Finding Of No Significant Impact (FONSI)

Environmental Assessment
for the
Nihoku Ecosystem Restoration Project
at the
Kīlauea Point National Wildlife Refuge
March 2014

An environmental assessment (EA) was prepared by the U.S. Fish and Wildlife Service (Service) to evaluate a proposal for the construction of a predator-proof fence, removal of non-flighted mammalian predators from within the fenced unit, and habitat restoration for approximately 7 acres of coastal seabird habitat. The project site is located within the Kīlauea Point National Wildlife Refuge (NWR or Refuge) in Kaua‘i County, Hawai‘i.

The primary goal of the Nihoku Ecosystem Restoration Project (NERP) is to create an area protected from the damaging effects of dogs, cats, rodents, and mongoose and restore native coastal habitat within that area. This would immediately benefit the endangered nēnē (Hawaiian goose) and the mōlī (Laysan albatross), both of which currently nest in the project area. It is hoped that the creation of a predator-free fenced unit will improve nesting success for nēnē and mōlī, facilitate natural re-colonization by other seabirds such as the ‘ā or ‘ua‘u kani, and support future efforts to translocate the threatened ‘a‘o (Newell's shearwater) and reintroduce rare and endangered plants.

Potential impacts associated with Alternative A, the no action alternative, and Alternative B, the proposed action, were fully disclosed and analyzed in the EA. As described in detail in the EA, implementation of the proposed action will not result in significant impacts to any affected resources.

Proposed actions include (1) fence construction; (2) predator eradication from within the fenced area and monitoring; and (3) native habitat restoration through invasive species removal and revegetation with native plants.

The Service incorporated a variety of public involvement techniques in developing and reviewing the EA. This included direct mail of an initial scoping letter to a wide variety of Federal, State and County agencies, non-governmental organizations, and individuals, several public presentations about the project, direct mail (to the scoping distribution list) inviting review and comment on the Draft EA, press releases about the project, and posting information about the project and the Draft EA on the Kīlauea Point NWR website. The EA was available for a 45-day public review beginning on September 16, 2013 during which time six public comment letters were received. The comments received expressed concerns over impacts to State water quality, public access to nearby sites, and introduction and spread of invasive species. Responses to the public comments were prepared and are included in the Final EA (March 2014). Based on the public comments we received and considered, Alternative B as described in the EA has been slightly modified.

- Additional information on planned best management practices to reduce the potential for impacts for water quality was added.
- Recommendations to prevent the introduction or spread of invasive species within the project site were incorporated.
- Clarification on the impact of construction to public visitation to nearby sites (Kīlauea Point, Kīlauea Lighthouse) was made.
- Some text changes were made to improve readability and accuracy.

The U.S. Fish and Wildlife Service (FWS) has prepared this Finding of No Significant Impact (FONSI) in satisfaction of requirements of NEPA. This FONSI documents the decision of the Service to construct a predator-proof fence, remove non-flighted mammalian predators, and restore native habitat from within approximately 7 acres of the Refuge.

Based on review and evaluation of the information contained in the EA, I have determined that implementing Alternative B would not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of section 102(2)(C) of the National Environmental Policy Act of 1969. Accordingly, preparation of an environmental impact statement for the proposed action is not required.

This Finding of No Significant Impact and supporting references are available for public review at the Kaua'i National Wildlife Refuge Complex, Kīlauea Lighthouse Road, Kīlauea, HI 96754. These documents can also be found on the Internet at http://www.fws.gov/refuge/kilauea_point/. Interested and affected parties are being notified of our decision.

Acting Ben Harper
Regional Chief, National Wildlife Refuge System

3/19/2014
Date

FINAL
ENVIRONMENTAL ASSESSMENT

Nihoku Ecosystem Restoration Project
Kīlauea Point National Wildlife Refuge
Kaua‘i, Hawai‘i

March 2014

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Executive Summary

In accordance with the National Environmental Policy Act (NEPA), this Environmental Assessment (EA) discloses the effects of alternatives for the proposed Nihoku Ecosystem Restoration Project (NERP) in the Kīlauea Point National Wildlife Refuge (NWR or Refuge). The Refuge is located on the north coast of the island of Kaua‘i in Hawai‘i.

The need for the project is derived from the U.S. Fish and Wildlife Service (USFWS or Service) mission and Refuge-specific goals to conserve migratory birds and federally-listed endangered and threatened plant and animal species. The purpose of the proposed project is to create an approximately 7-acre refugium for native plant and animal communities through fencing, removal of introduced predators, and habitat restoration in the Crater Hill section of the Refuge.

