time, will no doubt yield additional relevant evidence.

Fieldwork

The fieldwork was conducted in two phases. The first phase took place from January to May, 2013. On January 10, 2013, the Principal Investigator (Christopher M. Monahan, Ph.D.) conducted a brief reconnaissance of the project area in advance of formal fieldwork, which began on January 15, 2013. The bulk of the Phase 1 fieldwork took place sporadically over the next two and a half weeks. Monahan conducted additional fieldwork (primarily excavation of TU-4) on February 28 and March 1, 2013. Doug Thurman, B.A., conducted one additional day of fieldwork—completing cross-section elevation drawings of Features 1 and 2 and plan view drawings of Features 5 and 6—on May 17, 2013. Altogether, the Phase 1 fieldwork consisted of approximately 12 person days. All phases of the fieldwork were designed and conducted by Chris Monahan, and assisted by Doug Thurman, B.A., who has seven years of archaeological experience in Hawai'i and additional, previous experience on the U.S. mainland.

After analyzing and synthesizing the results of the Phase 1 work, we requested (and KS agreed to) additional funding for a second round of excavation, the Phase 2 fieldwork, which was carried out by

Chris Monahan, Doug Thurman and Malia Evans between September 29 and October 11, 2014. We worked a total of 10 person days on the Phase 2 fieldwork.

The entire ground surface of the project area, which includes the pond margins and all of its internal structures and features, was inspected for archaeological and other features.

A plan map to scale of the entire approximately 7.0-acre project area was produced using a combination of tape and compass and a laser distance/ range finder and compass. Several smaller-scale (detail) plan view maps were also made of individual features. Later, on the computer, these maps were drafted using Adobe Illustrator. We mapped all relevant features discussed in the text, including those that are *not* historic properties, so that the document could serve as a useful land management tool for KS going

Subsurface testing (hand excavation) was conducted at five main locations (these are depicted in maps described in the Results section below): (1) near the midpoint of the long wall (Feature 1) defining the northwest portion of the pond (TU-1)—this excavation was oriented perpendicular to the long axis of the wall right through its constructed core; (2) at the makai end of this same wall (TU-3 and TU-4)—these excavations were positioned to explore the point at which the constructed wall intersects with the natural Jaucas sand berm along the Kamehameha Highway; (3) near the east end of the shorter wall (Feature 2) separating the main pond from the 'Uko'a waterway—this excavation (TU-2) went right down through the constructed core of this wall; (4) on the north (TU-5) and south side (TU-6) of the central island (Feature 4); and (5) on top of the lithified coral bluff along the east side of the fishpond (TU-7 and TU-8).

In general, the objective of subsurface testing was to determine construction methods and constituent materials of these features and areas; and to recover physical evidence of building phases, site occupation and dates thereof (relative and absolute), if possible. More specific objectives for each test unit are also described in the Results section below.

All excavations were dug entirely by hand using a shovel and trowel. We were prepared to pass excavated sediments through a standard 1/8-inch metal screen if we encountered traditional-style artifacts or midden; or if we encountered discrete subsurface features that might contain such materials. We did expose several important subsurface features, but nearly all of these were relatively large, structural features, rather than the types of archaeological phenomena that lend themselves to screening. We conducted limited screening of some sediments in several test units including TU-2, TU-6, TU-7 and TU-8.

We used a sump pump to suction off standing water in the bottom of two excavation units in order to investigate the soil-sedimentary stratigraphy at and below the water table.

Excavation was conducted by arbitrary 10-cm levels in all test units. Soil-stratigraphy was described and interpreted by layers using standard archaeological criteria based on USDA soil scientific classification and terminology. The base of excavation was defined by the first 10 cm or so of the water table. For the current project, nearly all sediments encountered were culturally-introduced (e.g., as part of wall-feature construction), rather than naturally-occurring because excavation was conducted through humanly-constructed features; this is in stark contrast to most archaeological excavation in Hawai'i, where natural sediments generally predominate, interspersed with less abundant cultural deposits and features.

Finally, in regards to field methods, the quotation by Kent Flannery in the opening pages of this report ("Archeology is the only branch of anthropology where we kill our informants in the process of studying them") is not only witty but true: a major factor we had to consider when deciding *where* to excavate was how best *not* to damage or destroy an active fishpond. So, for example, when digging a trench (TU-1) that cross-cut the main wall (Feature 1), we were motivated to get as close to its structural edges along the main pond on one side and the stream on the other, without at the same time being responsible for blasting a breach in the structure and emptying half of the pond into Waialua Bay! Thus, while a lot of thought and planning went into the placement of each excavation unit at Lokoea, it is possible that we may have missed something significant by inches or feet if we had moved our units ever so slightly. At all

times, however, our decisions were ultimately guided by concerns for the health and safety of Lokoea and all those who live and work at and near the pond. All factors being equal, the amount of information we were able to extract from the excavations is quite remarkable.

Consultation

On December 20, 2012, a consultation letter was transmitted to the SHPD/ DLNR and OHA (see Appendix A). The purpose of the consultation letter was to provide notification that the proposed project could affect historic properties of interest to these agencies, and to seek their views on the identification, significance evaluations and mitigation treatment of these properties. The consultation letter also made it clear that the primary consulting party for this project was the MLEF. TCP Hawai'i committed to transmitting a draft report to OHA and SHPD/ DLNR upon completion of the AIS. OHA, which responded in writing to our consultation letter, indicated support for the project and hoped that additional consulting parties would be part of the process moving forward.

Representatives of MLEF, primarily James Estores and Jessica Casson, were involved in various aspects of the fieldwork; and provided valuable information about the project area. We had numerous discussions about the results of the AIS as the work proceeded. Both James and Jessica were provided copies of this draft AIS for their review and comment, and in anticipation of completing the Archaeological Site Preservation and Development Plan for Lokoea.

Laboratory Analysis

When we found a wooden artifact in excavation, we sent photographs to several individuals and institutions with expertise in identifying such objects, including Professor Patrick Kirch (University of California-Berkeley), Mr. David Shideler (Cultural Surveys Hawai'i, Inc.), Ms. Betty Kam (Collections Manager, Bernice P. Bishop Museum), Mr. Kai Markell (Office of Hawaiian Affairs) and Dr. Susan Lebo (SHPD/ DLNR). Most of these individuals responded with various interpretations of what this object might represent.

After studying the object for some time and considering its likely utilitarian (rather than ritual) function and significance, we decided—in consultation with KS—to submit a small sample (0.22 grams) of the wood to the Wood Identification Laboratory at International Archaeological Research Institute, Inc. (Honolulu). This sample was subsequently submitted to Beta Analytic, Inc. (Miami) for radiocarbon dating (AMS method). The results of these analyses are described below (see Laboratory Results). We also sent a wood charcoal sample for taxonomic identification from a subsurface fire place feature in TU-6. Because it was identified as Douglas fir, we did not send it for radiocarbon dating.

Curation

Two small bags of portable artifacts—nearly all of which is Historic-era trash including glass, ceramic and metal fragments—were collected from two excavations (TU-1 and TU-2). One other portable object—the wooden artifact recovered in TU-1—was also collected. We also collected and saved artifacts from TU-5—the only traditional Hawaiian artifacts found on this project. All of this material is being temporarily stored at TCP Hawai^ci, but will eventually be transported to KS for permanent curation.

CULTURAL CONTEXT

The companion Preservation Plan for Lokoea explores some of the topics in this section in more detail. The primary objective here is to focus specifically on culturally-significant information about Lokoea, in particular, as it may inform the AIS work.

Lokoea and 'Uko'a as an Integrated System

In her memoir about living at Lokoea in the early 1980s, Wyban (1992:3) makes the point that it is probably best to think about both Lokoea and 'Uko'a as components of one traditional system or entity, dependent upon each other and linked at all levels; and, that many cultural and historical references to 'Uko'a are, in her opinion, actually describing specific features at Lokoea. We believe the latter assertion may be a bit of an overreach—in reality, it is hard to connect *specific* places on the ground at Lokoea (or 'Uko'a, for that matter) with any *specific* cultural or historical references.

For example, Wyban (1992:3) states that a cave along the eastern edge of Lokoea (in the current study, this cave has been designated Feature 5 or the "south cave") is the home of Laniwahine and her brother Puhi'ula (Figure 8). She cites an entry from the *Saturday Press* (August 25, 1883 edition), a short-lived (1880–1885) Honolulu-based newspaper published by Robert Grieve (Sterling and Summers 1978:120).⁵ Under an entry for "Ukoa" in its "Dictionary of Hawaiian Localities" section, it reads "[t]here is a large circular hole at the head of the pond commonly credited as the home of Laniwahine, the sister of Puhiula, children of a goddess of ancient Hawaiian Mythology." Thus, it does not really state that the cave was at Lokoea: it says a "circular hole" at "head" of 'Uko'a. Even if 'Uko'a is taken to mean the entire Lokoea-'Uko'a system, it may also be that the "head" refers to 'Uko'a proper, and may signify the equally famous location of the pumping station ("pump 4") at the east end of 'Uko'a. This place is associated with an oft-referenced subterranean passage to the sea (directly from 'Uko'a, rather than via the Lokoea Stream) and a fresh water spring. In short, it is probably more of a hypothesis, rather than a historically-based fact, that the cave at Lokoea is, in fact, the home of Laniwahine.

We are not making this point to be argumentative, but, rather, to set the record straight for those who depend on academic and professional research to inform them about what is known about this place. Regardless of whether we can identify Laniwahine's home or not, this cave is a most unusual phenomenon—and certainly qualifies as a significant wahi pana. There is no doubt it would have been a revered and protected place to Kānaka Maoli as long as there have been people at Lokoea. The naturally-placed, weathering basalt blocks upon which the lithified reef rests contributes to a sense or feeling about the place that is inherently magical or mystical.

In the final analysis, Wyban's overall point is well taken: that two ponds of 'Uko'a and Lokoea were really connected as a single entity in Hawaiian traditions, hearts and minds.

Thinking about Place Names

Lokoea is translated by Pukui et al. (1974) as "rising pond."⁶ We have never seen any nuanced interpretation of this literal translation, exploring its possible kaona (hidden meanings), but we believe it may refer to and reflect the pūnawai, fresh water springs emanating from the caves along its northeast side. Thus, this place name may signify and celebrate the "rising waters" that contribute to Lokoea's wai—along with 'Uko'a's kahawai (stream).

⁵ According to the digital newspaper archive "Chronicling America, Historic American Newspapers" (<u>http://chroniclingamerica.loc.gov/lccn/sn82014681/</u>), sponsored by the National Endowment for the Humanities and the Library of Congress, the *Saturday Press* was "the whitest of the white men's newspapers," staunchly anti-monarchy, pro-American, and mostly written by the prolific chronicler of Hawaiiana, Thomas G. Thrum.

⁶ Incidentally, Pukui et al. (1974:133) state there is another fishpond called Lokoea in Waipahu.

We are unaware of any specific interpretation of the name 'Uko'a, but, having spent several months now thinking holistically about the entire 'Uko'a-Lokoea pond and stream system, we are struck anew by the name of the ahupua'a they share, Ka-wai-loa, literally "the long water," which brings to mind the more than one-mile-long waterway and Kamakau's description of this system as the "long house" of its famous mo'o Laniwahine (Kamakau 1991:84). In this context, it interesting that, despite changes in ahupua'a names and boundaries over time in Waialua Moku (and many other places on O'ahu), these two connected ponds have always been part of Kawailoa proper (Figure 9).

Lokoea's Place in Hawaiian Traditions

Handy and Handy (1972:466), echoing a common understanding about the value and importance of Lokoea in the wider context of Waialua, wrote the following:

Two large fishponds were among Waialua's greatest assets. Ukoa was a long, narrow fresh-water pond about a mile in length. Laniwai (Sky-water) was its *mo*'o guardian. With her lived her brother, Puhi-'ula (Red-eel). The pond was said to be connected with the ocean by a tunnel, through which the *mo*'o would go to bathe in the sea (McAllister, 1933, p. 142). Another pond named Lokoea is mentioned elsewhere (*Ku*'oko'a, November 5, 1864) but this is not described by McAllister.

Alameida (1994), interpreting John Papa 'Ī'ī's *Fragments of Hawaiian History* (1959:98)—which 'Ī'ī originally wrote as a series of articles in *Nupepa Kuokoa* between 1866–1870 and which in this case refers to his recollections from around 1810, erroneously suggests Lokoea was directly associated with, and next to, an old village called Kamani, which was separated from the Anahulu River by a boundary wall. In the passage quoted by Alameida, however, 'Ī'ī does not refer to the pond at Kamani by the name Lokoea—Alameida (1994:32) inserts this name in brackets. 'Ī'ī goes on to say that "[o]n the opposite bank [from Kamani] lies Maeaea, a sandy beach with a canoe landing . . . ," making it clear that Kamani is actually on the south side of Anahulu, not the north (Figure 10). Furthermore, 'Ī'ī continues his narrative to specifically discuss "Ukoa and Lokoea" clearly as distinct from "Kamani, a village with a pond" in the previous paragraph. This clarification of Alameida's writing is important, among other reasons, because it argues against the misunderstanding that Lokoea was once a walled fishpond.

 ${}^{\circ}\overline{1}$, in the same passage as cited above, also stated that there were "many homes about . . . the ponds of Ukoa and Lokoea," and that the main coastal trail passed closely to the "sluice gate of Lokoea." As we will revisit and discuss throughout the report, and because the archaeological evidence we have uncovered is somewhat ambiguous on this matter, this latter bit of information is extremely important in establishing the antiquity of the gated pond at Lokoea. His matter-of-fact mention of the sluice gates at Lokoea around 1810 leaves us to conclude that this structure must have been a pre-Contact feature of the landscape, otherwise he would have describe it in very different terms. Completing this piece of relevant writing by ' $\overline{1}$ ' $\overline{1}$, he also mentions the nearby house of Kuokoa, an important local figure whose Land Commission Award was in Lot 1 of the QLT lands abutting the southwest side of Lokoea.

As discussed in the next section (Historical Context), if settlement patterns as revealed by Land Commission documents generated from the Māhele of the middle 19th century are any indication, Lokoea was a veritable hub of habitation in traditional times with dozens of house sites scattered around the south and east sides, in particular.

Mo'olelo (Legendary Accounts) about Lokoea and 'Uko'a

There are many moʻolelo about Laniwahine at Lokoea and 'Ukoʻa. Pukui et al. (1974:214), citing Nathaniel Emerson and ' \overline{I} ' $\overline{1}$ ', refer to her as a moʻo for whom many people left offerings; and recounts how she was known to swim to the ocean by way of an underground tunnel.

An October 19, 1867, edition of *Nupepa Kuokoa*, describing an account of Queen Emma Kaleleonālani's visit to 'Uko'a and Lokoea, described Lokoea and 'Uko'a as "na lua" of Laniwahine—literally, pits or



Figure 8. Cave ("south cave" or Feature 5 in the current study) interpreted by Wyban (1992:3) as the home of Laniwahine, view east; scale = 1 m



Figure 9. Comparison of older (pre-Contact) ahupua'a names and boundaries with Historic period names and boundaries shows Lokoea (red arrow) has always been considered part of Kawailoa (top map prepared by Kamehameha Schools, bottom map from Sterling and Summers 1978)



Figure 10. Portion of map by Sterling and Summers (1978) depicting some significant archaeological sites, wahi pana and places names in and near the project area; note location of Kamani (red arrow) below (south of) Anahulu River

holes, but which can also be translated in the context of the newspaper article as "depositories" or "craters," according to our Hawaiian language translator, Kahi Wight.

In some versions, Laniwahine is described as a shark or a shark god, with her companion Puhi-ula, who not only resided at 'Uko'a but who traveled through a subterranean passage (perhaps a lava tube) to the sea (Sterling and Summers 1978:118).

Kamakau (1991) had quite a lot to say about Laniwahine in the context of his explanation of the various mo'o forms in Hawaiian tradition, referring to her as an example of a mo'o akua and kia'i (guardian) of 'Uko'a. He stated she was often seen—and still was seen at the time of his writing (1866–1871)—by people at a place he referred to as "Ihukoko at 'Uko'a." Our research found that "Ihukoko" was the name of a mo'o (narrow strip of land, smaller than an 'ili, also known as mo'o 'āina) mentioned by Maio in LCA claim 10199 (2768) near 'Uko'a proper.

There is also a lot of mo'olelo about the strange and mysterious fishes of 'Uko'a as well as the exploits of Laniwahine, "the *kama'aina* woman of Uko'a," a full accounting of which is beyond the scope of this AIS (see Kamakau 1991:84).

Much of the Laniwahine lore seems to revolve around her ferocity and the extent to which people feared her. Kamakau (1991) goes into detail on this topic, and Wyban (1992:6–7), writing about the 1980s, remarked that many people still talk about the influence and presence of Laniwahine at 'Uko'a.

'Ōlelo No'eau about Lokoea and 'Uko'a

In our search of Hawaiian language newspapers for "Ukoa," we found numerous references and variations on the following saying, as reproduced in Pukui's (1983:301) '*Ōlelo No 'eau:* Pupuhi ka i'a o Uko'a (The fish of Uko'a is gone), which she interprets as "[s]aid of one who takes flight or of something quickly and secretly taken." At one time, this seems to have been a common saying, and one that might be worth looking into in more detail.

In reference to a great battle at the time of Kalani'opu'u, Kamakau (1992:87) refers to the "the mullet driven by the sound of beating into the sluice gate of 'Uko'a," as a metaphor for the great number of men killed.

Lokoea as a Traditional Cultural Property

Figure 11 is a heuristic, or organizing, device—developed by the first author during previous studies of Kamaile (Wai'anae) and Waimea (O'ahu) (see Monahan and Silva 2007; Monahan 2009, respectively)— that, when applied to Lokoea, illustrates the intersection of landscape and history. This is a powerful conceptual paradigm that reflects a uniquely Hawaiian way of comprehending a resource such as Lokoea where many lines of evidence and inquiry can be brought to bear on its cultural and historical significance. These diverse data sets derive not only from scientific perspectives (e.g., archaeology, biology and geology) but also from the humanities (e.g., oral-historical accounts, cosmology and cosmogony), including religion and spiritualism (e.g., mo'o narratives and beliefs). This paradigm is useful in the context of the AIS for remembering the interconnections between diverse data sets and observations, but it is most especially relevant to the companion Preservation Plan for Lokoea.



Figure 11. Lokoea is a Traditional Cultural Property (or Place) as well as a Wahi Pana (or Kahiko). It can be most effectively understood, and the information organized and expressed, by considering the pond as a Hawaiian example of the intersection of landscape and history

HISTORICAL CONTEXT

Since this is an archaeological study, rather than a history of Lokoea, per se, this section is *not* a systematic review of the history of Kawailoa Ahupua'a or Waialua Moku. Rather, this is a selective collection of historical information and perspectives about Lokoea that may help enhance our understanding of its archaeology.

No history of this project area would be complete without first mentioning Kamakau's (1992:192) statement that Kamehameha I famously worked the fishponds at 'Uko'a on one his "working the land" tours around O'ahu.

Nineteenth Century Tidal Waves and Tidal Surges

A search of Hawaiian language newspapers yielded first-hand accounts of tidal waves in 1839 and 1867. Two accounts in *Ke Kumu Hawaii* describe an event that started on January 28, 1839:

A tidal wave at Waialua and Ko'olau on the large meeting day [$l\bar{a}$ noa, interpreted as perhaps a temperance meeting], that is the 28th of January. The sea flooded the ponds of Lokoea and Ukoa and also flooded some outhouses [or house pits] on the edge of the stream and at Pua'ena also some house sites were destroyed. (Written by Emekona, *Ke Kumu Hawai'i*, February 27, 1839)

The passage continues to describe the damaging effects of the tidal wave at Waiale'e, on the other side of Waimea, closer to Kahuku, and notes that the taro patches were flooded and ruined due to the salt water; all the taro had to be pulled up, and the land was close to famine. This account also notes that the people had not experienced a tidal wave like this for many years, and that the old men have seen the rise up this in very old times, but not often.

The second account of this same event from Ke Kumu Hawai'i reads in part:

Ke Kumu Hawaii, I am telling you the things I heard and saw about the tidal wave. As for me, the things I heard at Waialua, O'ahu. The sea at Waialua rose up with a great roar. The cliffs "spoke" differently, there were moans as if coming from a wild pig. . . At Waialua the sea undermined the land. . .

On the 28^{th} of January, Ko'olau loa folks returned from the large meeting [lā noa] while Wai'anae folks stayed to talk with the teacher. That was indeed the day that the ocean began to rise. On the next night at midnight there were very large waves. The ocean then broke on the sand up to Lokoea. A wave rose and flooded Ukoa and then spread out to some houses below, however they did not fall down.

After describing damaged and destroyed houses and taro patches on the other side of Waimea (at Pūpūkea and Waiale'e), the question of whether folks had heard of such events in the past was mentioned:

When I asked some old folks have you folks ever seen a tidal wave? One said yes, I saw two tidal waves in the time of Kahahana, and in the time of Kamehameha that's how the ocean was. (Written by Kaiaikawaha, *Ke Kumu Hawai'i*, March 13, 1839)

An account in Nupepa Kuokoa of a tidal wave in 1867 specifically mentions fishpond gates at Lokoea:

On the sixteenth of this month a tidal wave arrived. When you looked seaward rocks were exposed. Huge ocean waves rose and then covered the length and breadth [ka loa me ka pa'a] of the well-known sand of Maeaea and flooded the fishpond gate at Lokoea. As to the auwai of Ukoa pond outside Lokoea [that is, the stream connecting these two ponds], it was covered with sand. However, the fish of the pond were not disturbed because "the fishpond gates are firmly guarded." (*Nupepa Kuokoa*, November 30, 1867)

Another destructive event, possibly a tidal surge rather than a tidal wave proper, was reported under the headline "Tidal Wave at Waialua" in the English-language *Evening Bulletin* in 1899:

There was a tidal wave at Waialua on Sunday last which did considerable damage. The water began to rise at 3 o'lock [this is not a typographic error; this is how it appears] in the afternoon and by night it was very high. The water swept into the fish ponds at Ukoa, across the bridge from the Waialua hotel and cleaned out the fish so that many natives of the district went out and gathered up the fish that lay stranded on all aides. This was one of the places where the "ill wind" story, told of old, was practically demonstrated. This water from the river in front of the Waialua hotel that flows into the sea near the hotel, rose to such an extent that the top part of the stone wall makai of the billiard room, was quite severely damaged. The water subsided during Monday night. The natives of the district were very much exercised. Some said the rise of the water was caused by the high surf but others contend that it was a genuine tidal wave. (*Evening Bulletin*, vol. VII, no. 1302, Dec 2, 1899)

Queen Emma's Visit to 'Uko'a and Lokoea in 1867

In its October 19, 1867, edition, *Nupepa Kuokoa* published an account of Queen Emma Kaleleonālani's visit to 'Uko'a and Lokoea, paraphrased here.⁷ The article describes the ponds as being "at Ke'ehukai" (literally, "the sea spray"). Under a new konohiki, men, women and children worked to clear out bulrushes from the ponds and from the "auwai" to 'Uko'a. The debris from this work was seen in the ocean by the caption of the sloop Wailele, which implies there must have been a considerable amount of vegetation removed. The Queen at this time was advised by kama'āina folks to visit the ponds in the early morning as that was the best time to see them. The ponds are mentioned as "na lua" of Laniwahine, literally pits or holes but which can be translated in the context of the article as "depositories" or "craters."