Under the proposed action, the construction of a predator-proof fence would keep non-flighted mammalian predators out of the area so that native species like the endangered nēnē (Hawaiian goose), the mōlī (Laysan albatross), and rare plants can flourish again in a protected environment. In addition, the absence of predators would make this restored site an appropriate future translocation site for the threatened ‘a‘o (Newell's shearwater) and for the reintroduction of rare native plants. While this project would construct the first predator-proof fence on a U.S. National Wildlife Refuge and the first of its kind on Kaua‘i, this type of fencing has been used with great success on the island of O‘ahu, where it resulted in record numbers of seabird chicks fledging in the year immediately following the project's completion and almost doubled the number of chicks within 2 years. It is hoped that similar outcomes will be achieved on Kaua‘i.

The NERP would have primarily positive impacts on the biological resources of the Refuge and no significant impacts would be anticipated. This project would be implemented in coordination with partners, including the American Bird Conservancy, the Kaua‘i Endangered Seabird Recovery Project, the National Fish and Wildlife Foundation, and others.

Chapter 1. Introduction

1.1. Need for and Purpose of Action

The need for this project is derived from the overall USFWS mission and Refuge-specific goals. The USFWS is the primary federal agency responsible for migratory birds, endangered plants and animals, certain marine mammals and anadromous fish. The mission of the National Wildlife Refuge System is to administer a network of lands and waters for the conservation and management of fish, wildlife, and plant resources of the United States for the benefit of present and future generations. Refuge-specific goals include, but are not limited to the following:

- Protect, enhance, and manage the coastal ecosystem to meet the life-history needs of migratory seabirds and threatened and endangered species;
- Restore and/or enhance and manage populations of migratory seabirds and threatened and endangered species.

Kīlauea Point NWR is one of the few places in the main Hawaiian Islands (MHI) with an abundant diversity of seabirds, and it provides a high-island refugium for seabird populations potentially displaced by climate change (e.g., rising sea levels impacting low-lying nesting areas). ʻUaʻu kani (wedge-tailed shearwaters, *Puffinus pacificus*) are the most numerous species on the Refuge, with an estimated 8,000-15,000 breeding pairs. The colony of ʻā (red-footed booby, *Sula sula*) is the largest in the MHI, with a maximum of 2,536 nests counted. About 200 pairs of mōlī (Laysan albatross, *Phoebastria immutabilis*) nest on and near the Refuge, the largest colony outside the Northwestern Hawaiian Islands (NWHI). About 350 pairs of koaʻe ʻula (red-tailed tropicbird, *Phaethon rubricauda*) nest on the Refuge, as well as smaller numbers of koaʻe kea (white-tailed tropicbird, *Phaethon lepturus*). The Refuge harbors at least 13 breeding pairs of ʻaʻo (Newell's shearwater, *Puffinus auricularis newelli*), whose numbers are dwindling on Kauaʻi. The Refuge is the only easily accessible location where this threatened species nests and thus is a source of much information on ʻaʻo breeding biology. A remarkable total of 27 seabird species have been observed at Kīlauea Point over the years, making it one of the premier sites for seabirds in Hawaiʻi (USFWS in prep.) Additionally, there are 300 nēnē (Hawaiian goose, *Branta sanvicensis*) in the Kīlauea Point area, making the Refuge one of the largest concentrations on the island.

However, these ground-nesting birds remain at risk from predation by introduced mammals that may feed on eggs, young, and adults. Feral dogs (*Canis familiaris*), cats (*Felis catus*), rats (*Rattus spp.*), house mice (*Mus musculus*), and small Indian mongoose (*Herpestes auropunctatus*) have all been identified as threats requiring action in the recovery plans for the Hawaiian goose and for endangered plants on Kauaʻi and in conservation plans for migratory seabirds (USFWS 2004, USFWS 1995, USFWS 2005).

Feral dogs (*Canis familiaris*) may seriously influence nēnē populations in the wild and colonial sea bird populations (USDA 2010). Dogs have been identified as responsible for the killing of a number of mōlī at Pacific Missile Range Facility (USDA 2010) and in 2006, 113 ʻuaʻu kani chicks were

killed in a single incident at Kaʻena Point Natural Area Reserve (NAR) by a pack of dogs (DLNR 2009).

Feral cats are potentially the greatest single threat to birds in general and are estimated to kill between 1.4 – 3.7 billion birds and 6.9 – 20.7 billion mammals annually in the United States alone (Loss 2013). In Hawaiʻi, cats are documented predators of endangered forest birds and burrow nesting colonial seabirds and have been suspected in killings of ʻuaʻu kani at Mālaekahana and . Kaʻena Point NAR (USDA 2010, DLNR 2009). In addition, confirmed predation events by cats on both ʻaʻo and Hawaiian petrel (ʻuaʻu, *Pterodroma sandwichensis*) have been recorded in montane breeding colonies on Kauaʻi (KESRP unpublished data).

While not as well-known to the general public, invasive rodents constitute a greater threat to native species, contributing to extinctions and ecosystem-level changes. Worldwide, rats are considered a major threat to seabirds, particularly those that nest in burrows or rock crevices. In Hawaiʻi, rats have been documented to prey on ground-nesting seabirds, including mōlī, ʻuaʻu kani, ʻaʻo, and petrels, forest birds (including the endangered Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*)) and the Laysan finch (*Telespiza cantans*) (USFWS 2008, DLNR 2009, KESRP unpublished data). In addition, as omnivorous feeders, rodents are also known to eat the seeds, fruit, leaves and shoots of Hawaiian plants, including chewing the apical and lateral buds of naupaka (*Scaevola sericea*), stripping the bark of koa (*Acacia koa*) saplings, and eating loulu (*Pritchardia spp*.) seeds (DLNR 2009, Young et al. 2012).

The small Indian mongoose is present on Oʻahu, Molokaʻi, Maui and Hawaiʻi, but until recent years, Kauaʻi was thought to be mongoose-free. On May 23 and June 29, 2012, 2 live mongooses were captured in Līhue and Nāwiliwili Port, confirming the presence of mongooses on the Kauaʻi, and credible reports of sightings now regularly occur (KISC 2012, 2013). In Hawaiʻi, mongooses are diurnal predators that primarily eat invertebrates and small mammals, as well as plants, birds, reptiles, and amphibians. They are a major threat to any ground-dwelling and ground-nesting bird species, as they are known to eat eggs, young, and adults of endangered Hawaiian birds, various seabirds, and migratory shorebirds (Mitchell et al. 2005, Hays and Conant 2007)). Predation on nēnē is well documented, and the presence of mongoose is considered a barrier to the reestablishment of ground nesting birds in their historical ranges (USDA 2010).

The benefits of predator eradication to native species is well-documented, both in Hawaiʻi and elsewhere, through eradication efforts on offshore islands (USFWS 2008). For example, rat eradication on Midway Atoll resulted in dramatic increases of Bonin petrels (*Pterodroma hypoleuca*); rat eradication on the offshore islet of Mokoliʻi resulted in an increase from 1 ʻuaʻu kani chick fledging to 185 chicks fledging in just two years (Smith et al. 2006, USFWS 2008). Onshore, predator control is necessary to reduce the threats generated by these predators, but it requires constant effort and expense and does not provide a consistent level of protection. In general, predator control decreases, but cannot eliminate, the predator population in an area because of the continued possibility of re-entry by other predators.

The construction of the first predator-proof fence in Hawai‘i at Ka‘ena Point NAR on O‘ahu in 2011 demonstrated the feasibility of using a combination of fencing and predator control to eradicate non-flighted mammalian predators from Hawai‘i's coastal environment and again confirmed the benefits of predator eradication on native species. After construction of the fence and subsequent eradication of dogs, cats, mongoose, rats, and mice, record numbers of ‘ua‘u kani and mōlī chicks fledged in the NAR (Young et al. 2013). In 2013, the first O‘ahu record of nesting black noddies (noio, *Anous minutus*) was documented within the NAR (L. Young, pers. comm.), and the establishment of new breeding colonies for other seabird species is anticipated. Finally, there are noticeable improvements to existing native plant populations.

The NERP is proposed to create a predator-free fenced unit at Nihoku for the benefit of ground-nesting birds and future reintroduction of rare birds and plants. Anticipated benefits at Nihoku would include improved nesting success for nēnē and mōlī, natural re-colonization by other seabirds such as the ‘ā or ‘ua‘u kani, possible translocation for ‘a‘o in the future, and restored native habitat to support endangered plant reintroduction.

1.2 Legal and Policy Guidance

The NERP implements or is consistent with the following laws and policies: the National Wildlife Refuge System Administration Act of 1966, as amended; the Endangered Species Act of 1973 (ESA); the Migratory Bird Treaty Act of 1918; Executive Order 13112 (Relating to Invasive Species); the Federal Noxious Weed Act of 1975; the National Historic Preservation Act of 1966, as amended (NHPA); and Service policies regarding integrated pest management (IPM). Many other Federal laws, executive orders, Service policies, and international treaties govern the Service and Refuge System lands. For additional information on laws and other mandates, a list and brief description of Federal laws of interest to the Service can be found in the Laws Digest at http://www.fws.gov/laws/Lawsdigest.html. The NERP also implements or is consistent with various State laws, including the Hawai‘i Coastal Zone Management Act.

National Wildlife Refuge System Administration Act of 1966, as amended
The National Wildlife Refuge System Administration Act states that the Director of the U.S. Fish and Wildlife Service shall provide for the conservation of fish, wildlife and plants, and their habitats within the Refuge System as well as ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained. Under the Administration Act, each refuge must be managed to fulfill the Refuge System mission as well as the specific purpose(s) for which it was established.

The specific purposes for which Kīlauea Point NWR was established include:

- carrying out the national migratory bird management program,
- the general protection of natural resources and the conservation of endangered species or threatened species, and
- more specifically, the protection and recovery of endangered Hawaiian waterbirds and other endangered birds, including the nēnē; and the conservation and management of native coastal strand, riparian, and aquatic biological diversity (USFWS in prep.).

The NERP is consistent with the purposes of both the Refuge System in general and Kīlauea Point NWR in specific as it is proposed solely for the benefit of native wildlife and habitat.