Some Early Maps that Include Depictions of Lokoea

Several historic maps that are not particularly accurate regarding the location or configuration of Lokoea are nonetheless worth a brief mention for the small bits of information they provide.

Interestingly, Ursula Emerson's 1833 map shows the 'Uko'a-Lokoea system as a series of three ponds (Figure 12), the northernmost of which corresponds with the location of the pump station shown in later USGS maps (e.g., see Figure 20 for 1929 map). Emerson's 1833 map is also instructive in that it labels the entire three-pond system, the southernmost of which corresponds with Lokoea, as "Ukoa." This depiction supports one of the main conclusions of this AIS: that both ponds and the wetlands between them should be considered as components of a single historic property known as the 'Uko'a-Lokoea Fishpond Complex.

Monsarrat's 1876 map (Figure 13) has a single pond only in the general vicinity of Lokoea.

A U.S. Hydrographic Office map from 1891 shows details of the area surrounding Lokoea including the swamp lands leading up to 'Uko'a and some structures around the east-northeast and southwest (QLT parcels) margins of the pond (Figure 14). This map also shows the Governor's house was in or near the QLT parcels.

⁷ Scott's *The Saga of the Sandwich Islands* (1968:766) claims Queen Emma's "famous tour" occurred in November 1875; not sure if this is different or an error somewhere.



Figure 12. Portion of Registered Map 445, Surveyor Ursula Emerson, 1833; note, the 'Uko'a-Lokoea system is depicted as a series of three connected ponds; the northernmost corresponds with the location of the pump station shown in later maps


Figure 13. Portion of Registered Map 320, Surveyor Monsarrat, 1876



Figure 14. Portion of Registered Map 2095, Surveyor U.S. Hydrographic Office, 1891

Land Commission Data and Maps Illustrating Residency Patterns around Lokoea

Lokoea and its surrounding lands are part of larger ali'i award (LCA 7713:33, RP 4475) to Victoria Kamāmalu (1839–1866), described as the "lord of Waialua" in her time (Sahlins 1992). Table 1 is a summary of observations about 18 kuleana holders around Lokoea. There is a relatively large amount of information, albeit mostly relatively general in nature, about the numerous houses sites that were densely packed around Lokoea at the time of the Māhele (Figure 15 through Figure 17). It is interesting to note that a few people mention the presence of other, smaller inland fish ponds just east and northeast of Lokoea. As well, a couple people state their family members were buried near some of these parcels.

Some landscape attributes shown on Figure 15—including the location and extent of the marshlands south of Lokoea, and the location and orientation of the small fishpond wall heading east from the central island—are discussed in more detail later in this section.

It is somewhat difficult to discern, but Edwin Locke's drawing of the Kawailoa lowlands from the early 1840s (see Figure 16) may depict rock walls around the west (Kamehameha Highway) and south (QLT parcels) sides of Lokoea. Today, there is no evidence at the ground surface of rock walls around Lokoea, and none of the other available graphics (historic maps and aerial photographs) show any rock walls. A careful reading of the Land Commission documents, including the survey notes and descriptions of the kuleana awards for the QLT parcels, shows no description of rock walls along the Lokoea pond side (e.g., when people describe parcel boundaries on the pond side, they simply say "bordered by Lokoea pond"). McAllister's circa 1930 observation of Lokoea states there were no rock walls around it either. Therefore, it would appear that, if Locke's drawing depicts rock walls, they were destroyed or possibly buried by later historic land alterations. Based on our analysis of all available evidence, we believe there never were rock walls around the west and south sides of Lokoea.

Table 2 is a summary of fish species mentioned in Land Commission documents compared with data from the 1980s (Wyban) and current conditions. In general, this information shows that in current and modern times there are and have been many more varieties of fish in the fishpond than when it was actively maintained by Hawaiians in the middle 19th century. This is not surprising and reflects the difference between a fishpond managed according to traditional Hawaiian practices versus contemporary approaches based on other considerations such as purely market economic forces. Wyban (1992), for example, describes various initiatives she and her husband tried to raise certain alien species at Lokoea.

Table 1. LCAs Adjacent to and Near Lokoea Fishpond*

LCA	' Āpana	Acres	RP	Name	Location	Comments
2699	4	0.20	876	Wewehi	Western margin of pond adjacent to Lokoea Road. Part of QLT Lands (part of Lot 1)	Written as "Wewehi no Keawehunahula" on some maps Awards. Keawehunahula is Wewehi's child according to end of this parcel on 1923 BPBE map
	5	0.12 or	876	Wewehi	East and mauka of pond along its margins; this small parcel is described as a "pond	According to BPBE survey maps, this is Wewehi's 2 nd
		0.14			by Lokoea" by Wewehi; this is adjacent to the SE to the "south cave" at Lokoea	depicted in Sahlins 1992:210)
2725	2	0.20	1470	Puhi	Southwest margin of pond adjacent to Lokoea Road	Appears not to be part of QLT lands but is sandwiched b
2740	2	0.23	5088	Paku or Poku	East-northeast and mauka of pond along its margins	Paku according to Sahlins (1992:210). Indices of Award "Paku."
2896	4	0.31	1466	Kamakea	South side of Lokoea Road along Anahulu Stream; abutting QLT Lot 3 to the east	Shares a boundary with Koiniho's parcel
2926	1	0.39	1474	Kahakai	North of pond along water course connecting with 'Ukoa. 'Ukoa 'Ili. Part of a contiguous set of lots in Nauahi's main complex. Kahakai was ''an old Oahuan whose roots go back to pre-Kamehameha days and who inherited land in his own right, but acknowledged holding a residence 'inside the enclosure of Nauwahi, a <i>kuleana</i> in the capacity of a hoaāina [that is, a tenant farmer type of relationship]' (Sahlins 1992:209).	Kahakai claimed 6 'āpana but received only 4, including Kahakai claimed rights to fish including 'o'pu, 'ōpae, lir by Waihona 'Aina] and "certain fish to which there is a r (NR 696 v3). Kahakai claimed his lands from his parents and Kuokoa testified on Kahakai's behalf (erroneously e Testimony describes the makai boundary of his house lo (south in this case) boundary.
2927	3	0.56	1465	Koiniho	South side of Lokoea Road along Anahulu Stream; abutting QLT Lot 3 to the east. Those testifying on Koiniho's behalf (Kuokoa and Nauahi) state the 'ili is Lahuimawaho.	Sometimes written as Kainiho. He describes 7 'āpana bu Anahulu Stream (he lists this as 'āpana 7 but it was recor described by his two testifiers Kuokoa and Nauahi). Koi that his lands date from the time of Kamehameha (NR 69 than 6 or 7) 'āpana, and that the first two date from Kam Kahalau in the time of Kinau. Interestingly, the house lo different from Koiniho's description. LCA incorrectly w
3373B	3	0.26	2895	Kahuna	Southwest margin of pond adjacent to Lokoea Road	Part of QLT Lands (part of Lot 1)
3790	3	0.62	1462	Olopana	North of pond. Part of a contiguous set of lots in Nauahi's main complex.	Part of a contiguous set of lots in Nauahi's main comple
3942	5	2.10	880	Nauahi	North of pond	Nauahi or Nāuahi described by Sahlins (1992:208–211) Application 1615. Some survey maps depict this LCA as spells it "Nauwahi."
3940	2	0.27	877	Napunawai	East and mauka of pond back a bit from the margins of the pond	Shares a boundary with one of Kolikoli's parcels. Accor brothers.
4306	2	0.85	1476	Kolikoli	East and mauka of pond back a bit from the margins of the pond. Wewehi's description of his (Wewehi's) 'āpana 5 claims it was next to another pond of Kolikoli's at this location. Kolikoli's entire 'āpana 2 is described as a pond.	According to Sahlins (1992:210), Kolikoli had another p notes, Napunawai and Kolikoli are brothers. Kolikoli say by agreement."
7342	8	0.15	1478	L. Kuokoa	Western margin of pond adjacent to Kamehameha Highway	Part of QLT Lands (part of Lot 1); small structure depict Kuokoa had another Royal Patent (no. 1479) for other la
7404	2	0.21	1459	Kealohaio	North of pond	'Āpana handwritten in as "4" on 1949 BPBE survey mag
7418	2	0.51	1471	Kaaiawa (Kaeawa) or Aiawaka	East-northeast and mauka of pond along its margins	According to Sahlins (1992:209), Kaaiawa's parcel with is not contiguous with the main Nauahi complex; Sahling to Liholiho's time, as granted by the former konohiki Ka
7424	2	0.33**	1475	Kawiwi	North of pond	Part of a contiguous set of lots in Nauahi's main complete
7722	2	0.33	None	Hookala	North of pond	Part of a contiguous set of lots in Nauahi's main comple Waialuan
9917	1	0.78	2893	Lohe or Loke	North of pond along west margin of 'Ukoa Pond near Kamehameha Highway	Name spelled differently on different maps; it's Lohe act "Lohe." This individual appears to have gotten another F
10769	2	0.25	2891	B. Pole	North of pond along west margin of 'Ukoa Pond near Kamehameha Highway	NR 586 v4 says "B. Pale," and also "Paele."

Notes:

1. LCA = Land Commission Award, RP = Royal Patent, QLT = Queen Lili'uokalani Trust, BPBE = Bernice Pauahi Bishop Estate

2. * Lokoea and surrounding lands are part of larger ali'i award LCA 7713:33 (RP 4475) to Victoria Kamāmalu (1839–1866), described as the "lord of Waialua" in her time (Sahlins 1992).

3. ** This is an estimate based on visual inspection of maps; unable to find it confirmed in written records.

s—says "Wewehi for Keawehunahala" in the Indices of the RP survey notes. Two small structures depicted at north

āpana around the pond, although this ownership is not

between Lots 1, 2 and 3 of QLT lands Is says "Paku oia o Peku." NR 615 v3 says "Peku." RP says

g his small house site ('āpana 1) adjacent to Nauahi's. mu kala [in this context, this is interpreted as "surgeon fish" right at the time when they can be caught, such as 'anae" is from before the time of Kamehameha I (ibid.). Makuaeu entered as Foreign Testimony) recognizing only 3 'āpana. ot as "Ukoa" and the presence of a road as the Wai'anae-side

at was only awarded 6, including his house site along orded as 'āpana 3, which is consistent with how it was iniho states he was a native-born resident of Kawailoa and 96-697 v3). Kuokoa and Nauahi state Koiniho had 4 (rather nehameha I, the third (his house site) was gotten from ot description provided by Kuokoa and Nauahi is quite written as "2972" on Royal Patent.

x; part of the well-known Olopana mā as a local "big man." This LCA part of Land Court s 3842, but 3942 appears to be correct. Indices of Awards

ding to RP survey notes, Napunawai and Kolikoli are

barcel just east-northeast of this one. According to RP survey ys 'āpana 2 "embraces a lake [pond] belonging to Napunawai

ted at north end of this parcel on 1923 BPBE map; L. ands in other places.

p (I believe this in as error).

n residence was part of Nauahi's complex, but Kaaiawa's lot is (1992:209) also states Kaaiawa's rights to this land go back ahalau. NR 333 v5 says "Kaeawa."

х

x; according to Sahlins (1992:209), Hookala was an old

cording to Sahlins (1992). NR 489 v4 says "Lohi." RP says Royal Patent (no. 3418) located elsewhere.



Figure 15. Portion of KSBE map dated 1938–1942 georeferenced to project TMK; this map retains abundant land tenure data from the Māhele, as well as information about the location and configuration of man-made structures and the marsh in the southern portion of Lokoea

Cattle Jun Boys' armitmies Buyan Mill Him take 20.6 Pa AAAA 120 0 0 2 2 1 Stan Salah Thistin Date Sam

Figure 16. Lower Anahulu River and Waialua Bay, 1842 or 1843, by Edwin Locke, showing Lokoea (B) and 'Uko'a Fishpond (A); note connection (linear feature) between the ponds (Sahlins 1992:174)



Figure 17. Graphic representation of most of the kuleana holders around Lokoea based on Land Commission documents research (Sahlins 1992:210)

Name				Time Period		Comments ^{4, 5}	
Hawaiian	Common	Linnaean	$19^{\text{th}} \text{ c.}^{1}$	$1980s^{2}$	Current ³		
'A'ama	Type of crab	Grapsus grapsus tenuicrustatus			Х		
	Hawaiian flagtail (Wyban 1992:30					Young stage also known as āholehole. Nauahi describes his right to take fishes of '	
Āhole	refers to this as Striped Perch)	Kuhlia sandvicensis	Х	Х	Х	include the young āhole and mullet, which can be "taken at the season" (FF/VC).	
						Napunawai claimed the right to take two fishes [mullet and young āhole] "at the tir	
	Striped Mullet					Lokoea proper, he describes his rights "in the pond named Ukoa" to these and othe	
'Ama'ama	(Large, but not full-grown)	Mugil cephalus	Х	Х	Х	kala"). Wyban (1992:37) reports some other types of mullet, including Chelon eng	
						Kahakai—who lived outside Lokoea's gates/mākāhā along the waterway to 'Uko'a	
						time of eating" (KW), that is, when they are mature enough to take. Wewehi's testi	
'Anae	Striped Mullet (Full-grown)	Mugil cephalus	Х	Х		right to take fish; the right to take the anae is only in the windy times, that is when	
Awa	Milkfish	Chanos chanos		Х	Х	Wyban (1992:37) reports this fish was occasionally observed at Lokoea.	
Awa 'aua	Ladyfish	Elops hawaiiensis		Х		Wyban (1992:37) reports this fish was occasionally observed at Lokoea.	
Kākū	Barracuda	Sphyraenidae spp.		Х	Х	Wyban (1992:37) reports barracuda occasionally observed at Lokoea.	
Lae (or Lai)		Scomberoides sancti-petri		Х		Wyban (1992:37) reports this fish was occasionally observed at Lokoea.	
						* FF/VC interpret "limu kala" from various testimonies (e.g., Kahakai, Wewehi, N	
"Limu kala"*	Type of surgeonfish*	Acanthurus spp.	Х			for the seaweed it feeds on.	
Manini	Type of surgeonfish	Acanthurus triostegus			Х		
Moi	Threadfish	Polydactylus sexfilis		Х	Х		
n.a.	Tilapia	Various		Х	Х	Introduced/non-native. Wyban (1992:37-39) reports three varieties.	
						Kealohaio, like others, claims rights to take "gobey, fresh water shrimp full-gro	
						these fish on windy days [when the visibility is poor, FF]. Wyban (1992:32-34) not	
'O'opu	Goby varieties	Various	Х	Х	Х	Awaous stamineus but which Ziegler [2002:154] calls A. guamensis) and also goby	
'Ōpae	Native shrimp varieties	Various	Х	Х	Х	Wyban (1992:39) identifies two natives at Lokoea: 'Ōpae huna (Palaemonella sp.)	
Palani	Type of surgeonfish	A. dussumieri			Х		
Pualu	Type of surgeonfish	A. xanthopterus or A. mata			Х	Also spelled puwalu	
n.a.	Samoan crab	Scylla serrata		Х	Х	Introduced/non-native	
n.a.	To'au or Blacktail snapper	Lutjanus fulvus		Х	Х	Introduced/non-native	
n.a.	Tahitian prawn	Macrobrachium lar		Х			
						Young stage (i.e., less than 10 lbs, according to Wyban 1992:35) also known as pa	
Ulua	Jacks	<i>Caranx</i> spp.		Х	Х	Lokoea as the "white" ulua/pāpio (Caranx ignobilis)	

Table 2. Comparative Summary of Fish Varieties Reported from Land Commission Documents, the 1980s and Today

Notes:

1. Unless otherwise stated in the Comments column, 19th century data are from Māhele documents associated with the 18 kuleana recipients studied in detail for this study. In certain cases, it is possible to distinguish between comments about Lokoea versus 'Uko'a, specifically; in other cases, it is not possible to make such a distinction. This is important because about half of the kuleana parcels discussed in this study are located around the main pond at Lokoea—that is, within the gates/mākāhā separating it from both the ocean and from 'Uko'a—while the other half are closest to the waterway linking 'Uko'a with Lokoea—that is, outside of the gates/mākāhā to Lokoea. It seems to reasonable to expect there may have been taxonomic differences between the fish of these two ponds. Wherever possible, these distinctions are clearly noted in the table.

2. Wyban (1992) is the source for the data from the 1980s. Unless otherwise stated, her observations refer specifically to Lokoea proper, rather than the entire Lokoea-'Uko'a system.

3. The current data are from Mālama Loko Ea and refer specifically to Lokoea proper.

4. As noted above, interpretation/translation of Hawaiian documents by Vicky Creed (VC), Waihona 'Aina database (<u>www.waihona.com</u>); Kahi Wight (KW), Kapi'olani Community College (work performed specifically for the current study in 2013); Jason Achiu (JA), Hawai'i State Archives (translated in the 1980s); and Frances Frazier (FF), Hawai'i State Archives (translated in the 1970s).

5. Individuals who lived close to Lokoea but whose only description of rights to fish was to "Ukoa" include Napunawai, Kolikoli, Kaaiawa, and Paku (alternatively spelled Poku and Peku). Individuals who lived close to the mouth of the waterway entering Lokoea but outside of the gates/mākāhā that refer only to "Ukoa" regarding their rights to take fish include Kealohaio

'Uko'a with the 'eke, a bag-shaped fish net. These fishes

me they can be caught" (FF). Although he lived close to er varieties (also "gobey fish, fresh water shrimp and limu gli, were in the pond as well during the 1980s.

a—describes his right to take 'anae as a "kuleana for the timony regarding Lokoea specifically is that he had "a daily a they can be caught" (FF).

Napunawai) as a type of surgeonfish. FF says it was named

bwn mullet ['anae] and the aholehole." He said he could take bets the presence of 'O'opu nākea (which she identifies as y of another family (Eleotridae) at Lokoea.

) and 'Ōpae 'oeha'a (Macrobrachium grandimanus)

āpio or pāpiopio. Wyban (1992:ibid) identifies the variety at

Variability in the Size and Configuration of Lokoea through Time

Different types of historical images, including survey maps and aerial photographs, indicate a great deal of variation in Lokoea's size and shape throughout the 20th century. Observable variation seems to be related to several main factors: the amount of fresh water available from upland sources including 'Uko'a, which appears to have varied both naturally and artificially due to plantation activities; filling and stabilization of the south and east portions of the pond margin; and maintenance, or the lack thereof, of the waterways most critical to pond levels—that is, Lokoea Stream and the connection with 'Uko'a. All of these factors combined to create a complex and dynamic history of change (Figure 18 through Figure 28). After pointing out some relevant observations above these images, we present a synthesis culminating in Figure 29, which is a composite (overlay) of the fishpond margins from 1928 to 1969. These include aerial photographs from 1928, 1949 and 1969, and a land survey from 1938-42 by the Bishop Estate. The land survey map (see, e.g., Figure 22), in particular, highlights an important caveat relevant to interpreting the aerial images: sometimes what appears to be "not open water" is not necessarily dry land, but rather, vegetation-choked water (marsh). If the marsh vegetation were removed, in some cases at least, the aerial image would likely look quite different.

A 1909 map (see Figure 18) sketched by a military officer, Major E. Winslow, may not be entirely accurate and probably should not be interpreted too literally; however, it is interesting in that it depicts Lokoea as an irregularly-shaped marsh extending to the south—right down to Lokoea Place—and to the east—beyond the current TMK boundary to the mauka road. Its overall shape is unlike any other available image of the fishpond, although the southeastern extension of the marsh is similar to the Bishop Estate land survey map of 1938-42. Although rock walls are shown on either side of Lokoea Place, none are depicted in the vicinity of Lokoea's shoreline. This is consistent with McAllister's later (circa 1930) observation that Lokoea was not a walled fishpond. Finally, it is worth noting that the habitation area with coconut palms depicted on the east margin of Lokoea shows up as modified by mechanized farming in later aerial images.

A 1928 aerial photograph (see Figure 19) and USGS topographic maps from 1929 and 1935 (see Figure 20 and Figure 21) depict Lokoea in a state of severe disrepair. Compared with current and recent configurations of the fishpond margin, this circa 1928–1935 series shows an oddly-shaped Lokoea with a very small area of open water. As stated above, it is not always possible to tell the difference between marshy, vegetation-choked water and dry land, and this is particularly true of the 1928 aerial photograph (because it is such poor quality). However, it does appear that a wide area abutting the main gated wall (Feature 1) to the south-today this is open water in the main pond-is dry land as indicated by what appear to be worn footpaths (light-colored lines) radiating out from the northeast end of the wall towards the open water to the southwest. Given the wide expanse of water shown flowing down from the 'Uko'a waterway as well as the wide Lokoea Stream backed up against the current Jameson's parcel, it would appear these images indicate sluice gates that were not maintained and cleared of sediment, rather than low water level, per se. These images are consistent with totally blocked sluice gates along the main (Feature 1) wall structure. This time period appears to coincide with Lokoea being leased to Waialua Sugar Company, or a sub-lessee of Waialua Sugar, but records are incomplete. As discussed in detail below, the position and orientation of Feature 2 (the smaller wall connecting the central island to the east side mauka land), as shown in the 1928 aerial, is completely different from any other available image and from how it is situated today.