Endangered Species Act of 1973
The ESA provides for the conservation of threatened and endangered species of fish, wildlife, and plants by Federal action and by encouraging the establishment of state programs. It provides for the determination and listing of endangered and threatened species and the designation of critical habitats. The proposed action is consistent with the ESA as it would support listed species, including the nēnē and the ʻaʻo, and their recovery by providing a safe nesting area protected from introduced predatory mammals such as cats, rodents, and dogs. In addition, the Refuge will conduct consultation under Section 7 of the ESA as appropriate for this action.

Migratory Bird Treaty Act of 1918
Established in 1918 with subsequent amendments and provisions following, this act protects migrating birds between the U.S. and Canada. Mexico, Union of Soviet Republics, and Japan. This act makes it illegal for people to "take" migratory birds, their eggs, feathers or nests (take is any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof). The NERP is consistent with the purposes of the Migratory Bird Treaty Act as it would support conservation of migratory seabirds.

Executive Order 13112 Responsibilities of Federal Agencies Pertaining to Invasive Species
This Executive Order requires Federal agencies to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. The proposed action is consistent with this EO as it would involve the removal of invasive predatory mammals and the removal of non-native invasive plants from within the project area and facilitates recovery of native habitat and enhances breeding seabird populations.

Federal Noxious Weed Act of 1975
The Federal Noxious Weed Act of 1975 provides for the control and management of non-native weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health. The proposed action is consistent with this act as it involves the removal of a noxious weed (Christmasberry, *Schinus terebinthifolius*) and restoration of native habitat.

National Historic Preservation Act of 1966, as amended
This act provides for the preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the States. Federal agencies are directed to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register. The regulations of Section 106 of NHPA require that the Service undergo a review process to determine whether the proposed action has the potential to affect cultural resources. The proposed action is consistent with this act as no historic features will be affected by the project (see sections 3.3 and 4.5 for more information).

Integrated Pest Management, 517 Departmental Manual (DM) 1 and 7 Refuge Manual (RM) 14
An IPM approach was previously adopted to eradicate, control, or contain pest and invasive species on Kīlauea Point NWR in accordance with 517 DM 1 and 7 RM 14. Under these policies, only pesticides registered with the EPA in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and as provided in regulations, orders, or permits issued by EPA may be applied on lands and waters under refuge jurisdiction. The NERP, specifically all planned predator eradication and invasive species removal, would be consistent with this IPM approach.

Hawai‘i Coastal Zone Management Act
Hawai‘i's Coastal Zone Management Act outlines objectives, policies, laws, standards, and procedures to guide and regulate public and private uses in the coastal zone management area, which is defined to be the entire State of Hawai‘i. The NERP would be consistent with the objectives and policies outlined in Hawai‘i Revised Statutes (HRS) Chapter 205A-2 because it would preserve the quality of coastal scenic and open space resources and minimize adverse impacts on coastal ecosystems. The NERP would also be consistent with the Special Management Area guidelines outlined HRS Chapter 205A-26 as it is proposed solely for the benefit of native wildlife and habitat. In addition, the Refuge will work with the County of Kaua‘i to secure any Special Management Area permissions required for this action.

1.3 Relationship to Other Planning Efforts

When developing the NERP and this EA, the Service considered the goals and objectives of existing national, regional, state, and ecosystem plans and/or assessments. The proposed action is consistent, as much as possible, with existing plans and assist in meeting their conservation goals and objectives. This section summarizes some of the key related planning efforts.

Kīlauea Point NWR Comprehensive Conservation Plan (CCP) (USFWS in prep.).
The draft CCP recognizes the importance of Kīlauea Point NWR to seabird populations threatened with the effects of climate change and notes the threats non-native mammals pose to these species. Once finalized, the CCP will provide important direction and long-range guidance for management of the entire Refuge. In addition, it provides a more complete description of the wildlife and habitats protected by this Refuge, the threats and challenges to management, and the general environment of the Refuge.

A Conservation Action Plan for Black-footed Albatross (*Phoebastria nigripes*) and Laysan Albatross (*P. immutabilis*) (Naughton 2007).
This plan is intended to provide a framework for partnership-based conservation and management actions and facilitate a collaborative, proactive approach to albatross conservation. The NERP would be consistent with the recommendations of this plan since implementation would reduce threats to nesting albatross and restore habitat.

Draft Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*) (USFWS 2004).
The nēnē recovery plan aims to restore and maintain multiple self-sustaining nēnē populations on Hawaiʻi, Maui Nui (Maui, Molokaʻi, Lānaʻi, Kahoʻolawe), and Kauaʻi. The NERP would be consistent with the recommendations of this plan since implementation would reduce threats to nesting nēnē by removing non-native predators from a known nesting site.