The 1938-42 land survey by Bishop Estate (see Figure 22) shows a vastly different Lokoea from the 1928 aerial. By this time, the fishpond appears to be functional again, with open water gates along Feature 1 and Feature 2 as well as between Lokoea Stream, the central island (Feature 4) and the 'Uko'a waterway. Clearly, a large amount of rehabilitation work went into transforming the fishpond from its 1928 to its 1938-42 condition. The position and orientation of the Feature 2 wall is completely different from the 1928 appearance, as discussed below.



Figure 18. 1909 military map including Lokoea from McGerty and Spear (2000:13); note, the label "Project Area" refers to SCS's work in the QLT lands; the margins of Lokoea are shown by the dashed line—here highlighted in yellow



Figure 19. Portion of 1928 aerial photograph supplied by Kamehameha Schools; poor quality of this image is related to the very large scale at which it was originally captured by the USGS; several key landmarks and features (discussed in more detail throughout the text) are indicated on the image



Figure 20. Portion of 1929 USGS 7.5-minute series topographic map Haleiwa Quadrangle (University of Hawai'i at Mānoa Library website, http://magis.manoa.hawaii.edu/maps/digital/quads.htmlUH)



Figure 21. Portion of 1935 USGS 7.5-minute series topographic map Haleiwa Quadrangle (University of Hawai'i at Mānoa Library website, http://magis.manoa.hawaii.edu/maps/digital/quads.htmlUH)



Figure 22. Portion of 1938-42 land survey by Bishop Estate (courtesy of Kamehameha Schools); north is to the left in this image—note, location of Kamehameha Highway across the bottom

Interestingly, the 1943 US War Department map (see Figure 23) appears to be inaccurate regarding the overall shape and size of Lokoea—assuming the Bishop Estate map from 1938-42 is correct. This USGS map likely just transposed the older Lokoea boundary without resurveying its margins.

A 1949 aerial image (see Figure 24) shows the construction of the makai-end gate along Feature 2 (the small fishpond wall heading east from the central island) was completed. This gate is not depicted on the 1938-42 Bishop Estate map, and thus, it appears to have first been built in the 1940s. The 1949 image also shows the south and east sides of Lokoea had not yet been artificially straightened and formally retained. These south and east ends were still very much marsh lands that resemble the 1938-42 shoreline depiction.

A 1969 aerial image (see Figure 27) shows the overall fishpond margins had finally been formalized and straightened resembling their current configuration.

Georeferencing aerial photographs from 1928 to 1969 and the 1938-42 Bishop Estate map shows the shoreline has changed significantly over the past 85 years (see Figure 29). The orange outline in the slide shows a very small amount of water in the system in 1928. This is the way the fishpond looked when McAllister described it around 1930 as measuring about 2.5 acres in size. Today, it is approximately 6 acres. The black and yellow lines, from the 1938-42 map, and the 1949 aerial, respectively, are probably close to what the original shoreline looked like. The <u>dashed</u> black line depicts the extent of the <u>marsh</u> from the 1938-42 map. This, too, appears to be closest to the original natural layout of Lokoea. In the 1960s, the blue line, the southern portion of the fishpond was straightened using mechanical equipment. And, this is essentially what it looks like today.

Photographic and Map Evidence of the Age and Position of Lokoea's Main Features

As depicted in Figure 30, georeferencing these same images shows the main gated wall designated Feature 1—the long orange line in the figure—has been in the same position and orientation since 1928. On the other hand, Feature 2, the smaller gated wall heading back from the central island, was in a different location and orientation in 1928 than it is today. The 1928 aerial photograph is not a very high resolution image. However, it shows this gated wall, Feature 2, was connected *not* to the present-day central island but to a cluster of remnant lithified coral outcrops that today are not solid land but rather like stepping stones over the water. This changed between 1928 and 1938-42, and the orientation and position of Feature 2 since then is close to what it is today.

An archival cost estimate from KS files to repair the large wall designated Feature 1 (Figure 31) suggests, as we confirmed with archaeological observations at the ground surface and through subsurface testing, this structure was substantially modified—repaired or rebuilt—sometime after 1957.

Finally, the major structural changes that created the Keiki pond (Feature 3) first appear on the 1969 aerial. Our observations suggest this feature in the northeast corner of the project area was built sometime in the 1960s.



Figure 23. Portion of 1943 U.S. War Department 7.5-minute series topographic map Haleiwa Quadrangle (University of Hawai'i at Mānoa, The Oceania Digital Library, http://evols.library.manoa. hawaii.edu/handle/10524/18844)



Figure 24. Portion of 1949 aerial photograph supplied by Kamehameha Schools



Figure 25. Portion of 1953 USGS 7.5-minute series topographic map Haleiwa Quadrangle (USGS website, http://geonames.usgs.gov/pls/topomaps/f?p=262:1:981281919519692)



Figure 26. Portion of 1960 USGS 7.5-minute series topographic map Haleiwa Quadrangle (USGS website, http://geonames.usgs.gov/pls/topomaps/f?p=262:1:981281919519692)



Figure 27. Portion of 1969 aerial photograph supplied by Kamehameha Schools



Figure 28. Portion of 1974 aerial photograph supplied by Kamehameha Schools



Figure 29. Composite (overlay) of fishpond margins from 1928, 1949 and 1969 aerial photographs (USGS) as well as 1938-42 Bishop Estate land survey georeferenced to current aerial imagery



Figure 30. Overlay showing changes in position and orientation of Feature 2 from 1928 and 1949 aerial photographs as well as 1938-42 Bishop Estate land survey georeferenced to current aerial imagery



Figure 31. 1957 cost estimate to repair the main wall at Lokoea (source KS files); base map is from 1938-42 Bishop Estate land survey

Commercial Activities and Influences at Lokoea

Based on all available evidence, we know Lokoea has gone through several phases of modification in the 20th century alone. We found evidence of many of these changes in our study. These phases of modification can be linked with several different commercial endeavors affecting Lokoea:

- As shown in the 1928 aerial, by the late 1920s, the fishpond was in a state of complete disrepair;
- In the 1930s, Waialua Sugar Company carried out major repairs to the main structures—including the concrete gates at Feature 1 and the central island (Feature 4)—and may have completely rebuilt the small wall (Feature 2) in a different location;
- After the 1947 tsunami, a tenant (Sato) appears to have made some changes to the central island;
- In the 1960s, a tenant (Kearns) carried out extensive modifications including construction of the "Keiki pond" and straightening/ formalization of the west, south and east pond margins;
- In the 1980s, a tenant (Wyban) rebuilt/ repaired parts of makai end of the large wall (Feature 1).

Waialua Sugar Company

Scott (1968:766) states the Waialua Sugar Company (or Waialua Agricultural Company) was "the first plantation community association in the Islands" to be organized. He also states (ibid) that by 1915, the Waialua Agricultural Company was operating a 10,000-acre complex with more than 2,000 workers employed and using eight billion gallons of irrigated water per year. According to James Estores, Chinese plantation workers built the concrete gates and retaining walls of the central island and the main wall at Lokoea in the 1930s. As described and illustrated in more detail in the Results section below, inscriptions indicate two dates (1936 and 1937) on portions of these structures.

Small-scale Fish Farming at Lokoea in the 20th Century

Carol and Jim Wyban lived and worked at Lokoea as commercial fishfarmers from 1981 to 1985. Carol Wyban's (1992) memoir of this time, entitled *Tide and Current: Fishponds of Hawai'i*, contains specific oral-historical information—passed on to her by word of mouth from long-time resident families—from as early as the 1920s; and first-hand accounts based on direct observation from the 1980s. Wyban also includes several drawings and a photograph that illustrate extant archaeological features as they appeared in the 1980s described in the current study (Figure 32 through Figure 36). Other observations on the biology and hydrology of Lokoea are also useful to reconstructing an overall picture of continuity and change at Lokoea.

Wyban discusses changes in water quality and amount (flow rate) as a result of the Waialua Sugar/Agricultural Company's construction of a pumping station at 'Uko'a. She notes that vegetation and sand removal were "two of their [pond operator's] arduous and constant tasks" (Wyban 1992:9).

[m]illions of gallons of freshwater are pumped daily from the station to irrigate the sugarcane fields above Hale'iwa. This diversion diminished the water that runs through the tributary system of 'Uko'a and Lokoea, reducing the flowrate in pond and stream. The reduced flowrate has affected Lokoea in several ways. The waterway from 'Uko'a has filled in with bulrush and introduced vegetation such as California grass. A decreased flowrate through Lokoea stream results in an annual buildup of sand in the stream mouth. The buildup of sand and sand inundation from the winter surf can cause the fishpond to overflow and do damage to adjacent inland areas. (Wyban 1992:8–9)

According to Dorothy Awai's oral testimony (personal communication with Carol Wyban), her ("Aunty Dot's") children used to jump off the bridge at Lokoea into the stream, which today is a relatively shallow and slow-moving outlet. We found approximately 1 foot of water in the stream shortly after a very rainy period in January 2013.



Figure 32. Wyban's artistic representation of the main features of Lokoea (Wyban 1992:14, Figure 3)



Figure 33. Another of Wyban's artistic representations of the main features of Lokoea (1992:17, Figure 6)



Figure 34. Wyban's drawing of mākāhā 1 at Lokoea (Wyban 1992:15, Figure 4); this is designated Feature 1A in the current study



Figure 35. Wyban's plan view of mākāhā 1 at Lokoea (Wyban 1992:16, Figure 5); this is designated Feature 1A in the current study



Figure 36. Jim Wyban throwing the net from a rock wall (designated Feature 2 in the current study) (Wyban 1992:47, Figure 17)

ARCHAEOLOGICAL CONTEXT

This section includes a brief review of relevant archaeological studies and observations at and near Lokoea. This is *not* a review of the archaeology of Kawailoa Ahupua'a or Waialua Moku. Interested readers can refer to Kirch's (1992) monograph for a more holistic, if somewhat dated, overview of human settlement and subsistence in Kawailoa and Waialua. Tulchin et al. (2012) have recently described the results of an archaeological reconnaissance around 'Uko'a Fishpond, which yielded a handful of traditional Hawaiian sites. For this report, however, we have chosen to focus very narrowly on previous work at and near Lokoea.

McAllister's (1933) brief description of Lokoea, which he did not actually identify by name but did locate on a map, provides a glimpse of the extent of the pond and some of its structural features around 1930. He describes Lokoea as,

A small fresh-water pond covering 2.5 acres, still in use. The present pond is divided from a small stream, into which its outlets (makaha) open by a stone and earth embankment. Its other sides are formed by the natural contours of the land. (Sterling and Summers 1978:115)

The most significant aspect of his description is the observation that the "other sides" of the pond—here he would be referring to everything other than the area of the north end of the pond where all the rock modifications are located—were in a natural state; and, thus, the pond was defined largely by the inherent "lay of the land." This conclusion is absolutely consistent with all of our observations on the ground and analysis of available archival resources, including maps and Land Commission documents. His comment of the overall size of the pond (2.5 acres) is interesting in that this is somewhat less than half of the current size of the main pond. His size estimate is, however, consistent with topographic maps and aerial images from this period (see, for example, Figure 20), which depict a substantially smaller pond and an irregular shape compared with the current size and configuration.

Scientific Consultant Services (SCS) conducted an archaeological inventory survey including six backhoe trenches along Lokoea Place, immediately south of the current project area (McGerty and Spear 2000). They also conducted some follow-up data recovery work (Yeomans 2001). Two archaeological sites were identified: State Site # 50-80-04-5795, a series of charcoal deposits and burn events; and Site 5839, a dry-stacked basalt boulder wall. One charcoal sample obtained in excavation (trench 3) of a subsurface feature interpreted as a post hole returned a conventional date of 410 +/- 40 BP, which was calibrated (2 sigma) to AD 1420–1530 (McGerty and Spear 2000:37). This trench was in one of the QLT parcels bordering the pond to the south, and provides direct evidence of traditional habitation in pre-Contact times of the pond margins.

On the other side of Lokoea, in the area of the current parking lot north of Jameson's Restaurant, Cultural Surveys Hawai'i (CSH) conducted an archaeological inventory survey for the proposed Hale'iwa Beach Park Skate Park (Borthwick et al. 2002). The most relevant find was a subsurface cultural layer (State Site # 50-80-04-5916) under the parking lot, described as consisting of poorly-defined, mixed strata containing modern to early 1900s trash with sparse charcoal flecking. The mixed strata rest upon gleyed deposits.

More recently, Pacific Consultant Services (PCSI) reported on archaeological monitoring of a linear project area (water main replacement) along several roads including Lokoea Place, where they reported no in-situ deposits but did describe several isolated historic artifacts (Park and Collins 2011).

RESULTS

Overview

This section starts with a formal and functional description of seven archaeological features at Lokoea, including the results of eight hand excavations (TU-1 through TU-8). This is followed by a brief description of eight *other* features determined to be either non-historic-age archaeological features or simply non-archaeological features. The last part of the results section describes the laboratory analyses of materials recovered in excavation.

Subsurface excavation at two different locations in Feature 1, the long wall heading makai from the central island, demonstrated subsurface features indicating major structural failure and repair of the wall over time. Excavation at the far west (makai) end of Feature 1 also exposed what appears to be a remnant portion of the original, traditional-style wall deep in the trench in Jaucas sand deposits. Excavation at the smaller wall (Feature 2), heading from the island back east (mauka), demonstrated its core construction materials and methods differ from Feature 1 and appear to be a traditional style, even though we believe, based on our analysis of aerial imagery that Feature 2 appears to post-date 1928.

Excavation (TU-1) in the middle of the long wall (Feature 1) also yielded a carved wooden artifact near the base of the trench, just above the water table. We present our analysis of this object, including our functional hypothesis that it represents part of a composite rudder (the handle, or tiller, of a two-piece rudder) to a small sail boat of non-traditional, non-Polynesian or Hawaiian design. We identified the wood species of this object and had it radiocarbon dated. Results suggest it is a non-native historic introduction (*Pseudotsuga menziesii*, Douglas fir) that does not seem to be older than the Historic period. We recovered traditional Hawaiian artifacts in excavation near the base of a test unit (TU-5) on the central island, as far as we know, the first such finds at Lokoea. A wood charcoal sample from a subsurface fire place feature on the other side of the central island (TU-6) was identified as Douglas fir, and we did not bother having it dated.

Regarding the eight features at Lokoea that do not qualify in a formal sense as archaeological phenomena, some of these are recently-built, humanly-modified rock structures that will presumably pass into historical "old age" if left alone for the requisite 50 years; others are natural components of the landscape that are associated either with historic-era oral history or more recent, contemporary oral history. Regardless of their archaeological status—that is, whether or not they retain evidence of human modification—some of these natural features clearly represent wahi pana, or wahi kahiko, based on available evidence such as moʻolelo; and, as such, these may qualify as historic properties (or component features of the historic property of Lokoea). The Queen's bath (hau thicket) along the QLT lands in the southwest portion of the project area is an example of this type of feature. The historic preservation status of other non-archaeological features, however, is less clear cut; for example, the purported "ko'a shrine," as described by Wyban (1992) near the Keiki pond.

Because a primary objective of this study is to serve as a land management tool for KS, and in order to organize the data in a useful way, archaeological features are designated by Arabic numerals (Features 1–7) while the "other features" are identified by letters (Features A–H).

Table 3 summarizes all identified features at Lokoea, including man-made structures and modifications of historic and non-historic age, natural phenomena of cultural significance (e.g., wahi pana) and other, noteworthy features.

Figure 37 is a plan view of Lokoea with all features identified as a result of this AIS.

Fea. ¹	Formal Description	Function/s	Age ²	Status	Comments
1	Sediment-filled, rock-retained wall with cast-in-place concrete and metal sluice gates	 Helps define the pond boundaries Defines and constrains Lokoea Stream Sluice gates allow for management of resources (water, fish) in main pond 	Pre-contact with modification into Historic and Modern times	Historic property	The old rock work defining this wall was covered by a more recent rock "veneer" in the late 1950s
2	Core and fill rock wall with prefabricated concrete culverts	 Helps define the pond boundaries as distinct from 'Uko'a waterway Walkway to the back of the pond Sluice gates allow for management of resources (water, fish) in main pond 	Post 1928 with modification into Historic and Modern times	Historic property	This is the "oldest looking" rock structure at Lokoea, even though is appears to post-date 1928
3	Mortar and rock walls, natural basalt outcrops, earthen and boulder embankments	 Formalizes size and shape of Keiki pond from its natural marshy condition Sluice gates allow for management of resources in Keiki pond 	Originally built in the 1960s	Historic property	Dates from the 1960s. There is an inscription in the mortar work of 1966
4	Central island containing house structure, rock terracing, concrete and hollow-tile retaining walls, concrete sluice gates and holding tanks	 With Features 1 and 2, helps define the pond boundaries Possible traditional habitation area Sluice gates allow for management of resources (water, fish) in main pond 	Pre-contact with modification into Historic and Modern times	Historic property	House structure (current office) first appears on 1949 aerial photo; concrete retaining walls and sluice gates inscribed with 1937
5	Small cave under south end of lithified reef outcrop with placed rocks around opening	 Pūnāwai (fresh water spring) that feeding the main pond Possible cache (storage/ hiding place) for unknown materials 	Pre-contact with modification into Historic and Modern times	Historic property and wahi pana	Interpreted by Wyban (1992) as home of the mo'o Laniwahine
6	Small cave under north end of lithified reef outcrop with placed rocks around opening; and a single lithified coral upright inside	 Pūnāwai (fresh water spring) that feeding the main pond Possible cache (storage/ hiding place) for unknown materials 	Pre-contact with modification into Historic and Modern times	Historic property and wahi pana	Part of the same lithified reef outcrop as the south cave but smaller interior space
7	Low, dry-stacked rock wall	 Property boundary along Jameson's parcel Possible formalization of north edge of Lokoea Stream 	Historic—19 th century	Historic property	Well-built structure using fitted rocks that were either dressed (shaped) or selected for their blocky shape
Α	Kū pōhaku (shrine) on prepared rock base	Guardian of the pond for MLEF	Built around 2010	Recent construction	Discovered and built by MLEF
B	Earthen and boulder ramp up to top of lithified reef, starting at the east end of Feature 2	Access from the lower fishpond area to the upper level area upon which is currently located a warehouse	Built around 2010	Recent construction	MLEF brought in sediment and boulders to build this sloping ramp up to the top; previously, Fea. 2 ended at base of coral bluff

Fea. ¹	Formal Description	Function/s	Age ²	Status	Comments
С	Low, dry-stacked rock wall	Retains sandy bank along the north side of Lokoea Stream helping to keep the channel open and flowing	Built around 2010	Recent construction	Built by MLEF using a variety of clast types, sizes and shapes; informal, loose construction
D	Dry-stacked rock wall along the north side of the driveway into the property	Defines the north side of the driveway near the main gate	Built around 2009	Recent construction	This wall was built by a class studying techniques of constructing traditional rock structures
E	Hau thicket within which is the "Queen's bath"	Regardless of whether a Queen's bath can be identified here, it is culturally- significant to some Hawaiians for its associated with Queen Lili'uokalani, the last monarch of the Hawaiian Kingdom	Indeterminate	Wahi pana (non- archaeological) ³	See note 3 below
F	Group of small islets of lithified coral reef in main pond	Line fishing currently takes place off these rocks	Built over the last few decades	Modern construction	Dilapidated wooden foot bridges are scattered about
G	Possible Koʻa pōhaku (shrine) ⁴	Guardian of the pond for Carol Wyban and Keoni Dudley	Natural feature	Natural feature, possible wahi pana	See note 4 below
H	Informal stacking and in-filling of cracks and pukas along the raised lithified reef bluff	Reinforcing the bluff and reducing soil erosion from the upper bluff down into the pond	Built over the last few decades	Modern construction	There are chunks of concrete aggregate blocks and slabs intermixed with clasts of lithified coral reef

¹Archaeological features of historic (greater than 50 years) age denoted with numbers; all others by letters

² All of the various terms commonly used to describe temporal periods in Hawai'i have their own potential biases, strengths and weaknesses. Unless otherwise stated or discussed, the term "pre-Contact" (rather than "prehistoric") is used to refer to the time before the arrival of Captain James Cook in the Hawaiian Islands, generally understood to be 1778. On the other hand, the term "historic" (rather than "post-Contact) is used to refer to events after 1778.

³ We thoroughly investigated the hau thicket, crawling through the entire area twice, and found no physical evidence of any human modification such as placed or positioned rocks that may indicate the remains of a formal bathing or swimming area. There is a shallow earthen depression that may once have been the location of a bath. It is worth noting that, according to Wyban's memoir (1992:9), major reconstructive work at Lokoea in the 1960s by the Kearns family included dredging the main pond and dumping the dredge in the "queen's swimming hole." Thus, it is possible that some formal evidence of this feature is buried under pond sediments in the hau thicket.

⁴ According to Wyban (1992), the interpretation of this natural feature as a ko'a was provided by Keoni Dudley, who appears to have intuited such information, rather than obtained it from oral-historical sources such as knowledgeable kūpuna, mo'olelo, etc.



Figure 37. Overall plan view of Lokoea showing features described in this report; all archaeological features (denoted by Arabic numerals) were mapped in greater detail (smaller scale) and these detail maps are included in feature narratives below; note location of TU-8 (other test units are depicted at smaller scale on plan view section maps of the project area)

Feature 1 – Large Gated Wall Separating Lokoea Stream from Main Pond

Feature 1, the largest and most prominent archaeological structure, is a rock-retained and sediment-filled wall separating the main pond from Lokoea Stream (Figure 38). Working with the natural terrain, soils and hydrology, and in conjunction with the central island to which it connects and a smaller wall (Feature 2) extending from the island to the east, Feature 1 serves three main functions: (1) it effectively creates the main pond at Lokoea, as distinct from the rest of the larger waterway extending back to and including 'Uko'a: without this large structure, Lokoea would simply be the south end of 'Uko'a; (2) it formalizes the location of Lokoea Stream, the short section of shallow water draining into the ocean, and limits its maximum width by preventing it from meandering to south; and (3) because it has two sluice gates between the main pond and Lokoea Stream, it helps manage the flow and mixture of fresh, brackish and salt water from several inter-related sources: subterranean springs or pūnawai; surface and shallow-subsurface fresh water flow from the greater 'Uko'a system; and the ocean. In turn, this hydrological control allows for management of the fauna and flora of the pond.

Current Appearance and Formal Description

Feature 1 is about 85 m in length from just west of the westernmost sluice gate to the island. The wall is oriented roughly NE to SW and is nearly straight but around its midpoint, near the central sluice gate (Feature 1B), it angles somewhat back to the east, giving it a slightly bent or bowed shape in plan view (Figure 39 and Figure 40). It is possible that one or the other end of this feature was realigned somewhat, from an originally-straight precursor, during a period of modification. We did not dig at the mauka (east) end where it meets the island, but, if we had to make an educated guess, there are multiple lines of evidence suggesting the makai (west) end is the best candidate for having been moved and remodeled over time. Not only does this end experience the most damage during tidal-surge events—as documented historically (Wyban 1992) and observed even today⁸—we documented extensive subsurface evidence of repair and other evidence of stress on this makai end (Figure 41).

The wall varies in height and width from one end to the other. In general, the makai end, especially its grass-covered center (as distinguished from its stacked-rock sides), is higher because of repeated episodes of cleaning out the stream channel—which generally becomes more choked with sediment at the makai end—and tossing this material on top of the center of the wall. We recorded cross-section (elevation) drawings down the middle, grassy surface of Feature 1 and representative heights of the rock work on the north side of Feature 1. Both of these data sets are expressed in Figure 33. The height of the top of the rock work varies from a high of 175 cm at the west end to only 135 cm near the island in the east with variation along its length. Width, measured from the exterior edges of the north and south faces of the stacked rocks, varies from about 4.0 m in sections that appear to be more or less intact up to 6.0 m in sections that appear to have suffered some collapse.

The sediment-retaining stacked-rock facing is interesting in that we discovered evidence of at least two major phases of construction style and material. Representative photographs along the north face of the wall, standing in the shallow Lokoea Stream, illustrate a more recent exterior layering—analogous to a "veneer"—of mortared, angular and subangular boulders over a dry-stacked (mortar-free) rounded and subrounded boulder interior (Figure 42 through Figure 44). This dry-stacked interior wall, which is illustrated most effectively in Figure 44, clearly represents the old, original design of the wall. We discuss possible dating of these two phases of rock work in the next section below.

In general, the east half of the wall—from mākāhā 2 heading back to the island—is in better physical condition than the west. The most substantial section of damage/ partial collapse is along the south face of the west portion of the wall (Figure 45 and Figure 46, and see Figure 38, plan map, where this section is called out). We noticed several small, informally-arranged piles of partially-submerged boulders in the

⁸ James Estores (MLEF) states the 2011 tsunami (the one that devastated parts of Japan) caused the slumping/ collapse damage to the south side of the west portion of Feature 1 (this is pictured below).

water, along the south side of the wall, and wondered if these were humanly-modified constructions. According to James Estores, these tumbled rocks were arranged by MLEF staff to create habitat for fish. We have not formally mapped or documented these piles in any other way, but it is important to realize they are modern (not historic-age) constructions.

The two sluice gates, interchangeably called mākāhā in this report, are poured-in-place (formed) concrete structures built in the 1930s. More recently, stainless steel framing and gate structures have been added (Figure 47), but the basic structures are roughly 80 years old. Mākāhā 1, at the makai end, also has dressed basalt blocks capping the concrete structure at the top (Figure 48). Inspection of the middle sluice gate (mākāhā 2) shows there may be such dressed capping blocks but they appear to have been covered in a layer of mortar. As depicted in Figure 49, the concrete structure of a portion of the west gate was repaired in the early 1980s. A date of "1936" is inscribed on this gate (Figure 50). Major cracking and buckling of the structure (Figure 51) was apparently serious enough to be addressed by the 1980s repair work, which was memorialized in another inscription, this one reading "1983" (Figure 52). Carol Wyban mentions this repair effort in her memoir on Lokoea.

Temporal Overview and Context

Based on observations at the ground surface, the results of subsurface excavation (presented below), background research (in particular Wyban 1992 but also documents provided by KS), and consultation with MLEF, the following chronology of Feature 1's original construction and modification is offered.

First and foremost, regardless of whether it can be proved with archaeological evidence—and it is worth stating that we cannot provide definitive, empirical proof at this time—the basic layout and structure of Feature 1 almost certainly dates from pre-Contact times. A comment by John Papa 'Ī'ī, in his *Fragments of Hawaiian History*, provides anecdotal support for the antiquity of this feature. He was writing about trails on O'ahu, and specifically recollecting to around 1810. He noted that "[b]etween the sandy stretch of Maeaea [Hale'iwa Beach Park] and the houses at Ukoa, on the seaward side, was the trail from Kamani to the place in front of the sluice gate of Lokoea, and on to Koolauloa" ('Ī'ī 1959:98).

Our excavation (TU-1) of the middle portion of Feature 1, east of the central sluice gate, revealed that it has a sediment-filled core containing 19th century wood and other scattered debris; and that this feature experienced a major structural failure to its base on the north side that was repaired with a sheet metal shoring of some kind. This phase of repair dates either to the 1930s—when there is ample evidence of construction work at Lokoea—or as late as the 1950s, when there was a major phase of repair work. Oral-historical information provided by James Estores suggests the 1930s work was conducted by Chinese workers associated with the Waialua Sugar Plantation.

Excavation at the makai end of Feature 1 showed additional evidence of multiple episodes of failure and repair of Feature 1. We not only documented what appears to be an old remnant of the feature's traditional stacked-rock design—rounded boulders in Jaucas sand at the very bottom of TU-3, but we also discovered an abandoned and buried concrete sluice gate structure in TU-4 just makai of the existing mākāhā 1. This subsurface structure was more lightly-built and lower in elevation (its top surface begins at 32 cmbs) compared with the current sluice gate. This evidence suggests the 1930s gates built by the Chinese plantation workers was not even the first concrete gate structures at Lokoea! All in all, our subsurface work argues for a fairly complex history of building and repair of Feature 1.

We have already mentioned the observation that there appear to be two distinctly different styles of stacked-rock facing along the sides of Feature 1. Figure 53 is a schematic depiction of what we believe to be essentially a wall within a wall, resulting from a repair job that, quite logically, appears to have simply added to what was already there, thus increasing both the overall width and height of the original Feature 1. Consultation with KS during our fieldwork yielded documentary evidence from their files of a circa 1957 proposal to repair Feature 1 (see Figure 31).


Figure 38. Plan view and cross sections of Feature 1, large pā (wall), separating the main pond (right) from the stream (left); TU-1 indicated in red, TU-3 and TU-4 in blue; representative elevations (heights in cm) along Feature 1 were measured from the top of the stacked rocks to the bottom of the stream channel



Figure 39. Looking across the northwest portion of the main pond to the large pā, Feature 1; Jameson's By The Sea Restaurant is at the right; mākāhā (sluice gates), indicated by red arrows



Figure 40. View west of Feature 1 from its east end; Lokoea Stream to the right empties into the ocean behind the large ironwood next to the restaurant; the low wall retaining the north side of the stream was built around 2010 and is not an archaeological feature (it is designated Feature C in this report)



Figure 41. View east of Feature 1 from its west end; storm damage to wall (partial collapse) indicated by red arrows; damage to a portion of sluice gate (cracked and failing concrete) indicated by white arrow



Figure 42. Detail, north side Feature 1, viewed from Lokoea Stream, just south of mākāhā 1; note, old mortar in the middle of the rock work; view SSE; scale = 1 m



Figure 43. Detail, north side Feature 1, viewed from Lokoea Stream, near the mid-point of the pā, just south of mākāhā 2; note, darker, more rounded boulders at the base with mortared, angular boulders on top; view SSE; scale = 1 m



Figure 44. Detail, north side Feature 1, viewed from Lokoea Stream, near its east end; the base of darker, dry-stacked, rounded and sub-rounded boulders, which represents the oldest constructed rock work at Feature 1; view SSE; scale = 1 m



Figure 45. View from main pond—standing in the water—of partially-collapsed south side of Feature 1; grassy upper portion of this feature, which is its sediment-filled core, is relatively high due to repeated "clean outs" of the stream and dumping of sediment atop the wall; view NNE



Figure 46. Another view of partially-collapsed portion of Feature 1; the photo scale, which is in the same position as in the photograph above; is in a small "sink hole" within which can be viewed the older, rounded and sub-rounded boulder edge of the wall (indicated by red arrow); view NE



Figure 47. Mākāhā 2 (Feature 1B) near the middle of Feature 1, view south; note the difference in elevation of the top surface of the wall between the right (west) and left (east) half; scale = 1 m



Figure 48. Mākāhā 1 (Feature 1A) near west end of Feature 1, view south; photograph taken from Lokoea Stream; note, dressed basalt blocks capping the concrete structures; scale = 1 m



Figure 49. Mākāhā 1 (Feature 1A) near west end of Feature 1, view NNW; photograph taken from the main pond; dressed basalt blocks capping the concrete structure to the left are not visible (covered and/or replaced) by 1980s repair work (red arrow); Kamehameha Highway bridge in background



Figure 50. Inscription on concrete at mākāhā 1 that appears to date the structure; see photograph below for location of inscription; scale measures 10 cm in total length



Figure 51. Mākāhā 1, view SW, showing cracks through its center (red arrows), area of 1930s inscription (yellow arrow) and 1980s inscription (green arrow)



Figure 52. Inscription in concrete repair work to mākāhā 1; Wyban's (1992:15, Figure 4) drawing indicates the date is 1983, and this appears to read "8-83," as in August of that year; she describes a storm that damaged the gate, which is still cracked through its center (see photograph above)



Figure 53. Schematic (not to scale) interpretation of construction phases of Feature 1 based on observations at the ground surface, subsurface excavation, and records available at Kamehameha Schools describing late 1950s repair work to this wall

Subsurface Testing of Feature 1

Hand excavation of three test units was conducted at two locations at Feature 1 (see Figure 38) to determine its construction methods and constituent materials; and to recover physical evidence of its age. TU-1 was placed east of the midpoint of the wall, through the center of the structure (Figure 54). TU-3 and TU-4 were placed at the far, west end of the wall at its intersection with the natural beach berm.

<u>TU-1</u>

A 2.2 m by 0.8 m test unit was hand-excavated to 155-160 cmbs. The water table was encountered at ~130 cmbs. A sump pump was used so that the lowermost 30 cm of sediment could be observed. **TU-1** was positioned at a portion of Feature 1 that appeared from the ground surface to be relatively intact and undisturbed by recent damage or modification compared with other portions of the wall. The trench was oriented roughly NNW to SSE and perpendicular to the long axis of the wall.

The constructed core of the wall consists of sand, sandy clay and clay sediment with occasional small boulders, cobbles and pebbles of basalt. This feature does not have a constructed rock core. The exterior structure—rock-faced retaining walls—are relatively narrow and extend no more than 40–50 cm in towards the centerline of the feature.

The upper 65–70 cm consists of several alternating thin layers and lens of sand and sandy clay (Layers I– VIII) (Table 4 and Figure 55 through Figure 57). Relatively abundant modern rubbish was found to a depth of 40–50 cmbs; less abundant debris, including ceramic tile (60 cmbs) and a chunk of concrete conglomerate (70 cmbs), was found to a depth of 70 cmbs, where a significant stratigraphic break occurs. Below 70 cmbs, the sediments comprising Layer X appear to represent the oldest, original clay core-fill material.

There is also a major intrusive feature in the north end of TU-1 (Layers VII and IX). Here, starting between 50–70 cmbs, a large section of in-situ corrugated sheet metal shoring was discovered; this sheeting was placed parallel to the long axis of the wall, up against its eroded exterior north face, during a phase of major structural repair and modification to the wall between the 1930s and 1950s (Figure 58 and Figure 59).

Naturally-occurring sediment—loose, unconsolidated dark gray coarse sand (Layer XI)—was exposed at the base of excavation, below 140–145 cmbs, throughout most of the trench (Figure 60). At the south end, the natural sediments are closer to the surface at ~100 cmbs. This may indicate the ground surface of the central core of the constructed fill was first partially excavated of the natural (loose, unconsolidated) sand and replaced (packed in) with more solid, impermeable clay. This preparation may represent the oldest evidence in TU-1 of the original pre-Contact construction phase at Feature 1.

As stated, a small number of historic-era objects—mostly fragments of ferrous metal, window and bottle glass, and ceramics—were recovered in the upper layers. None of these objects are particularly interesting or significant, but, as described below, we did make a couple discoveries near the base of the lowest cultural layer that have major implications for interpreting the age and origins of Feature 1.

A wooden artifact was recovered just above the water table near the base of the thick clay (Layer X) (Figure 61 through Figure 63). The bottom of the artifact, at 122–125 cmbs, was more or less level but slightly inclined up to the west. This elongate piece of carved wood has a tapered shape (in plan view), and the tip of the narrow end was partially embedded (extending several centimeters) into the west wall of TU-1. Rather than excavate next to it down through over 125 cm of overburden just to remove it, the west wall was dug into by about 10–15 cm to retrieve the object, leaving a small hole in the sedimentary profile.

It is important to note that a large piece of brown bottle glass was also recovered in the center of the trench at 125 cmbs, which surprised us by suggesting one or both of the following conclusions must be

true: (1) the central core base of the constructed clay fill of Feature 1 is not very old (given the bottle glass); (2) the central core base of the feature is disturbed and includes intrusive material.

The wooden artifact was analyzed for clues about its possible function; a small sample was also submitted for taxonomic identification and radiometric dating, as described in detail below (see Laboratory Results). Summarizing the discussion presented below, this artifact is clearly a utilitarian—rather than a ritual—object. The working hypothesis regarding its function is that it was a component of a rudder to a small sail boat. The wood was identified as Douglas fir (*Pseudotsuga menziesii*), a native of the Pacific Northwest and western U.S. It returned a conventional (AMS) radiocarbon date of 160 +/- 30 BP. If this single date (calibration is discussed below) is taken at face value, it suggests the portion of Feature 1 sampled by TU-1 was built in the terminal pre-Contact to early Historic period.⁹ In actuality, given the vagaries of radiocarbon dating, it also may be substantially younger. Regardless, this finding has major chronological implications for dating Lokoea.



Figure 54. Documentation of excavation of TU-1 in progress; view NE

 $^{^{9}}$ BP = Before present, with "present" being 1950. Thus, in layman's terms, 160 +/- 30 BP is AD 1760–1820.

Table 4. TU-1 Stratigraphic Description

#	Cmbs	Thickness (cm)	Description	Interpretation
Ι	0-5	4-5	Gray (10YR 5/1) medium sand; abundant fine to medium roots and rootlets; smooth lower boundary; dry, non-plastic, loose consistency	Top soil upon which grass is growing; clean out from adjacent stream channel; modern deposition
II	5-18	10-12	Light yellowish brown (10YR 6/4) coarse sand; some fine rootlets; smooth lower boundary; dry, non-plastic, loose consistency	Clean out from adjacent stream channel; modern deposition
III	18–25	0-6	Reddish brown (5YR 4/4) coarse sandy clay; few fine rootlets; smooth lower boundary; dry, slightly- plastic, firm consistency	Pinches out (terminates) at south end of trench; primarily terrigenous fill (not clean out from stream); modern deposition
IV	20/25-27/30	0–5	This is a lens of the same material as Layer II— same description (see above)	Pinches out (terminates) near south end of trench; clean out from adjacent stream channel; modern deposition
V	27/30–27/42	0-17	Dark gray (10YR 4/1) medium sandy clay with angular basalt gravels and some larger clasts; dry, slightly-plastic, firm consistency	Pinches out (terminates) near south end of trench; several flat, blocky cobbles and boulders from this layer depicted in Figure 52; primarily terrigenous fill (not stream clean out); modern deposition
VI	15/35-60/75	15–40	Swirls (admixture) of clay and sandy clay; description of clay is same as Layer Xa; description of sandy clay is same as Layer II	Truncated near north end of trench by intrusive feature; swirling appearance suggests deposition by water flow during a period of storm damage to the upper sediments
VII	35/42-42/52	0-15	Dark brown (10YR 3/3) medium sandy clay; moist, plastic, firm consistency; sparse fine roots; lower half (VIIb) contains pieces of corroding sheet metal	Laterally equivalent with Layers VI and VIII, which are older; this layer with sheet metal and Layer IX represent major repair effort on north side of Feature 1 between 1930s and 1950s
VIII	50/60-70	10-20	Swirls (admixture) of clay and sandy clay; sandy clay predominates; clay same as Layer Xa; sandy clay same as Layer II	Truncated near north end by intrusive feature; swirling of clay and sandy clay suggests deposition by water flow during a period of storm damage to the upper sediments
IX	70–155	85	This is a mixture of Layer X and XI with pieces of corroding sheet metal	Intrusive feature; upper boundary defined by bottom of sheet metal; represents a major repair effort on north side of Feature 1 between 1930s and 1950s
X	60/65-110/145	40-72	Moist, plastic, firm clay divided into 3 sub-layers based on color: Xa is dark reddish brown (5YR 3/3), Xb is dark brown (10YR 3/3), Xc is dark gray (Gley 1 4/N); wooden artifact was found in Xc; large piece of bottle glass at 125 cmbs	Truncated to north by Layer IX (intrusive feature); appears to be the original clay fill comprising the core of Feature 1; this impermeable sediment is ideally suited to the function of separating the two waters of the pond and stream
XI	100/145–BOE*	30+ Depth unknown	Dark gray (Gley 1 4/N) coarse sand; wet, non- plastic, moderately-loose consistency	Natural sedimentary layer with a marine (salty) smell

BOE = Base of excavation = 155-160 cmbs; water table encountered at ~ 130 cmbs



Figure 55. TU-1 stratigraphic profile, color-coded to indicate temporal phases of deposition: (1) modern deposition (yellow, Layers I–V), (2) intrusive feature created during reconstruction/repair in 1930s–1950s (purple, Layers VII & IX), (3) water-deposited, possible storm damage (blue, Layers VI & VIII), which is older than intrusive feature, (4) clay fill representing original constructed core of Feature 1 (white, Layer Xa–Xc), which appears to date to 19th century, (5) oldest natural sediments (gray, Layer XI); scale bar on left is in 50 cm increments



Figure 56. TU-1 during excavation, view NNW; in this image, the north half has been excavated to 30 cmbs, while the south is down to 50 cmbs; the unit was bisected to determine if the flat rocks visible to the north were the top of a continuous rocky core of the feature, or merely tossed on top of the wall during a rebuilding/ modification phase (the latter turned out to be true); scale = 1 m



Figure 57. TU-1 during excavation at 90 cmbs; note, the presence of a few rounded boulders in the profile walls; scale = 1 m



Figure 58. Near the base of excavation in TU-1; note, the hole in the west wall was where the wooden artifact was removed; note also the several rounded small boulders on the bottom of the trench; the major stratigraphic break below which represents consolidated clay interpreted as the original constituent core fill of the feature is indicated by dashed yellow line; red arrow points to corrugated sheet metal shoring



Figure 59. Detail of sheet metal shoring placed at the base of the water table during a previous effort to stabilize the north side of Feature 1; yellow line shows orientation of intact sheet metal; red dashes indicate continuation of sheet metal into the west wall—the shape of this sheet metal can also be appreciated by examining the drafted stratigraphic profile; note also the rounded boulders to the right of the shoring



Figure 60. South end of TU-1 near base of excavation; several rounded boulders at the base of the trench; note also the gray sand at the bottom of the trench, which represents the only natural (as opposed to humanly-introduced) sedimentary layer; as indicated by the yellow dashed line, note how the gray sand is higher at the south end of the trench—close to the south rock wall—compared with the center of the trench



Figure 61. Wooden object (still wet) recovered near the base of TU-1 right after it was removed from the trench; scale in centimeters; maximum length of the artifact is 87 cm (34.3 inches); tapered end (right) is partially damaged but was once complete; hole in the center of the object and the wide end (left) are depicted in detail in photographs below; scale bar = 10 cm



Figure 62. Detail of wooden object (still wet) recovered in excavation at TU-1 showing hole in center; both sides of this hole exhibit groove-like use-wear consistent with abrasion with ropes or rigging; scale = 10 cm



Figure 63. Detail of the wide end of the wooden object (still wet) showing a U-shaped notch and use-wear perpendicular to the long axis of the object (arrows); scale = 10 cm

<u>TU-3 & TU-4</u>

Two test units were excavated at the west end of Feature 1 in the vicinity of its intersection with the natural beach berm (Jaucas sand deposits) (see Figure 38). This area was excavated to explore the construction methods and constituent materials of the wall; to determine how the constructed feature was tied into the natural landscape; to recover subsurface evidence of construction phases or dating samples; and to explore the physical integrity of this part of the wall, which historical accounts suggest may have been damaged and repaired on multiple occasions after storm events such as tsunami and tidal surges.

The original plan was to complete only one test unit (TU-3), but a second unit (TU-4) was excavated because TU-3 was found to consist almost entirely of rocks and trash from a relatively recent (1980s) depositional event, and therefore was not particularly informative. TU-4 was then placed in a location that would hopefully avoid most of the 1980s disturbance, while also taking consideration numerous surface and subsurface obstacles (i.e., a wooden gate with large posts set in concrete footings; the active water line for Lokoea [PVC pipe] just below the surface; a deeper, abandoned water line running through TU-3; and avoidance of the existing structural rock work along the south side of Feature 1 where it ties into the natural sand berm). TU-4 was angled off the east end of TU-3. Completion of both units resulted in a pair of joined trenches angled at a flection point (see Figure 38).