Newell's Shearwater and Hawaiian Petrel Recovery: A Five-Year Action Plan (Holmes et al. 2011) and **Draft Newell's Shearwater Five-year Workplan (Newell's Shearwater Working Group 2005).**
This action plan and workplan provide specific recovery objectives for the ʻaʻo. The NERP would support workplan implementation by creating a fenced predator-free area suitable for translocation of ʻaʻo.

Regional Seabird Conservation Plan (USFWS 2005).
The purpose of this plan is to identify USFWS priorities for seabird management, monitoring, research, outreach, planning and coordination. It lists the need to control non-native predators in Hawaiʻi where they negatively affect seabird populations, especially in ʻaʻo and Hawaiian petrel colonies. The NERP would support implementation of this plan by creating a fenced predator-free area that could host future colonies of breeding seabirds.

Kauaʻi Island-wide Draft Recovery Plan (USFWS in prep.).
This draft recovery plan is being developed to incorporate all listed and candidate species on the island of Kauaʻi, including those in other recovery plans. In total, it will address 172 species. For multi-island species, this recovery plan will only address the recovery needs and actions for Kauaʻi populations. Recovery goals for Kauaʻi island endemic species will be developed in this recovery plan. The NERP is expected to be consistent with this recovery plan since implementation would restore native coastal habitat and create a predator-free area where ʻaʻo reintroduction and rare plant reintroduction could occur.

Recovery Plan for the Kauaʻi Plant Cluster (USFWS 1995).
This plan covers 37 plant taxa, 34 of which are federally listed as endangered and 3 of which are threatened. The recovery actions identified in the plan include protecting current populations, controlling threats, and monitoring; expanding current populations; conducting research essential to conservation of the species; establishing new populations as needed to reach recovery objectives; validating and revising recovery objectives; and devising and implementing a public education program. The NERP would be consistent with this recovery plan by restoring native coastal habitat within a fenced predator-free area, thereby providing a safe location for reintroduction of rare and endangered plant species.

Hawaiʻi's Comprehensive Wildlife Conservation Strategy (CWCS) (Mitchell et al. 2005).
Hawaiʻi's CWCS reviews the status of the full range of the State's native terrestrial and aquatic species (over 10,000 of which are found nowhere else on Earth) and provides management recommendations for their continued conservation. Hawaiʻi's Species of Greatest Conservation Need include all native terrestrial animals, all endemic aquatic animals, additional indigenous

aquatic animals identified as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. The NERP would be consistent with the CWCS by restoring native coastal habitat within a fenced predator-free area, thereby providing a safe location for nesting seabirds, nēnē, and the reintroduction of rare and endangered plant species.

Kaua‘i Seabird Habitat Conservation Plan (KSHCP) (in prep.).
The KSHCP is currently being developed by the USFWS and DLNR-DOFAW to provide interested businesses and agencies with a streamlined cost-effective way to attain legal authorization and coverage for unavoidable incidental take of endangered and threatened seabirds on the island of Kaua‘i. While both the NERP and the KSHCP planning effort seek to benefit endangered Hawaiian seabirds through similar actions, it should be noted that a portion of the funding for the NERP comes from fines associated with the settlement of criminal cases related to the past take of endangered seabirds, while the KSHCP is focused on mitigating the effects of current and future take of endangered seabirds.

1.4 Scoping and Public Participation

Initial planning for this project began in 2011. Public scoping began informally in 2012, and a formal scoping letter was sent to a variety of Federal, State, and Kaua‘i county agencies, community groups, non-profits, and interested individuals in May 2013 by postal mail and by email. Written comments were received from the Kaua‘i Invasive Species Committee (requesting a decontamination protocol for supplies and equipment to prevent spread of invasive species), the Kaua‘i Fire Department (expressing concern about access, particularly to radio sites on Crater Hill), the County of Kaua‘i Planning Department (commenting on the need to submit a Special Management Area Assessment form to the Department), the State of Hawai‘i Office of Planning (noting the project's presence within the State Coastal Zone Management Area and County Special Management Area and identifying the *Hawai‘i Watershed Guidance* as a resource), the State of Hawai‘i Division of Historic Preservation (requesting a copy of the archaeological survey) and several individuals (expressing support for the project).

In addition, project partners gave presentations to the Kīlauea Point NWR staff and volunteers, the Kīlauea Neighborhood Association, the Kīlauea Point Natural History Association, to the general community at the North Shore Public Library in Princeville, to attendees of the Hawai‘i Conservation Conference poster session, and to several individual stakeholders in the first half of 2013. To date, public response to the project has been positive.

The Draft Environmental Assessment for the project was released in September 2013. In addition to posting the document on the Kīlauea Point NWR web page, the Service issued a press release announcing its availability and sent letters via postal mail or email to all those on the initial scoping distribution list and any stakeholders added during the public scoping period. The EA was available for a 45-day public review ending October 31, 2013, during which time six comment letters were received. A summary of the public comment and the FWS response is included as Appendix E. As a result of the comments, minor changes were made in the preparation of this Final EA.

1.5 Scope of Analysis

Issues raised during the scoping process and addressed in this EA include:

- concern regarding the introduction and spread of invasive plants during construction;
- the need to maintain access to the radio sites on Crater Hill;
- potential impacts to archaeological resources;
- potential impacts on bats;
- potential visual impacts of the fencing;
- the overall size of the project; and
- planned methods of construction and potential for erosion.

The NERP is proposed to create a predator-free fenced unit for the benefit of nesting seabirds and nēnē and the future reintroduction of rare seabirds and plants. This Draft EA evaluates the environmental impacts of building the fence, removing non-native plant species, eradicating non-flighted mammalian predators, and restoration of native habitat. While it is hoped that this protected area would be used in the future for translocation of ʻaʻo chicks, the actual translocation of ʻaʻo and the corresponding effects are outside the scope of this EA. Instead, future translocations of ʻaʻo, or any other endangered bird, will be the subject of a separate NEPA document, as appropriate.

1.6 List of Permits Required

FWS will submit a Special Management Area permit application to the County of Kauaʻi. Consultation under Section 106 of NHPA has been initiated with the State of Hawaiʻi Division of Historic Preservation, and the Refuge will conduct consultation under Section 7 of the ESA as appropriate for this action. No other permits are anticipated at this time.

Chapter 2. Alternatives Including the Proposed Action

2.1 Alternatives Considered but Eliminated

Early in the alternatives development process, the planning team considered the following actions in one or more alternatives. These actions were ultimately eliminated from further consideration for the reasons provided.

Other options for project siting were considered. Areas that would not be appropriate for potential ʻaʻo nesting were eliminated from consideration since one of the purposes of this project includes restoration of habitat that may be suitable for ʻaʻo translocation. Crater Hill, Kīlauea Point, and Mōkōlea Point were also considered, but these areas were eliminated due to higher levels of public use and visitation, topography that would make construction extremely difficult and expensive, and existing nesting seabird colonies that could be impacted both during (noise) and after (collision) construction.

Alternative size and fence configurations were considered. Due to topography, increasing the size of the fenced area required the crossing of more natural drainages, which would require the incorporation of additional culverts into the fence design. The resulting increase in cost, combined with the potential for interference with area drainage patterns during rain events, eliminated a larger fence from further consideration. Configuring the fence to run to the coast at each end (as at Kaʻena Point NAR using the ocean as a natural barrier) was considered, but due to the topography (steep cliffs), there was no feasible route to run the fence all the way to the high tide line. Ending the fencing on the top of the cliff was considered, but eliminated from further consideration due to the nearly unlimited opportunities for rodent incursion from below.

More aggressive methods for rodent removal were also considered, including application of diphacinone pellets through hand broadcast and the use of brodifacoum. These options were eliminated as the additional regulatory permissions required would be cumbersome and unnecessary based on the success of bait boxes in the Kaʻena Point eradication.

2.2 Alternative A. No Action Alternative (Current Management)

Alternative A assumes little to no change in current management programs. Current management of the Refuge at large is aimed at long-term protection and enhancement of migratory seabird populations, the endangered nēnē, and existing plant communities and their habitats. Activities include weed control and outplanting native plants by volunteers, mowing and weeding grassland-shrubland habitat for nēnē, controlling introduced predators, and biological monitoring of endangered and rare wildlife species.

Predator control currently occurs year-round for cats and rats within Kīlauea Point NWR. There is ongoing immigration of feral cats, particularly from Kāhili Beach, southeast of the NERP project area. Feral cats are controlled by live-trapping and euthanasia, using a combination of trap cycles and opportunistic trapping based on cat sign. Rats are controlled year round at

Kīlauea Point NWR through the use of live-trapping and rodenticides approved for conservation of endangered species (e.g., 0.005% diphacinone) in tamper-proof bait stations concentrated in key management areas such as high-density nesting habitat for endangered birds. There are 40-80 bait stations on the Refuge; bait stations are replenished every 2 weeks, and the amount of bait used is recorded and reported. These efforts reduce but do not eliminate cat and rodent populations within the Refuge. There are no current predator control efforts directed at mongoose, as they have not been observed within the Refuge.

Within the specific NERP project area, current management does not involve weed control, outplanting, or mowing. Predator control occurs and is limited to opportunistic cat trapping. Monitoring reproductive success of nesting nēnē and mōlī occurs during breeding season.

2.3 Alternative B. Proposed Action: Construction of Predator-Proof Fence, Removal of Non-Flighted Mammalian Predators, and Habitat Restoration

Alternative B consists of the construction of a predator-proof fence and removal of non-flighted mammalian predators from within the fenced unit, to protect approximately 7 acres of coastal seabird habitat within the refuge.

The proposed action is substantially similar to a recently completed restoration project at Ka‘ena Point NAR on O‘ahu and would be divided into three phases: (1) fence construction; (2) predator eradication from within the fenced area and monitoring; and (3) native habitat restoration. The total cost of the proposed action is approximately $500,000, with an estimated $300,000 for fence materials and construction. Total costs may vary depending on the difficulty of eradicating non-flighted predatory mammals from within the fenced unit and the success of re-establishing native vegetation within the fenced unit.