TU-3, a 2.0 m by 0.8 m test unit, was hand-excavated to 130–150 cmbs. The water table was exposed at \sim 160 cmbs, but it was not completely uncovered given the many obstacles to digging that were encountered.¹⁰ TU-3 was positioned at a portion of Feature 1 that appeared from the ground surface to be at or near the original intersection of the constructed feature and natural sand berm along Kamehameha Highway (Figure 64). The trench was oriented roughly ENE to WSW and parallel to the long axis of the wall.

Most of the trench contained evidence of a 1980s filling and reconstruction phase of the nearby Feature 1 rock wall along its south-facing side on the main pond. In addition to abundant trash, the 1980s fill consisted of large numbers of angular and subangular boulders. The boulders filled most of the south and east portions of the trench. The stratigraphic profile (Table 5 and Figure 65) illustrates this 1980s layer completely truncated the older layers to depth in the south half of the unit. Below the modern layers (Layers I and II), two distinct sedimentary units (Layers III and IV) appear to have been deposited by water flow, perhaps associated with storm damage (e.g., tidal surge events). Layer III is more fine-grained (clay) and appears to have originated from the pond bottom. Layer IV (banded clay loam and coarse sand), which appears to incorporate a mixture of beach and other terrigenous sediments, likely originated from outside of the pond proper. Both of these layers are inclined down towards the main pond.

At the base of the trench, only in its west end, excavation exposed what appeared to be a remnant of the original Feature 1 wall in Jaucas sand deposits. A rough, linear arrangement of several rounded boulders, totally different from the other rocks in this trench, was encountered in the northwest quadrant (Figure 66 and Figure 67). These rounded boulders were within a coarse, coralline sand layer whose upper surface was 110–135 cmbs and which continued beyond the base of excavation (150 cmbs) into the water table (160 cmbs). The orientation of the boulders roughly paralleled the long axis of the trench. If this subsurface feature does, in fact, represent an old remnant of the base of the original Feature 1 wall, TU-3 demonstrates the rest of the overlying structure was totally destroyed, most likely by storm events that are mentioned in historical accounts. A large amount of sediment and angular/ subangular boulders was filled into this general area in the recent past, most likely the 1980s based on certain types of trash (aluminum soda can and fast-food Styrofoam container—see stratigraphic profile) discovered in Layer II (Figure 68 and Figure 69).

 $^{^{10}}$ A small probe was excavated with a trowel in the northeast corner of the unit to expose the level of the water table at ~160 cmbs. This probe extended 10 cm below the BOE.



Figure 64. Overview of TU-3 (post-excavation, red arrow) and TU-4 (pre-excavation, yellow arrow) location; dashed white line shows edge of constructed rock work comprising west end of Feature 1; view SW; note, the wooden structure (gate with heavy posts) in the upper right of this image

Table 5. TU-3 Stratigraphic Description

#	Cmbs	Thickness	Description	Interpretation
		(cm)		
Ι	0–25/50	25-50	Banded mixture of dark brown (10YR 3/3) silty loam and brown (10YR 5/3) coarse sand; dry, non- plastic, very loose consistency; irregular lower boundary; abundant modern trash, roots and wide variety of clast type, shape and size	Top soil upon which grass is growing; modern deposition
Π	25/50-75/150	25–125	Dark brown (10YR 3/3) clay loam with abundant angular basalt pebbles and cobbles, and abundant modern garbage; dry, slightly-plastic, loose consistency	Modern fill and deposition; garbage in this layer is consistent with 1980s deposition; in the east end of the trench, where the underlying layers (III–V) are not present, Layer II yielded Styrofoam (McDonalds) fast food containers at 105 cmbs incorporated into large, angular boulder fill; aluminum Coke can observed in the north wall at the base of Layer II at 80 cmbs
III	75/80–85/95	10–18	Dark gray (2.5YR 4/1) clay with yellow and orange mottling; smooth lower boundary; slightly moist, plastic, very firm consistency; inclusions are rare	This layer is truncated by Layer II in the south half of the trench; Layer III appears to be water deposited—possible storm damage
IV	85/95-110/138	20-43	Banded mixture of dark brown (10YR 3/3) clay loam and brown (10YR 5/3) coarse sand; slightly wavy lower boundary; slightly moist, slightly- plastic, firm consistency	This layer is truncated by Layer II in the south half of the trench; this is a zone of transition/admixture of overlying clay fill and underlying Jaucas sand with rounded boulders; the strongly- expressed series of multiple, superimposed banding structures appears to be the result of deposition by flowing water—possible storm damage
V	110/135-BOE*	40+ Depth unknown	Brownish yellow (10YR 6/6) very coarse coralline sand; constituent coral/shells are very coarse grain size; slightly moist, non-plastic, relatively loose consistency; includes abundant rounded boulders	This layer of Jaucas sand with rounded boulders appears to be a remnant of the original base of construction of Feature 1 with placed boulders in natural sand berm sediments

BOE = Base of excavation = 130-150 cmbs; water table encountered at ~ 160 cmbs



Figure 65. TU-3 stratigraphic profile, color-coded to indicate temporal phases of deposition: (1) modern deposition (yellow, Layers I–II), (2) waterdeposited, some of which may be possible storm damage (blue, Layers III & IV), (3) oldest layer containing Jaucas sands (Layer V), which appear to be a portion of naturally-deposited back beach berm, also with large rounded boulders that may represent a remnant of the base of the original construction of Feature 1; scale to left is in 50 cm increments



Figure 66. Base of excavation, TU-3, showing remnant evidence of rounded boulders and Jaucas sand at bottom of trench; note, active (white pipe) and abandoned (curved pipe) water lines; view north



Figure 67. Another view of rounded boulders and Jaucas sand interpreted as representing remains of old constructed base of Feature 1 (rounded boulders) atop natural sediments (Jaucas sand); view NNW



Figure 68. TU-3, view east, showing angular boulders that continue to the base of excavation in south side of trench; these boulders are loosely fitted, easily dislodged and contain rubbish dating from the 1980s; this portion of Feature 1 was mostly rebuilt about 30 years ago



Figure 69. Another view of TU-3, view ENE showing lack of Jaucas sands and predominance of angular boulders and dark fill in south and east ends of the trench

TU-4, a 2.0 m by 0.8 m test unit, was hand-excavated to 155–160 cmbs (Table 6 and Figure 70). The water table was encountered at ~160 cmbs, but it was only exposed completely in the north half of the trench. The east and southeast profiles of the south half of the trench were dominated by large, angular boulders from the circa 1980s modification of Feature 1; this created a safety concern given the instability of these vertical profiles, which were prone to collapse. Thus, the south half of TU-4 was only excavated down to 130–135 cmbs. As described above, TU-4 was angled off the adjacent TU-3 in order to test sediments closer to the original west end of Feature 1 and away from the 1980s modification that dominated TU-3. Figure 71 and Figure 72 show the relationship between these trenches (see also Figure 38, the plan map for Feature 1, which also illustrates this spatial relationship). TU-4 was oriented roughly north to south and oblique to the long axis of the wall.

The most interesting find in TU-4 was a buried, abandoned portion of concrete sluice gate (Figure 73), the upper surface of which is located 32 cmbs. A plan view depiction (Figure 74) shows it extends into the base of excavation and rests in the natural Jaucas sand deposit (Layer VI) underlying this area.

The uppermost, circa 1980s sedimentary deposit—which is dominated by angular and subangular boulders at the south end—truncates all the other layers down to the Jaucas sand in the south end of TU-4 (see stratigraphic profile). Below this 1980s deposit, two layers (II and III) represent terrigenous back fill sediments deposited at the time of the construction of the nearby (existing at the ground surface) sluice gate (mākāhā 1), which was built in or around 1936. Layer II is a very distinctive red color and resembles lateritic sediments from the nearby uplands of Kawailoa. Because it is a relatively firm and consolidated clayey silt, this red sediment would have functioned well as a capping fill layer to this storm-damaged area. Deposition of Layers II and III clearly came after the abandonment of the old buried sluice gate, which thus predates 1936. Below this circa 1936 back fill, two other layers (IV and V) appear to represent water-deposited sediments, likely associated with storm damage that overwhelmed the relatively lightly-constructed and low (at least 32 cm below the top of the existing sluice gate) buried sluice gate. Based on stratigraphic observations (see Figure 70), Layer IV, a banded clay loam and sandy deposit, post-dates the construction of the buried sluice gate, while Layer V is older than the buried gate since it was clearly cut through (truncated) by the forms used to pour and shape the old buried gate (see stratigraphic profile; dashed lines indicate the truncated Layer V).

Details of the base of the abandoned sluice gate (Figure 75 through Figure 77) show it included design elements (e.g., a slotted groove) that allowed for the placement or removal of a wooden gate component. After documentation of the trench was completed, the ground surface immediately north of the north edge of TU-4 was partially exposed (cut back) down to the level of the top of the old gate to explore its lateral extent and to look for possible signs of inscription that may directly date the feature (Figure 78). This cutting into the adjacent ground surface demonstrated the concrete structure is parallel and perpendicular to structural elements of the existing sluice gate; it continues and unknown distance back east to the existing gate (we did not want to continue digging back too close to the existing gate, which is already failing and susceptible to further degradation if undermined in any way); it is much more lightly-built than the currently in-use gate; and it lacks any evidence of a date of construction.

Table 6. TU-4 Stratigraphic Description

#	Cmbs	Thickness	Description	Interpretation
Ι	0-10/130	10–130	Banded mixture of dark brown (10YR 3/3) silty loam and brown (10YR 5/3) coarse sand; dry, non- plastic, very loose consistency; irregular lower boundary; abundant modern trash, roots and wide variety of clast type, shape and size	This is modern fill associated with the 1980s modification/ repair of the adjacent south-facing wall of Feature 1; this layer includes abundant angular boulders and fills the trench to the base of excavation (130 cmbs) in the south end
II	10/20–25/75	15–50	Red (10YR 4/6) clayey silt; some fine rootlets; smooth lower boundary; dry, slightly-plastic, firm consistency	This layer, which is truncated by Layer I, is terrigenous fill brought in around the time of the 1930s construction of the nearby sluice gate (mākāhā 1); Layer II partially covered the abandoned sluice gate (subsurface feature in TU-4)
III	15/30-25/40	10-12	Dark brown (10YR 3/3) silty loam; dry, non-plastic, moderate consistency; smooth lower boundary; fine roots and wide variety of clast type, shape and size	This discontinuous layer only appears on the west side of the subsurface (abandoned) sluice gate in TU-4; terrigenous fill deposits, presumably penecontemporaneous with Layer II
IV	45/60-72/85	25–27	Banded mixture of dark brown (10YR 3/3) clay loam and brown (10YR 5/3) coarse sand; slightly wavy lower boundary; slightly moist, slightly- plastic, firm consistency	The strongly-expressed series of multiple, superimposed banding structures appears to be the result of deposition by flowing water—possible storm damage
V	77/90–90/110	8–17	Dark gray (2.5YR 4/1) clay with yellow and orange mottling; smooth lower boundary; slightly moist, plastic, very firm consistency; inclusions are rare	This layer is cut right through its middle by the subsurface (abandoned) sluice gate, which is thus older than Layer V; it appears to be water deposited—possible storm damage
VI	85/110-BOE*	70+ Depth unknown	Brownish yellow (10YR 6/6) very coarse coralline sand; constituent coral/shells are very coarse grain size; moist, non-plastic, relatively loose consistency; this layer contained the base of the subsurface (abandoned) sluice gate feature—see stratigraphic profile below	This layer of Jaucas sand represents natural sand berm sediments; the base of the abandoned sluice gate was poured into these Jaucas sands

BOE = Base of excavation = 155-160 cmbs; water table encountered at ~ 160 cmbs



Figure 70. TU-4 stratigraphic profile, color-coded to indicate temporal phases of deposition: (1) modern deposition (yellow, Layer I), (2) terrigenous fill (red, Layers II & III) brought in when the nearby sluice gate (mākāhā 1, *not* the buried remnant shown here) was built in the 1930s, (3) water-deposited, some of which may be possible 19th century or early 20th century storm damage (blue, Layers IV & V), (4) oldest layer containing Jaucas sands (Layer VI), which appear to be a portion of naturally-deposited back beach berm; scale to left is in 50 cm increments; "A" denotes angular boulders, "SA" denotes subangular boulders



Figure 71. Overview of location of TU-4 prior to excavation; arrows indicate corners of test unit; view SW; note, the cracked, damaged concrete of mākāhā 1 (foreground)



Figure 72. Overview of completed TU-4 excavation; view north



Figure 73. TU-4 excavation completed; note, the subsurface feature—old concrete sluice gate—in the north end of the trench; view north; the measuring tape extends 160 cmbs



Figure 74. Plan view of TU-4 (and portion of TU-3) showing location of buried, abandoned sluice gate (gray color) in NE corner of trench, in relation to existing sluice gate (mākāhā 1); top of the buried sluice gate is 32 cmbs; its base extends into the Jaucas sand at the base of the trench



Figure 75. Detail of subsurface feature (old buried sluice gate), the base of which extends several centimeters below the water table; the top of this concrete feature is 32 cmbs



Figure 76. Detail of the base of the subsurface sluice gate; measuring tape is extended about 12 cm



Figure 77. Another view of the subsurface sluice gate; this and the view above show a formed slot designed to hold a large piece of lumber



Figure 78. Prior to backfilling the trench, the top of the concrete structure was exposed more by cutting back beyond the boundaries of the trench (original boundaries indicated by yellow lines); the feature continues to the NE and its full extent was not determined; scale = 10 cm overall length

Feature 2 – Small Wall with Culverts Separating Main Pond from 'Uko'a Waterway

Feature 2 is a small wall linking the east side of the island to the back of the pond (Figure 79). Unlike Feature 1, whose core consists of sand, sandy clay and clay, Feature 2 has a rocky (rubble-filled) core. Along with Feature 1 and the island, Feature 2 functions to create what we call Lokoea—without it, the main pond would simply be part of the greater 'Uko'a waterway (Figure 80). Because it has two culverts that allow water to pass between the main pond and the 'Uko'a waterway, Feature 2 is also an important management tool for balancing the mixture of wai (fresh water) and kai (ocean water). In fact, Feature 2 originally had only one opening—presumably an actual sluice gate—at its east end. Historic maps indicate there was no opening at the location of the current west end culvert in 1938-1942. Feature 2 also provides a walkway across the pond to the bluff on the other side (Figure 81 and Figure 82).

Current Appearance and Formal Description

Feature 2 is \sim 30 m in length from just west of the westernmost culvert, where it links up with the island, to just east of the easternmost culvert. The wall is oriented roughly east to west and is more or less straight in plan view (see Figure 79). As depicted in a historic map from 1938-1942 (see Figure 15), there was no opening (culvert, sluice gate or otherwise) at the west end of Feature 2. An aerial photograph from 1949, however, shows some kind of constructed opening at this west end (see Figure 24). As discussed earlier in the report, analysis of aerial images indicates Feature 2 post-dates 1928.

Although it has been altered in numerous ways, most of the original structure and configuration of Feature 2 can be discerned by close inspection of its structural boulders, the oldest of which are rounded/ subrounded and covered above the high water mark by lichens. Where it is possible to distinguish its original dimensions, the wall is about 2.0 m wide and 90 cm in high. Around 2010, a large amount of rock was added to the main pond (south) side of Feature 2 along most of its length (depicted in yellow in Figure 79), which has widened its width by a few meters. Other, recent alteration of Feature 2 has occurred at the west end, on the south side, where an abandoned weather-recording station now sits. It is not clear exactly when this "bump out" was constructed, but it does not appear to be historic in age.

Based on an inscription ("1964") in the mortar of one of the culverts, and their identical design and construction, both appear to have been built during the 1960s phase of pond development, conducted by the Kearns family (Wyban 1992). The culvert rock work reveals a high degree of skill in fitting the basalt boulders, which were dry-stacked and topped with mortar (Figure 83 through Figure 85). The upper surface of the easternmost culvert is damaged and covered with a steel plate (see Figure 85). There is an inscription on the mortared surface reading "9-9-64, KAY," a reference to Kay Kearns (Figure 86).

Much of the north-facing side of Feature 2 is very well preserved and in excellent physical condition (Figure 87). These well-preserved sections of dry-stacked rounded boulders most closely resemble what all of Feature 2, and the long wall at Feature 1, originally looked like. If reconstruction of the walls at Lokoea is undertaken, the north face of Feature 2 would be an ideal place to study the appropriate techniques and materials. Figure 88 shows the heavily-modified east end of Feature 2 where a pair of gate posts (there is only one standing post at this point) stood as recently as the middle 1970s based on photographs supplied by KS. Figure 89 illustrates in detail the pile of recently-added rocks along the south side of Feature 2.

Temporal Overview and Context

It is clear that Feature 2, along with the island and Feature 1, are the oldest and most important humanlybuilt structures at Lokoea because they are essentially responsible for creating and delineating the pond as a distinct entity from the 'Uko'a waterway. Based on Feature 2's relatively old-style appearance, we were surprised to learn it post-dates 1928. As discussed below, subsurface testing (TU-2) near the east end of the wall did not yield any evidence to contradict this idea; it showed that Feature 2 was constructed of rocky rubble filled in between two, parallel, dry-stacked walls of boulders; and yielded a small amount of Historic-era debris.


Figure 79. Plan view and cross sections of Feature 2, small pā, separating the main pond (right) from the waterway to 'Uko'a (left); gray rocks are the oldest, traditional style; purple rock work is from the 1960s; yellow (including Feature B, sediment and rock ramp up to the lithified coral bluff) is from post 2008; uncolored (white) rocks are indeterminate



Figure 80. Looking south across the waterway from 'Uko'a (foreground) to the small pā, Feature 2, and main pond behind it; Mount Ka'ala—the highest peak on O'ahu—is atop the distant Wai'anae Mountains



Figure 81. Looking west across Feature 2 from the top of the lithified reef that forms the east margin of the pond; Feature 2 has been heavily modified in recent years along its south and east sides; red arrow indicates Ka'ena Point in the distance which is visible from this spot



Figure 82. View ENE from south side of central island across Feature 2 to raised lithified reef (red arrows, background); yellow arrows indicate recently-added rocks along south side of Feature 2; wooden walkway (foreground right) leads to Feature F (group of lithified coral islets)



Figure 83. North side of culvert 1 (Feature 2A) at the west end of Feature 2; this modification took place in the 1960s; view SSE; scale = 1 m



Figure 84. Another view of culvert 1 (Feature 2A), a 1960s addition to Feature 2



Figure 85. North side of culvert 2 (Feature 2B) at east end of Feature 2; this end was where the original sluice gate/ mākāhā was located; culvert pictured above was part of the 1960s remodeling of Lokoea; view south; scale = 1 m; red arrow shows location of inscription shown in next photograph



Figure 86. Inscription on mortar topping culvert 2 (Feature 2B)—see location above—reads "9-9-64, KAY," and refers to Kay Kearns, daughter of Bill and Naomi Kearns who leased the pond in the 1960s



Figure 87. Detail of representative section, north side of Feature 2, view south; this construction style—dry stacking of rounded and sub-rounded boulders—is the oldest at Lokoea; the lichen line marks the historical high water mark; scale = 1 m



Figure 88. East end of Feature 2, which has been extensively modified since the 1960s; the photo scale (meter stick) is in a constructed rock and mortar post hole that—as visible in 1970s photographs—once supported a gate post that matched the surviving one in the left of this image; scale = 1 m



Figure 89. Recently-added (non-historic age) rocks on south edge of Feature 2 (main pond at left); original south edge is visible in this image as lichen-covered boulders indicated by arrows; view WNW

Subsurface Testing of Feature 2

Hand excavation of one test unit was conducted at Feature 2 to determine its construction methods and constituent materials; and to recover physical evidence of its age. TU-2 was placed near the east end of wall, through the center of the structure, which appears to preserve some of the oldest, undisturbed rock work in the project area (see Figure 79).

TU-2, a 1.2 m x m by 0.9 m test unit, was hand-excavated to 90 cmbs (Table 7 and Figure 90). The water table was encountered at \sim 95 cmbs.¹¹ TU-2 was positioned along a portion of Feature 2 that appeared from the ground surface to be relatively intact and undisturbed by recent damage or modification compared with other portions of the wall, although the south side of this feature has been recently added onto by piling of a large amount of rock material (see previous photography). TU-2 was oriented roughly north to south and perpendicular to the long axis of the wall.

The constructed core of the wall consists of rock rubble in a fine sandy silt matrix. The rocky fill in TU-2 was piled in between the two parallel wall structures forming the sides of Feature 2. The density and size of the fill increased towards the bottom of TU-2. The fill consists of mostly angular and subangular basalt pebbles and cobbles, but also includes some larger clasts, a few rounded and subrounded clasts, and several pieces of lithified coral reef. The fill appears to rest on large boulders that may represent a formal base to the feature. Excavation exposed a portion of the interior edges of the north and south walls of Feature 2; and demonstrated that the width of these structures increases with depth. This tapering up of the width of the rock wall structures appears to be a design feature of Feature 2.

The upper 10–15 cm consists of a few thin layers and lens of fine sandy silt (Layers IA–IC) (Figure 91 and Figure 92). These inorganic layers are modern deposits of terrigenous sediment, most likely brought in to level the ground surface between the two walls. The ground surface between the two walls has a slightly concave cross-section, which is mirrored by the underlying strata (Layers II and III). This concavity appears to be the result of settling and compaction over time of the filled-core sediments of Feature 2, which also serves as the only walkway across to the east side of the pond. Periodic filling and leveling of this space has probably been a regular maintenance activity at Feature 2 for a long time. Layer II, directly underlying the modern depositional layers, appears to be a historic-age fill—similar in function to the uppermost sandy silt, but exhibiting more soil development characteristics (higher organic content and the presence of soil peds). Below this, starting at 10–30 cmbs, the rest of the unit is comprised of the rocky fill (Layer III) (Figure 93 through Figure 97).