2.3.1 Fence construction

The fence alignment largely follows an existing road bed along the top of the unit and follows natural landscape contours down towards the coast. The fence alignment was developed based on the following factors: quality of area as potential ‘a‘o nesting habitat, taking into account orientation towards the ocean, presence of prevailing winds, absence of light pollution, current use for nesting, and presence of invasive species; ease of construction; potential for successful eradication of non-flighted mammalian predators; impact on visual resources and public access; avoidance of rare plant species; cost; and absence of historic and cultural features. Minor deviations to the fence alignment may occur as required by terrain considerations and site-specific issues (e.g., discovery of cultural sites or rare plants).

Fence construction would begin by clearing a corridor, approximately 13 feet wide wide and approximately 2,400 feet long, following the selected fence alignment. The width of the corridor facilitates construction, and a minimum 2 meter (6 foot) clearance is required on the exterior of the fencing once built to ensure that non-flighted predators, particularly cats, are not able to use vegetation to climb or jump into the fenced unit.

The existing roadbed that forms the top portion of the fence corridor is fairly level, and as a result, limited grading and little to no vegetation clearing would be required to make it suitable as a fence platform. Where the fencing leaves the existing roadbed, the corridor would be cleared of vegetation and some earthworks would be created to form the fencing platform. Culverts would be incorporated into the fence platform at locations where water may accumulate, to prevent erosion during heavy rain events.

In the upper section of the project area, ground preparation would involve the use of heavy equipment such as a bulldozer or excavator to move soil or rocks to form a level stable platform. Toward the coast, the grade is too steep to allow for the use of heavy equipment, so ground preparation would involve clearing and construction using hand tools only. No material would be imported from off-site; only soil and rock from within the planned fence corridor would be utilized. Overall, less than 1 acre of land area would be disturbed. Best management practices to be incorporated during construction include avoiding the use of heavy equipment in the steeper and more erosion-prone portion of the project area, phasing construction to reduce exposed ground areas, minimizing the length and steepness of disturbed areas, avoiding earthwork during inclement weather, utilizing vegetative buffers for erosion control, incorporating culverts to allow water to easily pass through during heavy rain events, and revegetating bare areas with native coastal plants.

Heavy equipment, materials, and supplies brought to the site would be thoroughly cleaned and inspected for invasive species prior to entering the Refuge and would be inspected and cleaned as needed during construction to prevent the further spread of invasive species already found within the project area.

The fence design has 3 main elements: base fence, predator-proof mesh and skirt, and predator-proof rolled hood. The base fence provides the structural strength and would be made of anodized aluminum posts and stays, with stainless steel wires and fastenings. The posts would be set into the ground approximately 10 feet apart; approximately 3 feet of the post would be buried, while 6.5 feet would remain above ground. Marine-grade stainless steel mesh with an aperture of approximately 0.2 inches would be attached to the entire face of the base fence and also used to form a skirt of horizontal mesh at ground level, to prevent predators from tunneling under the fencing. The mesh would extend from the top of the posts to just below ground level, while the skirt would extend approximately 1 foot from the fence and would be pinned to the ground where possible.

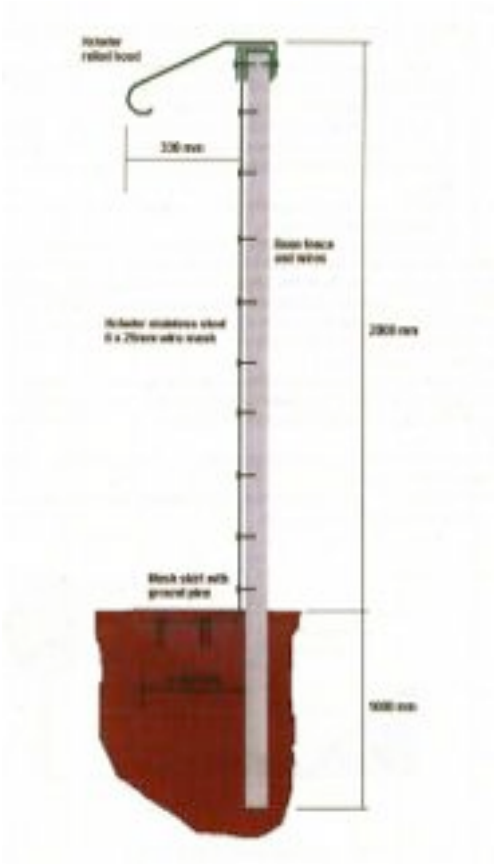

Figure 2-1. Illustration of Fence Design. Schematic provided by Xcluder, who built similar fences in New Zealand.