The rocky fill (Layer III), which is part of the original design and construction of Feature 2, contains modest amounts of historic-age debris—mostly glass and ceramic fragments between 20–50 cmbs, which seems to indicate that much of the core-fill does *not* date from pre-Contact times. A basalt flake fragment (distal end of a snapped flake lacking a bulb of percussion) was recovered at 29 cmbs, intermixed with the historic debris. In addition, two somewhat anomalous finds in TU-2 deserve mention: a cigarette filter was recovered at 25 cmbs; a plastic bottle cap was recovered at 70 cmbs in the northwest quadrant, against the stacked rocks comprising the north wall. Taken at face value, the deeply-buried plastic cap against the interior stacked-rock structure suggests nearly the entire rocky fill (or at least down to 70 cmbs) is a modern deposit; however, there is an alternative stratigraphic interpretation that, if correct, is still consistent with a historic-era age for the wall fill: that is, the cap represents an intrusive anomaly created by partial collapse and rebuilding, in the modern era, of a section of the exterior north wall. This could account for the plastic cap at 70 cmbs, while still allowing for an older age for most of the feature. There were quite a few air pockets and open spaces between many of the rocks in Layer III, suggesting some kind of intrusive turbation seems likely.

¹¹ A small probe was excavated through rocky rubble with a trowel in the east side of the unit to expose the level of the water table at \sim 95 cmbs. This probe extended about 5 cm below the BOE.

Table 7. TU-2 Stratigraphic Description

#	Cmbs	Thickness (cm)	Description	Interpretation
IA	0-2/3	2-3	Reddish brown (5YR 4/3) silt with some fine sand; dry, crumbly, non-plastic, loose consistency, smooth lower boundary; occasional pebble-size basalt and coral inclusions; roots and rootlets common	Relatively inert, inorganic top layer upon which surface vegetation is growing; pinches out to south; modern deposition of terrigenous material
IB	0/3-7/13	0-10	Dark reddish brown (5YR 3/4) silt with some fine sand—rest of the description is the same Layer IA	Part of upper, insert, inorganic layers upon which surface vegetation is growing; pinches out to south; modern deposition of terrigenous material; a small PVC water pipe (abandoned) extends across the unit parallel to the long axis of the wall feature
IC	0/7-5/7	0–5	Dark brown (7.5YR 3/3) silt with some fine sand— otherwise, same description as Layers IA & IB	Part of upper, insert, inorganic layers upon which surface vegetation is growing; pinches out to north; modern deposition of terrigenous material
Π	7/13-10/30	9–18	Dark brown (7.5YR 3/3) clayey silt with occasional inclusions of coarse sand and small bits of coral; pebbles and small cobbles of basalt are present but rare; dry, slightly-plastic, firm consistency with soil structures (peds); moderate organic content; rootlets are abundant	This is a top soil-like material, introduced fill at some indeterminate time in the past; this terrigenous layer is most likely historic in age
III	10/30–depth? BOE*	80+ Depth unknown	Dark yellowish brown (10YR 5/4) fine sandy silt with extremely abundant basalt pebbles and cobbles that are mostly angular to subangular; occasional small rounded clast or coral or lithified reef material present; this layer yielded some cultural material— mostly historic glass and ceramic fragments between 20–50 cmbs, but also a cigarette filter (25 cmbs) and a basalt flake fragment (29 cmbs); a black (modern) plastic bottle cap was recovered at 70 cmbs, but is believed to be intrusive—see discussion in the text	This is the main structural fill layer piled in between the two boulders structural walls comprising Feature 2; this rubbly fill represents the original construction core material of the walled structure; there appears to be a larger-boulder base to the rock structure and the rubbly fill sites directly atop this as well

BOE = Base of excavation = 90 cmbs; water table encountered at \sim 95 cmbs



Figure 90. TU-2 stratigraphic profile, color-coded to indicate temporal phases of deposition: (1) modern deposition (yellow, Layers IA–IC), (2) middle to later 20th century fill (purple, Layer II), (3) original, constituent core and fill material (white matrix and gray boulders, Layer III) dating from early 20th century; note, stratigraphic layers in the east profile are concave



Figure 91. Completion of excavation of level 2 (20 cmbs) TU-2; top, interior edge of north wall is starting to become exposed (beneath abandoned conduit oriented east to west); waterway to 'Uko'a in background; view north; scale = 1 m



Figure 92. Another view of TU-2 at 20 cmbs; view west; scale = 1 m



Figure 93. Completion of excavation of level 3 (30 cmbs) TU-2; top, interior edge of north wall is clearly visible; the light-colored top of Layer III (rubble fill cultural layer) is just starting to become exposed in the north and west sides of the unit; view north; scale = 1 m



Figure 94. Base of level 5 (50 cmbs) showing Layer III (rubble fill cultural layer) throughout the unit; this material is part of the original construction of Feature 2, which was formed by piling rubble between two boulder retaining walls



Figure 95. Base of level 8 (80 cmbs) showing continuation of rubble layer



Figure 96. Base of excavation at 90 cmbs; darker sediment in the bottom is wet from underlying water table; this view shows the north profile



Figure 97. Base of excavation at 90 cmbs; water table was reached at 95 cm by probing through the denselypacked rocky rubble; this view shows the east profile

Feature 3 – Keiki Pond

Feature 3 is all of the humanly-modified structures and associated natural components of the landscape that collectively create the Keiki pond (Figure 98 through Figure 100), a small pool in the northeast corner of the project area. As illustrated in the plan view below, the raised coral bluff along the east side of the pond terminates near the southeast end of the Keiki pond. Several large bougainvillea bushes are located above this southeast corner of the Keiki pond. Several large basalt outcrops also occur in this area, partially submerged in the shallow water. All available evidence indicates that Feature 3 is a relatively recent (1960s) creation that was not part of the historic landscape at Lokoea. Until the 1960s, this area was a natural marsh.

Current Appearance and Formal Description

The Keiki pond is formed by several main components:

- a low, linear rock and mortar wall incorporating several large boulder outcrops along part of its west side (Figure 101 through Figure 103);
- a mechanically-formed (e.g., using a backhoe, bulldozer and/or excavator) soil and rock peninsula also along part of its west side (Figure 104);
- mechanically-created east and north banks that are relatively steep and covered with soil and large boulders (Figure 105); numerous coconut palms have been planted around these artificially-created banks; and
- another soil and rock spit or mini-peninsula on its south side heading back south along the base of the lithified coral bluff to Feature 2.¹²

Two concrete gates are located along the linear rock and mortar wall; one of these includes an inscription with a date of 1966 (Figure 106 through Figure 108).

Temporal Overview and Context

Without a doubt, the Keiki pond did not exist, as such, prior to around 1960, at which time a major phase of landscape modification by the Kearns family formalized this natural marshy area into its current configuration. Comparison of the 1949 aerial photograph (see Figure 24) and the 1969 aerial photograph (see Figure 27) clearly shows the difference between the older marshy area and the more recent formally-defined margins of the pond. These Keiki pond margins, especially the east and north sides, but also part of the west side (the wide peninsula shown in Figure 105), were formed by mechanical, earth-moving equipment that created a steep bank defined by large boulders.

Prior to the formalization of the Keiki pond, some of the water draining from 'Uko'a would have filled this marshy area along with subterranean flow from the "north cave" area (Feature 6). In historic preservation parlance, the Keiki pond is on the cusp of being sufficiently old (50 years) to qualify as a contributing feature to the historic property of Lokoea Fishpond.

¹² This little spit of land is home to a natural outcrop interpreted by Wyban (1992) as a "ko'a (shrine)," designated in this study as Feature G, and discussed later in this report (see Other Features: Wahi Pana and Non-historic Age Structures below)



Figure 98. Plan view of Feature 3, Keiki pond, and location of other nearby features; the entire man-made infrastructure of the Keiki pond was built in the 1960s; note location of TU-7 up on the bluff above the pond



Figure 99. Overview of Keiki pond, Feature 3, from the top of the lithified reef that forms the east margin of the pond; this location marks the north end of the raised reef; view north



Figure 100. Recently-constructed shrine—a Kū pōhaku, designated Feature A (foreground)—on the east side of the Keiki pond, view west; the bougainvillea bush to the left represented the north end of the raised, lithified reef outcrop



Figure 101. North portion of wall structure at Feature 3—which incorporates naturally-occurring basalt outcrops (foreground) connected by mortar-and-rock sections; these modifications to formalize the Keiki pond (to the right) were made in the 1960s by the Kearns family; view NNW



Figure 102. South portion of wall structure at Feature 3; view SSE; the naturally-occurring rock formation in the back right of this image was described as a ko'a by Wyban (1992) based on Keoni Dudley's interpretation; we have designated this Feature G



Figure 103. Detail of mortar-and-rock construction, west side of south portion of Feature 3 wall with Keiki pond in background



Figure 104. Detail of north end of wall structure at Feature 3 showing how it is built against a wide earthen and boulder peninsula created by mechanical earth-moving equipment (arrow shows its overall width); view north



Figure 105. North end of the Keiki pond showing a portion of the mechanically-constructed earthen peninsula (left) and other artificially-created margins; view NNE



Figure 106. Gate 1 (Feature 3A) at south end of Feature 3 wall; view east; the south side (right) of the concrete gate is built against the base of a naturally-occurring basalt outcrop



Figure 107. Inscription (KAY, 10-11-66) on mortar leading up to gate 1, Feature 3



Figure 108. Gate 2 (Feature 3B) at north end of Feature 3 wall; view SE; coconut palm to the right is growing on the artificial earthen peninsula

Feature 4 – Central Island

Feature 4 is all of the humanly-modified structures and associated landscape components that collectively create the central island (Figure 109 and Figure 110), which is currently the site of the KS office. According to oral-historical information provided by James Estores, this residential structure (which has since been modified and upgraded if it is the same house) was constructed shortly after the 1946 tsunami by one Mr. Sato, who was a tenant at Lokoea and maintained a house closer to the ocean near the Jameson's parcel and the mouth of Lokoea Stream. When this house was damaged or destroyed, he moved up to the central island, which, along with Features 1 and 2, is the most critical structural component at Lokoea because it effectively delineates the main pond from the 'Uko'a waterway. Without these three features, what we call "Lokoea" would simply be the south end of 'Uko'a Fishpond.

We did not attempt to document all of the many components comprising Feature 4, most of which are more architectural than archaeological (e.g., concrete pads, steps and walkways, the house itself), and outside of the AIS scope of work. We did, however, work to conceptualize and convey the function of this central area to the working fishpond; and describe at least in general terms how this landform may have evolved over time from its traditional purpose and appearance to the present.

Current Appearance and Formal Description

The central island (Feature 4) consists of several main components:

- a concrete sluice gate (Feature 4A), similar in form and construction materials and techniques to those at Feature 1, controlling the flow of Lokoea Stream (Figure 111 and Figure 112); this gate is functionally the "bridge" onto the central island over the now-channelized Lokoea Stream; there is an inscription next to this Feature 4A sluice gate of "1937" (Figure 113);
- a second sluice gate system (Feature 4B) up against the main part of the island where the office sits (Figure 114); this creates a series of holding tanks or storage compartments between the 'Uko'a waterway and the main pond;
- a network of poured-in-place concrete walls built contemporaneously with the sluice gates (1930s) that retain and define the soil and rock of the approach to the main island from the entrance to Lokoea and the structures listed above (Figure 115);
- two sets of earthen terraces, a higher one partially defined and retained by dry-stacked rocks on the north side (Figure 116) and hollow-tile and concrete walls on the south and west sides—this is the surface upon which the main structures are located; and a lower terrace that wraps around from the north to east to south sides (Figure 117);
- numerous other features and details that likely date from the 1960s into more recent times, including a set of stone and mortar steps up to the upper terrace with another inscription from Kay Kearns (dated 1961) (Figure 118).

Temporal Overview and Context

Before conducting the Phase 2 fieldwork, which included subsurface excavation in two locations of the central island, we hypothesized that it probably preserves buried archaeological deposits dating from the earliest establishment of the main Lokoea infrastructure in pre-Contact times. Furthermore, we also proposed that the central core of this island, in its natural condition prior to being modified by humans, probably consisted of discontinuous outcrops of resistant basalt and lithified coral reef, similar to what one sees at the northeast margins of Lokoea; and that people filled in, around and atop these remnant outcrops to create this central "spoke" of the Lokoea water management system. The Phase 2 excavations confirmed both of these hypotheses, as described below.



Figure 109. A view of the current office structure on the island (Feature 4) from the south side of Lokoea; view north



Figure 110. Plan view of the island that, along with Features 1 and 2, creates Lokoea pond by separating it from the waterway to 'Uko'a; note the location of TU-5 and TU-6 on either side of the central island



Figure 111. The main entrance to Lokoea showing concrete retaining walls (left, indicated by red arrows), the sluice gate to Lokoea Stream (foreground), which flows to the right in this image, and other features of the island upon which the current office is located (background); view SSE



Figure 112. Reverse view of previous photograph, which was taken directly in front of the green gates; the main concrete structures defining the island and sluice gates were built in the 1930s; red arrow in this image shows location of the inscription shown in next photograph; view NNW



Figure 113. Inscription on the upper surface of the cast-in-place concrete retaining wall at Feature 4



Figure 114. View from near the main entrance shows another sluice gate (arrow), which marks the east end of a series of gates and holding tanks that eventually empty into the main pond to the west; view south



Figure 115. View from the east side of the lower soil terrace area on the island; view NW



Figure 116. Dry-stacked rock terrace creating the upper level soil area (upon which the tent sits); view south



Figure 117. View of the 'Uko'a waterway from the upper soil terrace area on the island; view north



Figure 118. Another inscription by Kay Kearns (this one reads "1961") on the steps leading up to the upper terrace and office area

Subsurface Testing of Feature 4

Hand excavation of two test units was conducted at Feature 4 to determine its construction methods and constituent materials—in particular, to test the hypothesis that the central island was originally built up, over and around lithified coral outcrops and/or weathered basalt as seen along the eastern margin of Lokoea. These units were also excavated to recover physical evidence of pre-Contact (prehistoric) occupation of Lokoea. TU-5 was placed in front of a dry-stacked terrace on the north side of the central island (see Figure 110). TU-6 was placed on the south side of the lower terrace of the central island adjacent to the office (see Figure 110).

TU-5, a 1.0 m x m by 1.0 m test unit, was hand-excavated to 120 cmbs (Table 8, Figure 119 and Figure 120). The water table was encountered at \sim 112 cmbs. TU-5 was positioned near the base of the rock terrace that helps create the upper level soil area. This placement was designed to investigate the original, core construction of the central island without having to dig through what we believed to be modern fill comprising the upper soil terrace (Figure 121). Later, during excavation of TU-5, we learned from Lokoea staff that the upper terrace area may contain a subsurface cesspool or tank (which we were glad to have avoided).

The excavation of TU-5 confirmed our hypothesis that the island appears to have been constructed by filling in, around and atop coral outcrops (Figure 122). We also discovered the first in-situ traditional Hawaiian artifact at Lokoea (see below), in direct association with fire-affected rock and a possible hammerstone, near the base of excavation. Excavation exposed a large portion of coral outcrop in the south wall; we did not find the base of this coral outcrop, which extends back to the south beyond the limits of excavation. We believe the coral outcrop is based in, and intersects with, the lowermost stratum at TU-5 (designated Layer VII, see stratigraphic profile below).

The upper 22–24 cm consists of two modern fill deposits (Layers I and II). Layer II contains small amounts of modern trash. Below this, extending to 38–42 cmbs, is another layer of introduced (fill) sediments dating from the middle 20th century based on fragments of late historic debris; this layer may be related to establishment of the house in the middle of the central island following the 1946 tsunami. Below this, Layer IV contains an extremely dense concentration of fragmentary bottles, ceramics and other glass dating from around 1900. It is worth noting that the closest previous archaeological excavation by Cultural Surveys Hawai'i—near the current Jamison's parking lot—documented a trench with similar finds, suggesting the possibility of a widespread dumping or filling episode sometime after 1900 or so. The 1928 aerial photograph of Lokoea shows the fishpond is total disrepair with very little water and lots of sediment in places where there is water today. It is possible that sometimes around the 1920s, there was extensive dumping at and adjacent to Lokoea, and that this Layer IV is part of that event.

The most interesting stratum, by far, is Layer VI, extending from approximately 92–110 cmbs. We made several discoveries in this layer that are, to our knowledge, the first traditional-style Hawaiian artifacts found in a controlled stratigraphic excavation at Lokoea. A side-notched net weight, or sinker, on a basalt cobble was found wedged behind a boulder, on its south side, between the boulder and the coral outcrop (Figure 123). This artifact was recovered at approximately 100 cmbs (Figure 124). A possible hammerstone was found in the same stratigraphic layer at 105 cmbs. Several pieces of fire-affected rock were also recovered from this same discrete sedimentary layer, which appears to represent the original edge of the central island before it was expanded laterally (Figure 125). Layer VI rests directly over the lowermost Layer VII, a sandy clay that seems to be the natural marsh bottom at Lokoea. This layer is located in the water table.

Table 8. TU-5 Stratigraphic Description

#	Cmbs	Thickness	Description	Interpretation
		(cm)		
Ι	0-6/8	6-8	Dark reddish brown (5YR 3/3) sandy, pebbly clay loam; hard, moderately-plastic, blocky structure; includes grassy root mat; no cultural material	Recently-introduced (fill) sediments/ top soil
II	6/8-22/24	16	Dark grayish brown (10YR 4/2) sandy clay loam; medium consistency; crumb structure; other than an occasional piece of modern rubbish, no cultural material	Introduced (fill) sediments dating from modern time period
III	22/24-38/42	16–18	Grayish brown (10YR 5/2) ashy, sandy loam with moderate amount of lithified coral pebbles and cobbles; structureless with small amounts of late historic debris; moderately loose consistency	Introduced (fill) sediments dating from the middle 20 th century; may be related to establishment of the house in the middle of the central island following the 1946 tsunami
IV	38/42-60/62	20–22	Grayish brown (10YR 5/2) ashy, sandy loam with dense accumulation of earlier historic (circa 1900) bottles, other glass fragments and ceramics; structureless; moderately loose consistency	Introduced (fill) sediments dating from the earlier part of the 20 th century; this layer may date to around the time of the fishpond's major period of disrepair evident in the 1928 aerial photograph
V	60/62–78/95	18-32	Very dark grayish brown (10YR 3/2) sandy clay; moderately friable, granular structure; high clay content than overlying stratum (Layer IV); some historic debris (mostly glass and ceramic fragments) present but much less compared with above layer	This layer may be partially water-deposited, rather than an introduced terrigenous fill layer
VI	92/95–93/110	1–19	Very dark grayish brown (10YR 3/2) sandy clay with some lithified coral and basalt clasts (mostly pebble- and cobble-sized); there are no historic- period materials in this layer, which included a traditional basalt artifact (net weight or sinker) at 100 cmbs, a possible hammerstone (at 105 cmbs) and several pieces of fire-affected rock	This is the original pre-Contact cultural layer within which the traditional artifacts and other cultural materials were found; this layer appears to be the natural margin (edge) of the central island in pre-Contact (prehistoric) times
VII	78/110–depth? BOE*	120+ Depth unknown	Brown (10YR 4/3) sandy clay; structureless, uniform, massive; culturally-sterile becoming anaerobic with depth due to the presence of the water table	This natural layer appears to pre-date the construction of the island; these sediments resemble the natural sandy clays underlying the oldest fishpond features (e.g., Feature 1)

BOE = Base of excavation = 120 cmbs; water table encountered at \sim 112 cmbs



Figure 119. TU-5 stratigraphic profile of all four walls; the top three layers are modern or very recent historic age; Layer IV contains dense glass bottles and other artifacts dating from the late 19th century to early 20th century; Layer V contains occasional shards of glass but very few historic artifacts; Layer VI is the original, prehistoric (pre-Contact) ground surface containing the traditional basalt net weight (sinker); Layer VII is the natural, sterile underlying sediments



Figure 120. Plan views of TU-5 at 100 cmbs (left) and 110 cmbs



Figure 121. Location of TU-5 in front of the dry-stacked terrace on the north side of the central island; view to the southeast



Figure 122. Excavation in progress at TU-5 (80 cmbs) showing dense layer of late 19th-early 20th century historic bottles and other debris (arrows) between approximately 35–65 cmbs



Figure 123. In situ position of the basalt net weight or sinker recovered at 100 cmbs in TU-5 wedged in behind a basalt boulder; inset photo shows detail of this find in a different light setting



Figure 124. Net weight or sinker made by notching (arrows) a rounded basalt cobble; image shows both sides of the artifact



Figure 125. Fire-affected rock recovered in excavation from Layer VI at TU-5

TU-6, a 1.5 m x m by 1.0 m test unit, was hand-excavated to 140 cmbs (Table 9, Figure 126 and Figure 127). The water table was encountered at \sim 135 cmbs. TU-6 was positioned in the middle of the lower level soil area on the south side of the central island (Figure 128). This placement was designed to investigate the original, core construction of the central island without having to dig through what we believed to be modern fill comprising the upper soil terrace. We were also looking for evidence of older, pre-Contact use of the island.

The excavation of TU-6 confirmed our hypothesis that the island appears to have been constructed by filling in, around and atop coral outcrops. We discovered a distinctive yellowish-brown stratigraphic layer between 65–100 cmbs (Layer V, see stratigraphic profile below) that appears to be introduced fill consisting of fine coralline-sandy clay—this is most likely the original fill placed in and around the coral outcrops to establish the central island.

The upper 28–41 cm consists of three modern fill deposits (Layers I, II and III). Below this, extending to 65–72 cmbs, is a layer (Layer IV) containing historic-era debris dating from the middle 20th century; this layer is appears to be temporally equivalent with Layer III from the other test unit (TU-5) on the north side of the island. We did not find a dense layer of circa-1900 artifacts in TU-6. We did, however, document a fire place feature in Layer IV (Figure 129 and Figure 130). It contained angular and sub-angular basalt cobbles and small boulders with a thick layer of concentrated wood charcoal. Because it included a large number of incompletely-consumed chunks of wood charcoal indicative of a "wasteful" fire, it does not closely resemble what one would expect to see of a traditional Hawaiian feature. A sample submitted to the Wood Identification Laboratory at International Archaeological Research Institute, Inc. (Honolulu) was identified as Douglas fir. Thus, the wood identification confirmed the interpretation that this is not a pre-Contact (prehistoric) feature.

Below this historic layer, we documented Layer V, a fine coralline-sandy clay that appears to represent the original effort to fill in and around the coral outcrops that likely make up the core of the central island. It is likely that this sediment layer was deposited in pre-Contact times by Hawaiians that first established Lokoea fishpond (Figure 131). Below this, a lowermost clay (Layer VI) appears to be a natural sedimentary layer consistent with the original marsh bottom.
Table 9. TU-6 Stratigraphic Description

#	Cmbs	Thickness	Description	Interpretation
		(cm)		
Ι	0-5/20	5-20	Brown (7.5YR 4/3) fine sandy silt; very compact,	Recently-introduced (fill) sediments; resting directly on lithified
			hard, dry; with inclusions of modern garbage	coral outcrop in northwest corner of the excavation unit
II	5/20-6/39	1–20	Brown (7.5YR 4/4)-same basic description as above	This discontinuous introduced (fill) layer shows up in the entire
			(Layer I) with slightly older garbage in it, pockets	west wall and tapered out along the south wall; it rests against the
			and lens of loose sand, and one ash/charcoal lens in	top of a lithified coral outcrop at the north end of the excavation
			the west facing wall	unit
III	6/39–28/41	1–25	Dark brown (7.5YR $3/2$) silt with late-historic	This is another introduced (fill) layer; it rests directly on lithified
			artifacts; these artifacts include non-ferrous metal	coral outcrop in the north portion of the excavation unit; this
			fragments and plastic suggesting this layer dates	layer is truncated to the north by the superimposed Layer II
			from non-historic-era (modern times); includes cut	
	22/10 65/52	1.40	(sawn) cow bones	
IV	32/40-65/72	1-42	Dark brown ($10YR 3/3$) loam with sparse fragments	The fire place feature contained angular and sub-angular basalt
			of non-diagnostic historic artifacts; a wood charcoal	coopies and small boulders with a thick layer of concentrated
			sample obtained from a fire place feature was	wood charcoal, this feature contained lots of large, partially
			Identified as Douglas III	thus not likely to be a traditional Hawaiian feature: the wood
				identification confirmed this interpretation
V	65-100	35	Light yellowish brown (2 5YR 6/3) fine sandy clay	This layer appears to represent the original effort to fill in and
•	05 100	55	mixed with clavey fine sand: this is coralline sand	around the coral outcrops that likely make up the core of the
			with abundant chunks of lithified coral: several	central island: it is likely that this sediment laver was deposited in
			linear fragments of branch coral were observed and	pre-Contact times by Hawaiians that first established Lokoea
			collected as examples; upper portion of this layer	fishpond
			very mottled with clay clumps and little clay clods;	1
			no cultural material	
VI	100-depth?	40+	Brown (10YR 4/3) moist clay; very "creamy" and	This natural sedimentary layer appears to be the original marsh
	BOE	Depth	smooth consistency; very homogeneous with no	bottom
		unknown	inclusions; culturally sterile; extends down into the	
			water table	

BOE = Base of excavation = 140 cmbs; water table encountered at \sim 135 cmbs



Figure 126. TU-6 stratigraphic profile of three walls; the top three layers are modern or very recent historic age; Layer IV contains a fire place feature with wood charcoal identified as Douglas fir; Layer V appears to represent the original filling event when the island was formalized around the coral outcrops; Layer VI is the natural, underlying sediment



Figure 127. Plan views of TU-6 at 60 cmbs (left) and 80 cmbs



Figure 128. Location of TU-6 on the south side of the lower terrace of the central island adjacent to the office; view to the northwest



Figure 129. TU-6 at 60 cmbs facing south; the fire place feature is visible in the upper left (southeast) corner of the excavation



Figure 130. TU-6 at 80 cmbs facing south; note, lithified coral outcrop being exposed throughout most of the floor of the excavation



Figure 131. TU-6 at base of excavation facing south-southwest; near the center of the unit, where the water table is visible in the deepest part, we punched down through the probable original pre-Contact filling episode (yellowish sediment indicated by arrow) into a natural clay at the base

Feature 5 – South Cave

Feature 5 is a small, natural cave formed under the lithified coral reef bluff that defines much of the northeast margin of Lokoea pond (see Figure 37 for location). Figure 132 shows the entrance and area in front of Feature 5. Figure 133 is a plan map of the cave. There are several stacked and aligned boulders just to the south (to the right in the view below) of the entrance to the cave opening, and there is a small concrete pad in this area as well (these features are depicted in the plan map below). These modest modifications to the cave entrance, in addition to the well-known mo'olelo (oral-history) about Laniwahine, the mo'o wahine (supernatural water spirit) of both 'Uko'a and Lokoea who was said to reside in such places,¹³ piqued our interest to explore this feature. As always with caves, we were cognizant of the possibility of encountering iwi kūpuna (human skeletal remains) or other sacred items; thus, we were careful to tread lightly in this feature. Fresh water currently trickles out of the cave and most likely flowed more forcefully in the old days, a phenomenon that no doubt was revered by Hawaiians at Lokoea.

The inner chamber is relatively small with a few meters of room inside in either direction, and ceiling heights up to about 70 or 80 cm in places. We did not find any artifacts or other items except for some small bits of modern trash that have filtered through the cracked and porous ceiling.



Figure 132. South cave, Feature 5, from which emanates fresh water from a subterranean spring, view east; the entrance is behind the photo scale, which measures 1 m

¹³ Wyban (1992) has suggested this cave is *the* home of Laniwahine, citing a 19th century newspaper article. We have deconstructed this assertion earlier in the report (see Cultural Context section) and concluded there is no specific support for it. This in no way detracts from the significance of Feature 5; rather, it simply sets the records straight on this matter.



Figure 133. Plan view of the Feature 5, the "south cave"

Subsurface Testing of the Lithified Coral Bluff above Feature 5

Hand excavation of a test unit was conducted on top of the bluff above the cave designated Feature 5 to recover physical evidence of pre-Contact (prehistoric) occupation of Lokoea. TU-8 was placed several meters back from the edge of the bluff (see Figure 37) in a level area near the current warehouse.

TU-8, a 1.0 m x m by 1.0 m test unit, was hand-excavated to 50 cmbs (Table 10, Figure 134 and Figure 135). A single sedimentary layer was excavated on top of the lithified coral outcrop, which was exposed throughout most of the unit between 20–25 cmbs. A deeper crevice was located along the north side of TU-8. We removed a portion of this deeper material down to 50 cmbs, but stopped when it became clear that it was sterile (Figure 136). Also, it is very likely that this crevice continued on down to the cave system below, and we did not want to undermine or impact this underlying feature.

The excavation of TU-8 failed to identify any cultural material on the bluff. Given these results, and in the context of similar results from TU-7 (see below), it is likely that any old Hawaiian occupation of this bluff was obliterated (graded or scraped away) long ago.

#	Cmbs	Thickness	Description	Interpretation
		(cm)		
Ι	0-23/50	23–50	Dark yellowish brown (10YR 3/4) silt; dry, non-plastic, moderately loose consistency; abundant cobble- and pebble-sized lithified coral inclusions; irregular (undulating) lower boundary; no cultural	This natural layer rests directly atop the lithified coral outcrop, which is its parent material; the lithified coral outcrop was not exposed in the north portion of TU-8—the sediments appear to extend down into a crevice that may go to the water of the pond
			materials	or the cave system; we did not want to undermine the cave below (Feature 5 system)

Table 10. TU-8 Stratigraphic Description

BOE = Base of excavation = 50 cmbs





Figure 134. TU-8 plan view at base of excavation (top) and stratigraphic profiles of west and north walls (below)



Figure 135. Overview of TU-8 location facing northwest



Figure 136. TU-8 after excavation to 50 cmbs

Feature 6 – North Cave

Feature 6 is another small, natural cave formed under the lithified coral reef bluff that defines much of the northeast margin of Lokoea pond (see Figure 37 for location). Figure 137 shows the entrance and area in front of Feature 6. Figure 138 is a plan map of the cave. There are some stacked and aligned boulders just north (to the left in the view below) of the entrance to the cave opening (these are depicted in the plan map below). It is not altogether clear whether these exterior rock modifications are associated with the cave or whether they were constructed during the 1960s formalization of the Keiki pond, which is immediately adjacent to the north and into which trickles spring water from the cave. We were, once again, well aware of the Laniwahine mo'olelo discussed above in the context of the south cave (Feature 5), and cognizant of the possibility of encountering potentially sensitive items; thus, we conducted ourselves with due caution.

The inner chamber extends further back than Feature 5, but its ceiling is relatively lower, no more than 70 cm high. We did not find any artifacts, but we did identify an upright coral slab (Figure 139) that may have been positioned in place by someone in the past. The function or significance of this slab is unknown but it should be treated with respect.



Figure 137. North cave, Feature 6, from which emanates fresh water from a subterranean spring; view ESE



Figure 138. Plan view of the Feature 6, the "north cave"; the "upright" is a slab of lithified coral (see photograph below)



Figure 139. White-colored upright coral slab within the north cave (Feature 6); the slab is about 40 cm high; its location is depicted in the previous plan map above

Subsurface Testing of the Lithified Coral Bluff above Feature 6

Hand excavation of a test unit was conducted on top of the bluff above the cave designated Feature 6 to recover physical evidence of pre-Contact (prehistoric) occupation of Lokoea. TU-7 was placed several meters back from the edge of the bluff (see Figure 98) in a level area overlooking the Keiki pond.

TU-7, a 1.0 m x m by 1.0 m test unit, was hand-excavated to 40 cmbs (Table 11, Figure 140 and Figure 141). Two sedimentary layers were excavated: Layer I, a relatively thin silt that looks reddish in the field—this is a modern fill layer spread over the bluff area; and Layer II, the natural silt resting directly on top of the lithified coral outcrop (which is its parent material). The bottom of this layer is undulating as it overlies the coral (Figure 142). We investigated a charcoal stain in the northeast quadrant, but it did not have any formal structure indicative of a cultural feature. Layer II was sterile.

The excavation of TU-7 failed to identify any cultural material on the bluff. Given these results, and in the context of similar results from TU-8 (see above), it is likely that any old Hawaiian occupation of this bluff was obliterated (graded or scraped away) long ago.

#	Cmbs	Thickness	Description	Interpretation
		(cm)		
Ι	0-10/12	10-12	Dark yellowish brown (10YR 3/6) silt; dry, crumbly, non-plastic, moderately loose consistency; occasional pebble-size lithified coral inclusions; roots and rootlets common; regular lower boundary; no cultural materials	This introduced (fill) layer is relatively inert, inorganic top layer upon which surface vegetation is growing; appears reddish in the field
Π	10/12– 17/50 BOE*	12–40	Dark brown (10YR 3/3) silt; dry, non-plastic, moderately loose consistency; abundant cobble- and pebble-sized lithified coral inclusions; irregular (undulating) lower boundary; no cultural materials	This natural layer rests directly atop the lithified coral outcrop, which is its parent material; a small boulder of basalt was located in the northwest corner; a charcoal stain was located in the northeast quadrant

Table 11. TU-7 Stratigraphic Description

BOE = Base of excavation = 40 cmbs





Figure 140. TU-7 plan view at base of excavation (top) and stratigraphic profiles of west and north walls (below)



Figure 141. Overview of TU-7 location on top of the lithified coral outcrop above Feature 6



Figure 142. TU-7 after excavation

Feature 7 – Dry-stacked Rock Boundary Wall

Feature 7 is a low rock wall running along a portion of the TMK boundary with the adjacent Jameson's Restaurant parcel (6-2-003:014). The wall is oriented roughly NE to SW and is approximately 32 m long. We briefly inspected Feature 7 and mapped its location (Figure 143) but did not document it in detail due to time constraints and other, more pressing priorities. The dry-stacked wall is very well constructed with shaped and fitted basalt rocks giving it a square profile approximately 30 cm high and wide.

This feature is currently protected by a small fence installed by MLEF to keep it from being damaged by activities in the adjacent parking lot.



Figure 143. Plan view showing the location of Feature 7, dry-stacked boundary wall along the TMK boundary with 6-2-003:014

Other Features: Wahi Pana and Non-historic Age Structures

Eight other features (A–H) were identified that are not historic-age archaeological sites, and whose study was not a primary focus on this AIS work. Some of these have cultural, historical or spiritual value to people once or currently associated with Lokoea (e.g., the Queen's bath, a modern $K\bar{u}$ p \bar{o} haku and a possible Ko'a shrine). Some of these features are purely functional constructions recently built by MLEF and previous pond tenants to meet their resource management needs (e.g., the low rock retaining wall along the north side of Lokoea Stream). A rock wall by the driveway entrance to the pond was recently built for education purposes.

All of these features have been located on plan maps made by TCP Hawai'i and presented in the narrative descriptions of the numbered features above. In general, we did not investigate or research most of these "other" features in great detail, although we do provide some, limited oral-historical information for a few of these. The primary reason for including these features—and mapping them especially—is to aid in future cultural resource management of Lokoea by memorializing the presence of phenomena that will pass into historic "old age" someday if left alone.

Feature A is a Kū pōhaku shrine built by MLEF (Figure 144) at the top of the east bank of the Keiki pond. The plan map of the Keiki pond depicts the location of this modern shrine (see Figure 98). The raised bank upon which it sits was created during a phase of major landscape modification in the 1960s when earth-moving equipment was used to formalize the pond (from its previous natural, marshy configuration) by creating a boulder-retained perimeter on its east and north sides. According to MLEF staff, the water worn pōhaku ("standing stone") at Feature A was discovered while clearing vegetation in the area; it was placed in an upright position on a small prepared base of rounded boulders and cobbles. The shrine sits just north of the end of the lithified coral reef (raised bluff) and has a commanding view of the Keiki pond, the island and the waterway to 'Uko'a (see Figure 100). This contemporary construction was built around 2010 and retains cultural and spiritual value to MLEF.



Figure 144. Kū pōhaku shrine, Feature A, built by MLEF; view east; scale = 50 cm

Feature B is an earthen and boulder ramp up to the warehouse area (top of the eastern bluff) from the east end of Feature 2 (Figure 145). The plan map of Feature 2 also depicts the location of this modern feature (see Figure 79), which was recently (around 2010) built by MLEF using earth-moving equipment. Prior to the construction of this ramp, the natural raised bluff created an obstacle to getting up to the warehouse area, and there is an old metal ladder in place to the right of this ramp structure that previously functioned as the way up.

This feature is an example of a purely functional modification to the pond landscape by the current tenants in order to meet their immediate management needs. They store educational materials and other equipment in the warehouse that is frequented by large groups from the community; thus, the walkway has been improved by virtue of this earthen and rock structure.

Without conducting much more investigation (e.g., trenching with a backhoe through this area), it is not possible to accurately map the lateral extent of the recent (circa 2010) modification—that is, how far north and south the 2010 ramp deposit extends; and, it is possible that some of this raised earthen and rock area was partially built up in the major 1960s formalization of the Keiki pond area. To the right of the ramp structure, in the shallow, near shore waters of the main pond, there are numerous large boulders with bulldozer scars that seem to be several decades, rather than, years old based on their weathering and patina.

In any case, it is likely that this area was never modified as such by Native Hawaiians back before the Historic era; and that the pond margins traditionally lapped up close to, if not directly against, the foot of the bluff.



Figure 145. Feature B, earthen and boulder ramp (arrows) built by MLEF up from the east end of Feature 2 (the pā, or wall, in the foreground) to the raised bluff and warehouse (right, background); view east

Feature C is a low rock retaining structure recently (2010) built along the north bank of Lokoea Stream (near Jameson's Restaurant) to keep its channel open and directed past the long wall (Feature 1) to the ocean, rather than allowing it to follow its natural tendency to meander and migrate north towards the restaurant and become choked with sand and debris. The location of this feature is depicted on several plan views presented earlier in the report (see Figure 37 and Figure 38). Feature C is included in several photographs presented above (see Figure 40 and Figure 118).

This feature is an example of a purely functional modification to the pond landscape by the current tenants in order to meet their immediate management needs. Time spent cleaning out the stream channel is time away from other pursuits. Wyban's (1992) memoir of living and working at the pond in the early 1980s discussed the labor-intensive nature of having to maintain and clean out this important drainage channel. Photographs from the middle 1970s obtained from KS for information only—not included in this document—show a meandering stream channel, part of which was choked with vegetation, and substantial sands bars in the area between the Feature 1 wall and a building structure (now Jameson's Restaurant).

Feature D is a low (approximately 50 high), dry-stacked rock wall just outside the main gate into the property, along the driveway out to the restaurant parking area (Figure 146). According to several individuals familiar with Lokoea's recent past, this wall was built around 2009 as an educational project (i.e., traditional, dry-stack rock construction techniques). The location of this feature is shown in Figure 106.



Figure 146. Feature D, dry-stacked rock wall built around 2009, along driveway into the pond; scale = 50 cm in height and width; view north

Feature E is the hau thicket on the southwest shoreline of the pond (for location, see Figure 37), straddling KS' TMK parcel and the adjacent Queen Lili'uokalani Trust lands, reportedly once reserved for exclusive use by Queen Lili'uokalani (Figure 147).

There is a general sense among people currently associated with Lokoea that this Queen's bath is a significant resource, but we were unable to obtain any specific knowledge of what this specific feature (other than being in the hau bushes) once looked like or looks like now.

Carol Wyban mentions this wahi pana in her memoir, and also includes the unfortunate observation that dredge from the main pond during the 1960s phase of modification by the Kearns family was dumped in the "queen's swimming hole" (Wyban 1992:9). If there ever was a formal feature—such as a rock-defined pool—in the hau bush before this dumping event, it is not observable at the ground surface today. We crawled through the entire hau thicket twice and found nothing but a small earthen depression; two small boulders were observed in different places of the hau bush (i.e., one in one place, the other elsewhere—neither at the earthen depression).

If there is any extant formal structure to this wahi pana, it is buried under the ground surface.



Figure 147. Hau thicket within which the Queen's bath is or was once reportedly located; in this view, to the SSE, the hau thicket, and thus the general location of the Queen's bath, is indicated by the arrow

Feature F is a group of small islets of lithified coral outcroppings in the main pond adjacent to the island and Feature 2. A series of dilapidated wooden foot bridges are scattered about these outcrops, which are sometimes used for line fishing. We did not spend time researching when these wooden structures were first built, but they do appear to show up as a very well defined linear feature on the 1974 aerial photograph (see Figure 28). In any case, they are currently a safety hazard given their state of disrepair. The location of Feature F is mapped on several plan maps above. It seems reasonable that these small islets have been important natural components of the pond, likely used to throw net or line fish, for as long as there have been fish in the pond.

Feature G is a natural, remnant outcrop of lithified coral reef resting conformably on weathered basalt interpreted as a Ko'a (fish god) shrine by Wyban, based on the interpretation of Keoni Dudley (Wyban 1992:18). The location of Feature G is depicted in plan maps of Feature 3 (see Figure 98). Photographs are shown in Figure 4 and Figure 102. We did not spend much time searching for additional, oralhistorical confirmation of Dudley's interpretation, although we did discuss the matter with Carol Wyban. In the final analysis, it would appear this interpretation represents Mr. Dudley's mana'o, ideas or opinion, rather than any specific knowledge passed down from kūpuna associated with Lokoea. Based on archaeological criteria, the natural outcrop does not resemble ko'a with which we are familiar—those typically are constructed piles or platforms of rock and/or coral, rather than free-standing natural outcrops.

Feature H is a few informal stackings and in-fillings of cracks and puka (holes) along the front face of the raised lithified coral bluff. We did not document these minor features in detail, but they are part of the current modified landscape at Lokoea. There are several of these between the north and south caves on either side of the modified ramp up to the top of the bluff. Their purpose is to reinforce the cracking bluff top and front; to reduce soil erosion from the upper surface down to the pond; and to increase useable ground surface area on top. Wyban (1992) notes this upper bluff was known among locals as "Mockingbird Hill," and she fondly recalls many $p\bar{a}$ in a here. The general location of this feature—really a series of several features—is indicated on the overall plan map for Lokoea (see Figure 37), but we did not specifically map them. Figure 148 shows a representative example.



Figure 148. Representative example of Feature H in-filling of a lower level of the bluff (arrows); view NE

Laboratory Results

One of the most interesting finds was the wooden object recovered in TU-1. This artifact—which was analyzed for data relevant to its taxonomy, age and function—is discussed in detail below. Besides this single wooden object, the test excavations, in general, yielded relatively few portable artifacts. This result was consistent with our expectations prior to the Phase 1 excavation, which was focused on obtaining evidence of the structure and constituent material of the fishpond structures, rather than artifacts or subsurface features typically associated with habitation sites or activity areas (e.g., domestic objects or food midden, byproducts of tool manufacture or maintenance, fire pits or imu). During Phase 2 excavation, we managed to find traditional Hawaiian artifacts near the base of excavation in TU-5, on the north side of the central island.

The two units at the far end of Feature 1 (TU-3 and TU-4) yielded only modern trash in their upper layers dating to no earlier than 1980. TU-6, on the south side of the central island, yielded small amounts of historic debris from the middle 20th century. We submitted a wood charcoal sample from a subsurface fire place feature in TU-6, but it proved to be an alien, introduced species (Douglas fir). None of the modern or late historic artifacts from TU-3, TU-4 or TU-6 were collected or analyzed. Two units on top of the coral bluff on the east side of the fishpond (TU-7 and TU-8) were culturally sterile.

TU-1, TU-2 and TU-5 yielded a small number of artifacts as summarized in Table 12. Photographs of all items listed in the table for TU-1 and TU-2 are included in Appendix D for reference. With the exception of the possible hammerstone (which has been saved), photographs of the TU-5 materials are in the main body of the results description above.

From an analytical perspective, there is not much of particular interest regarding the artifacts recovered in TU-1 and TU-2; however, the provenience, or stratigraphic position, of some of these is worth highlighting. In TU-1, a most surprising find was the discovery of a large piece of brown bottle glass near the base of excavation, in the center of the trench, at 125 cmbs; this was more or less in direct association with the wooden artifact. Both of these items were contained in a clay fill interpreted as constituent construction material making up the core of the Feature 1 wall, which we assumed was older than the Historic period. The implication of this is that the base core of Feature 1 is not very old.

In TU-2, a noteworthy find was the discovery of a plastic bottle cap at 70 cmbs—relatively deep into the rocky rubble fill comprising the constituent core of the Feature 2 wall; and below a modest amount of historic-era debris. Once again, we were somewhat surprised to see modern debris near the base of this feature. We now know the entire feature post-dates 1928.

One observation made on a small number of artifacts in both TU-1 and TU-2 (especially on ceramic sherds) was their high level of edge abrasion/ rounding such as one might observe on a sandy beach (as with "beach glass"). This is consistent with the interpretation that these artifacts were simply incorporated into fill sediments and do not indicate any specific activities took place at these test unit locations.

Wooden Object Recovered in Excavation at TU-1

The stratigraphic context and discovery of this object in TU-1 were described and depicted above. Photographs of this artifact immediately after it was removed from the excavation—when it was still wet from being so close to the water table—were included above as well (see Figure 61 through Figure 63). The photographs below (Figure 149 through Figure 151) were taken after the object had a chance to dry in storage. Because we were not entirely sure what this object represented—what its function might have been—we transmitted photographs and notes to several knowledgeable individuals to see if they had any specific functional hypotheses.¹⁴ Our initial impression, based not only on the actual object but also its archaeological and physiographic context, was that it was some kind of maritime or fishing-gear item.

¹⁴ These individuals included Pat Kirch (University of California-Berkeley), David Shideler (Cultural Surveys Hawai'i), Kai Markell (Office of Hawaiian Affairs) and Susan Lebo (State Historic Preservation Division)

Based only on what we provided, other hypotheses offered by the consulted individuals included a stool leg, a kalo cutter, a net-making tool and part of the framing ("arm extension") of an outrigger. Monahan also consulted several authoritative, published volumes—including Peter Buck's (Te Rangi Hiroa) multi-volume *Arts and Crafts of Hawaii*—and poured over the items at the Bishop Museum's Hawai'i Hall, but found really no close matches or possibilities. Based on close examination of this object, and a heavy dose of intuition, we believe the item is a rudder handle, a component part of a composite rudder, for a small sail boat, as depicted in the schematic sketch (Figure 152).

This style of rudder is *not* a traditional Hawaiian or Polynesian one, and this interpretation implies the wooden object is a product of the Historic period. Both the taxonomic and radiocarbon dating results support this interpretation.

We submitted a small (0.22 gram) sample of the partially damaged (narrow, tapered) end to the International Archaeological Research Institute's Wood Identification Lab (Honolulu) for taxonomic identification (Appendix B). The sample was identified as Douglas fir (*Pseudotsuga menziesii*), a native of the Pacific Northwest and western U.S.

Beta Analytic's (Miami) dating of this sample returned a conventional (AMS) radiocarbon date of 160 +/-30 BP (years before present), which translates in layman's terms to AD 1760–1820 because the "present" in BP, by convention, has been set at 1950 (after which time widespread global nuclear testing skews the data). Unfortunately, for dates that are less than ~250 BP, meaningful calibration—that is, a statisticallyrelevant statement about the probability of this single date referring to a specific calendric time period—is not possible. Several calibrated ranges of dates are included in Appendix C for reference, but it is not possible to scientifically choose among these date ranges. It does seem relevant, however, that this object did not return a very old (pre-Contact) date; and that other observations such as its taxonomy and interpreted function are suggestive of a Historic period date.

Unit	Depth (cmbs)	Provenience	Description	Comments
TU-1	30-40	North half of trench	2 pieces of unidentifiable ferrous metal	One of these appears to be a nail but it is too degraded to identify any further
	40-50	North end of trench	1 shard clear window glass, 1 shard brown bottle glass, 1 small glass bottle with plastic cap	Glass bottle with plastic cap looks like a nail polish container
	40-50	South end of trench	1 shard very thin opaque glass, 2 fragments unidentifiable ferrous metal, 1 small fragment ceramic vessel with blue decoration (possible Asian tea cup)	The ceramic sherd has abraded/ rounded edges—resembles "beach glass"; opaque glass looks like light bulb material
	80	South half of trench	1 ceramic sherd with green decoration	
	90	North half of trench	1 shard clear window glass	
	90-100	North end of trench	Representative chunks of degraded corrugated sheet metal with adhering conglomerate	The depth (90-100 cmbs) is just a sample—this material is part of a subsurface feature that extends from ~60-130 cmbs
	125	Center of trench	1 large shard brown bottle glass	As described in the section above on Subsurface Testing at TU-1, the stratigraphic context of this find suggests the base sediments of Feature 1 are not particularly old
TU-2	10-20		2 opaque bottle glass shards, 1 brown bottle glass shard	
	20-30		1 medium-sized clear glass medicine bottle	Lacks maker's mark; shoulders and neck are missing
	20-30		1 snapped basalt flake, 4 shards very thin clear glass, 2 ceramic sherds, 1 shard clear window glass, 1 shard brown glass	1 of the ceramic sherds has blue decoration; snapped basalt flake is distal end (proximate end with bulb of percussion is missing)
	38		1 large clear bottle glass shard	
	40-50		1 thick shard dark green bottle glass	This appears to be a piece of the base of a wine bottle
	50		1 large white ceramic sherd, 1 clear glass shard	The ceramic shard has abraded/ rounded edges
	70	Northwest corner	1 black plastic threaded cap	Diameter 1 ³ / ₄ inches
TU-5	100	Plotted – see Figure 119 & 120	Side-notched net weight or sinker on basalt cobble	9.6 cm (maximum length) x 6.8 cm (maximum width) x 3.4 cm (maximum thickness)
	105	Plotted (near northeast corner) – see Figure 120	Possible hammerstone of very dense black basalt	10.1 cm (maximum length) x 6.3 cm (maximum width) x 4.2 cm (maximum thickness)
	95–105	Layer VI	4 fragments of fire-affected rock (basalt)	These fire-affected rocks were recovered from the same stratum as the net weight and the possible hammerstone





Figure 149. Two sides of the wooden artifact after drying in storage; scale = 20 cm



Figure 150. Detail of wide end of wooden object showing adhering dry clay matrix (arrow); scale = 10 cm



Figure 151. Detail of hole in the wooden object showing use-wear groove emanating from hole; scale = 10 cm



Figure 152. Schematic sketch of one possible functional interpretation of the wooden object recovered in excavation at TU-1: the handle, or tiller, of a composite rudder on a small sail boat; overall length of the object ("rudder handle") is 87 cm (34.3 inches) or approximately 2.9 feet

CONCLUSION

Significance Assessment

As far as we know, although Lokoea Fishpond was assigned a State Site number (50-80-04-233) long ago, it has never been formally assessed for historic significance.

Once a historic property is evaluated as "significant," and the SHPD/ DLNR concurs, this implies it is eligible for the Hawai'i Register of Historic Places (HRHP). In accordance with HAR §13-284-6, significance of a historic property is evaluated by first establishing that it possesses "integrity of location, design, setting, materials, workmanship, feeling, and association," and, second, that it meets one or more of the following criteria:

- A. Be associated with events that have made an important contribution to the broad patterns of our history;
- B. Be associated with the lives of persons important in our past;
- C. Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;
- D. Have yielded, or is likely to yield, information important for research on prehistory or history; or
- E. Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts--these associations being important to the group's history and cultural identity.

Although substantial portions of Lokoea have been altered, modified and rebuilt over time, from its probable origin in the pre-Contact period through the Historic and Modern eras, its basic structure and configuration—especially of Features 1 (large wall extending makai from the island) and 4 (the central island)—has probably not changed much. This is primarily due to the natural, physiographic constraints and opportunities presented by the local geology, terrain, soils and hydrology. Furthermore, from a Hawaiian perspective, it is probably true that fishponds, more than any other traditional constructions, have *always* required significant maintenance and modification over time. In other words, this history of alteration, modification and rebuilding we have documented in portions of Lokoea is *normal* and to be expected, *especially* at pu'uone fishponds. For example, between 1928 and 1938-42, Feature 2 appears to have been rebuilt in a slightly different location and orientation.

With these comments in mind, we believe Lokoea possesses a high degree of integrity of location, design, setting, materials, workmanship, feeling, and association with the caveat that its features integrate different time periods and styles, rather than a single "snap shot" in time.

Therefore, TCP Hawai'i evaluates Lokoea, in its entirety, including all seven of the archaeological features identified in this AIS report, as historically significant under criteria B, C, D and E.

<u>Criterion B</u> applies because many ali'i, including monarchs such as King Kamehameha I, Queen Emma Kaleleonālani, and Queen Lili'uokalani, spent time at Lokoea; in the case of Kamehameha, this may have only been a brief visit—on one of his "working the land" demonstrations for which he was famous; but others, such as Queen Lili'uokalani, spent considerably more time at Lokoea.

<u>Criterion C</u> applies because of the quality of much of the wall building (for example, significant portions of Features 1 and 2) and overall engineering of the entire system, which ingeniously walls off the 'Uko'a waterway from the south end of the wetland, thereby creating what we call Lokoea; at the same time, the multiple sluices gates and causeways allow for a significant degree of control over the management of fresh and salt water that is so integral to an active pu'uone fishpond.

<u>Criterion D</u> applies because of the wealth of potential archaeological data that still lies locked in the subsurface deposits of Lokoea; in particular, we demonstrated that the central island upon which the main

structure (office) now sits contains a traditional, likely pre-Contact (prehistoric) deposit dating from the initial development of Lokoea. We only looked at a small (1.0 m by 1.0 m) portion of this cultural layer, which extends laterally in all directions around the test unit (TU-5).

<u>Criterion E</u> applies because of Lokoea's ongoing role in the perpetuation of the traditional cultural practice of fish-farming by Native Hawaiians, including the Mālama Loko Ea Foundation (MLEF).

Project Effect and Recommendations

The proposed project for which this study was conducted is the development and implementation of an Archaeological Site Preservation and Development Plan (Preservation Plan) by KS in support of MLEF's efforts to move forward with their activities and kuleana at Lokoea. Based on all available information gathered during this study, TCP Hawai'i's project specific effect recommendation is "effect, with proposed mitigation commitments."

The recommended mitigation measures, which will be delineated in a Preservation Plan developed in consultation with MLEF, will reduce the project's effect on the historic property of Lokoea Fishpond by identifying high, moderate and low sensitivity areas of the project area; and proposing what types of activities (e.g., new construction, rebuilding and rehabilitation of existing structures) can take place in these areas. Preliminary consultation with MLEF has indicated they are broadly interested in preserving and enhancing as much of the old, traditional Hawaiian feel of the built structures as possible.

Finally, we propose renaming the entire 'Uko'a-Lokoea system as the 'Uko'a-Lokoea Fishpond Complex. This would combine the two State Site numbers (233 for Lokoea and 236 for 'Uko'a) and recognize once again the true Hawaiian sense of place that is Ka-wai-loa ("the two waters").

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LIST OF APPENDICES

- 1. Consultation letter sent to OHA and SHPD on 12/20/12
- 2. Wood identification report from International Archaeological Research Institute, Inc.
- 3. Radiocarbon dating report from Beta Analytic, Inc.
- 4. Photographs of Portable Items Recovered in Excavation

APPENDIX A. CONSULTATION LETTER SENT TO SHPD/DLNR & OHA



TCP Hawaiʻi, LLC

Documenting Traditional Cultural Properties of Hawai'i Preserving and Restoring Cultural and Natural Resources of Hawai'i

December 20, 2012

To: [Consulting party]

Re: Consultation for an Archaeological Inventory Survey of Loko Ea, Kawailoa Ahupua'a, Waialua District, O'ahu Island, Hawai'i, TMK (1) 6-2-003:002

Aloha [Consulting party],

TCP Hawai'i, LLC, is conducting an Archaeological Inventory Survey (AIS) of Loko Ea in Kawailoa Ahupua'a, Waialua District, O'ahu Island, TMK: (1) 6-2-003:002 (see Figure 1) in support of a project to develop an Archaeological Site Preservation and Development Plan (hereafter, Preservation Plan, or PP). The approximately seven-acre project area is located near Kamehameha Highway and Jameson's By The Sea Restaurant in Hale'iwa. The AIS fieldwork is scheduled to begin in mid-January and to last approximately one week. The purpose of this letter is to notify you that the subject project could affect historic properties of interest to you or your organization. In accordance with Hawai'i state law, consultation for this project includes (1) notifying you of the proposed project; and (2) seeking your views on the identification, significance evaluations and mitigation treatment of these properties.

Project Background

The project proponent is Kamehameha Schools, 567 South King Street, Suite 200, Honolulu, HI 96813. The project representative is Sean McNamara, phone (808) 534-3952, email: semcnama@ksbe.edu. The AIS is being conducted in order to inform the PP, which will be developed in collaboration with KS' non-profit partner organization Mālama Loko Ea. This community group has begun restoration efforts at Loko Ea, which is a pu'uone-type (inland, brackish) fishpond, including the raising of 'ama'ama, 'āholehole and others. The pond is also frequented by native and endemic birds such as 'alae ke'oke'o and 'auku'u. The results of the AIS will provide specific archaeological, historical and cultural information on Loko Ea, in the context of other significant resources such as 'Ukoa Fishpond and the wider cultural landscape of the muliwai of Anahulu Stream. This information will facilitate project planning and consultation for the PP.

Historic Preservation Context

The proposed work will satisfy the general requirements of HRS Chapter 6E-42 and HAR Chapter 13-284; and the specific details in HAR Chapter 13-276 governing the conduct and components of an AIS.

Loko Ea (State Site # 50-80-04-233) is closely associated with 'Ukoa Fishpond (State Site # 50-80-04-236). These cultural resources were physically connected in historic and pre-Contact times. As such, there are significant metaphysical and spiritual connections between these wahi pana, both of which are well known in the historical literature as royal fishponds. Numerous ali'i, including Kakuhihewa, Ka'ahumanu and Lili'uokalani, had exclusive rights to Loko Ea in the 19th century. Substantial modifications to the pond were made by the Waialua Sugar Company.

In general, the objectives of the current AIS are to develop a spatial and temporal reconstruction of the evolution of Loko Ea from ancient times to the present. Paleoenvironmental work at 'Ukoa Fishpond (Athens 1993; Athens et al. 1995) suggests human settlement of the project area environs is at least 1,000 years old. Subsurface testing will focus on identifying phases of fishpond modification as well as evidence of habitation around the margins. Work at the ground surface will focus on identifying all features greater than 50 years in age. These data will eventually be integrated into an overall picture of how Loko Ea has changed through time.

An important component of the current AIS is the translation and interpretation of Hawaiian language documents, including newspapers and Land Commission documents. Our overall approach is to treat the Hawaiian-language information as a complementary component of the AIS, rather than as merely background information. This integrated approach guarantees the AIS will go above and beyond regulatory adequacy by addressing meaningful research objectives in a holistic way that expresses a Hawaiian sense of place about the project area.

Participating in the Consultation Process for this Project

In addition to consulting with Mālama Loko Ea, which we anticipate will lead us to specific individuals that may share relevant information on the identification, significance evaluation and mitigation treatment of historic properties at Loko Ea, we also seek your participation in this process. This consultation letter has been sent to representatives of SHPD/DLNR and OHA. Please let us know if you are aware of other individuals or organizations you believe should be included in consultation for this AIS.

When a draft AIS report is completed, you will also be sent a copy for your review and comment. Should you have any input at the present time regarding the identification, significance evaluations and/or mitigation treatment of any affected historic properties, please contact Chris Monahan to discuss how we can work together to address your concerns.

Please feel free to contact me if you have any questions about this request for consultation.

With aloha,

Chul

Christopher M. Monahan, Ph.D. Principal Investigator, Archaeologist TCP Hawai'i, LLC 333 Aoloa Street, #303 Kailua, HI 96734 (808) 754-0304 mookahan@yahoo.com


Figure 1. Loko Ea boundary depicted in red; note, KS lands around the fishpond extend out to the blue line

APPENDIX B. WOOD IDENTIFICATION REPORT BY IARII

WOOD TAXA IDENTIFICATION OF A SAMPLE FROM LOKOEA FISHPOND, KAWAILOA, O'AHU ISLAND

By

Trever Duarte and Gail M. Murakami April 17, 2013

INTRODUCTION

This report presents the result of taxa identification of a single wood sample from Lokoea fishpond, Kawailoa, Waialua, O'ahu, performed at the request of Chris Monahan, TCP Hawai'i, LLC. The identified sample is from a wood object approximately 80 cm (length) by 2 cm (thickness) that was recovered from an excavation along the fishpond rock wall.

METHODS

A small sample piece (0.22 g) was removed from the worked wood using a hand held razor blade. The freshly cut transverse and tangential facets of the wood sample was viewed under magnification of a dissecting microscope. Taxa identification was made by comparing the anatomical characteristics seen during examination against those of known woods in published descriptions, such as Barefoot and Hankins (1982).

RESULTS AND DISCUSSION

This wood is probably *Pseudotsuga menziesii* (Mirabel) Franco, also known as Douglas fir. This large evergreen tree which may be up to 61 m (200 ft.) in height is found from central British Columbia south along the coast to central California and from the Rocky Mountains to southeast Arizona and Texas. Pockets of these trees may be found in north and central Mexico (Neal 1965:42). The wood has been used in building and construction as lumber, timbers, piling and plywood; as veneer; railroad ties; pulp; planing-mill products such as sash, doors, flooring, and general millwork; boxes and crates; ship- and boatbuilding; and furniture (Brown and Panshin 1940:395-396).

Small trees of Douglas fir are annually shipped from the Pacific Northwest to Hawai'i for use as Christmas trees. A small population has been planted at about 5,000 ft elevation on the Hamakua coast of Hawai'i Island (Staples and Herbst 2003:69, Neal 1965:42), and within Volcano Village around 4,000ft elevation (G. Murakami pers. com.). The introduction date of the planted Douglas firs is not known at this time.

The immediate implication of this identification of modified Douglas fir is that it dates to a more recent time and likely was imported as lumber.

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APPENDIX C. RADIOCARBON DATING REPORT BY BETA ANALYTIC



Beta Analytic Inc. 4985 SW 74 Court Miami, Florida 33155 USA Tel: 305 667 5167 Fax: 305 663 0964 Beta@radiocarbon.com www.radiocarbon.com Darden Hood President

Ronald Hatfield Christopher Patrick Deputy Directors

May 15, 2013

Dr. Christopher Monahan TCP Hawaii LLC 333 Aoloa Street #303 Kailua, HI 96734 USA

RE: Radiocarbon Dating Result For Sample LOKOEA 13091

Dear Dr. Monahan:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. The report sheet contains the method used, material type, and applied pretreatments and, where applicable, the two-sigma calendar calibration range.

This report has been both mailed and sent electronically. All results (excluding some inappropriate material types) which are less than about 42,000 years BP and more than about ~250 BP include a calendar calibration page (also digitally available in Windows metafile (.wmf) format upon request). Calibration is calculated using the newest (2009) calibration database with references quoted on the bottom of the page. Multiple probability ranges may appear in some cases, due to short-term variations in the atmospheric 14C contents at certain time periods. Examining the calibration graph will help you understand this phenomenon. Don't hesitate to contact us if you have questions about calibration.

We analyzed this sample on a sole priority basis. No students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. We analyzed it with the combined attention of our entire professional staff.

Information pages are also enclosed with the mailed copy of this report. If you have any specific questions about the analysis, please do not hesitate to contact us. Someone is always available to answer your questions.

The cost of the analysis was charged to the VISA card provided. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely, Dardew Hood

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Christopher Monahan

TCP Hawaii LLC

Report Date: 5/15/2013

Material Received: 5/2/2013

Sample Data	Measured	13C/12C	Conventional
	Radiocarbon A ge	Ratio	Radiocarbon A ge(*)
Beta - 348082	140 +/- 30 BP	-24.0 0/00	160 +/- 30 BP
SAMPLE : LOKOEA 13091			
ANALYSIS : AMS-Standard del	ivery		
MATERIAL/PRETREATMENT	: (wood): acid/alkali/acid		
2 SIGMA CALIBRATION :	Cal AD 1660 to 1710 (Cal BP 290 to 240) AND Cal AD 1720 to 1830 (Cal BP 230 to 120)		
	Cal AD 1830 to 1890 (Cal BP 120 to 60) AND Cal AD 1910 to post 1950 (Cal BP 40 to post 1950)		

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard. The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS



Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@ radiocarbon.com

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APPENDIX D. PHOTOS OF ITEMS RECOVERED IN EXCAVATION



2 ferrous metal objects, northern half of TU-1, 30-40 cmbs



1 shard clear window glass (left), 1 shard brown bottle glass (center), 1 glass bottle with plastic cap (right), north end of TU-1, 40-50 cmbs



1 shard very thin opaque glass (center bottom), 2 fragments unidentifiable ferrous metal, 1 small fragment ceramic vessel (possible Asian tea cup) (left), south end of TU-1, 40-50 cmbs



1 ceramic sherd with green decoration, south half of TU-1, 80 cmbs



1 shard clear window glass, northern half of TU-1, 90 cmbs



Representative chunks of degraded corrugated sheet metal with adhering conglomerate from the subsurface (intrusive) feature in the north end of TU-1, 90-100 cmbs



1 large shard brown bottle glass, center of TU-1, 125 cmbs



1 medium-sized clear glass medicine bottle, TU-2, 20-30 cmbs



1 snapped basalt flake (right), 4 shards very thin clear glass, 2 ceramic sherds, 1 shard clear window glass, 1 shard brown glass, TU-2, 20-30 cmbs



Closer view of the snapped basalt flake from TU-2, 20-30 cmbs



1 large shard of clear bottle glass, TU-2, 38 cmbs



1 thick shard dark green bottle glass (base of wine bottle), TU-2, 40-50 cmbs



1 white ceramic sherd (left), 1 clear bottle glass shard (right), TU-2, 50 cmbs



Black threaded plastic cap, TU-2, 70 cmbs