The rolled hood would sit at the top of the fencing and extend approximately 1.5 feet on the outside of the fencing. The hood would be made of smooth sheet steel and prevents predators from climbing over the fence due to its slipperiness and width. The hood would be supported by a series of brackets that give the hood structural strength without aiding predator movement. One or more access doors would be be incorporated to facilitate construction, monitoring, and long-term maintenance of the fencing.

Fence construction would be timed to avoid impacts to nēnē and mōlī nesting in the project area. All materials and equipment would be driven to the project site. Construction is anticipated to take approximately 2 - 4 months, weather-dependent. Regular inspection of the entire fenceline would be a part of normal management for the area and extra fence materials would be kept on-hand for repairs.

Figure 2-2. Photo of predator-proof fence at Ka‘ena Point NAR, O‘ahu. View from above towards point. Photo by Lindsay Young.

Figure 2-3. Photo of predator-proof fence at Ka‘ena Point NAR, O‘ahu. View from point towards mountain. Photo by Lindsay Young.

2.3.2 Predator eradication

Upon completion of the fencing, all non-flighted mammalian predators would be removed from the fenced area to achieve the objective of a predator-free protected area. Intensive eradication efforts and monitoring would continue within the fenced area until predator-free status has been achieved. At that point, monitoring would continue and predator control would be conducted around the perimeter as necessary to prevent re-entry of non-flighted predators.

The methods used in this project would closely correspond to those used successfully at Ka‘ena Point NAR on O‘ahu, a State-owned protected coastal conservation area with sensitive biological resources. The objectives in designing the predator removal program are similar: select the most effective methods available while considering the pest species present, the tools legally available for use, and the timeline and funding available.

Pre-eradication monitoring and control estimates pest species composition, abundance, habitat use, seasonal variation of rodent population, and rodent home range size. Monitoring at the Kīlauea Point NWR began in December 2012. Based on preliminary results, pest removal would include trapping for cats, if any remain after fence construction, diphacinone poison in bait stations on a 25-meter grid for rats, and a combination of the 25-meter diphacinone bait station grid and mulitple-catch live traps for mice.

Diphacinone is an anticoagulant (blood thinner). It was prescribed for human heart patients until more effective drugs replaced it and is now registered by the EPA and the State Department of Agriculture for conservation uses. It is proposed for use in this project because it has been used in a variety of habitats statewide to reduce rodent populations, and in at least two instances, eliminate rodent populations. Furthermore, it has been used for decades in conservation areas throughout the State of Hawai‘i, including this Refuge, in the bait station format without any documented harmful effects.

After eradication of rodents, a strategic subset of the diphacinone bait stations and self-resetting kill traps would be used in combination with a system of tracking tunnels for ongoing monitoring to ensure rapid response to any rodent re-entry. In addition, a low-pest buffer zone would be established along the length of the exterior of the fence, using bait boxes and traps, to reduce the possibility of predator-re-entry in the event of a fence breach.

2.3.3 Habitat restoration

As part of the NERP, the invasive plant species within the fenced unit would be removed using a variety of methods, based on the plant species, location within the project area, and the anticipated effectiveness of the removal technique. Christmasberry removal (the primary invasive) would involve mechanical removal or manual cutting combined with application of herbicides approved for conservation use on the stump, leaving the root system in place to maintain soil integrity while the plant dies. Initially, a combination of natural regeneration of native plants such as ‘ūlei (*Osteomeles anthyllidifolia*) and outplanting of native plants and grasses such as panicum grass *(Panicum torridum*), ‘aki ‘aki *(Sporobolus virginicus*), pōhinahina

(*Vitex rotundifolia*), ‘ilima (*Sida fallax*), jacquemontia (*Jacquemontia sanwicensis*), ‘akoko (*Chamaesyce celastroides*) would be used. These plants and grasses are provide forage for nēnē, cover for seabirds, and are low-in-stature, thus facilitating digging and related nesting activities. In particularly sensitive areas, specific erosion control techniques such as staking down fence cloths or utilizing vegetative buffers (e.g., coconut coir or straw bales) for stabilization would be be used after removal of the invasive plants. Over time, as native cover is re-established, the area would provide a secure location for the reintroduction of endangered and rare plant species, providing protection from the threat of pigs (trampling, eating, uprooting) and rats (seed and plant predation).

Chapter 3. Affected Environment

3.1 Physical Environment

3.1.1 Project Site

The project site is composed of approximately 7.8 acres within Kīlauea Point NWR, at the northernmost tip of the island of Kaua‘i. The project area is just south of Makapili Rock, approximately 1 mile northeast of Kīlauea town, and slightly east of Crater Hill. The project site faces the ocean, on sloping land (averaging 22% slope, ranging to nearly 40% slope) above steep sea cliffs. The elevation range of the project site is approximately 140 to 250 feet above mean sea level.

Figure 3-1. Photo of project area. Photo by Lindsay Young.

Figure 3-2. Aerial photo showing the general location of the project area (Google Earth 2010). Map created by Cultural Surveys Hawai‘i.

Figure 3-3. 1996 USGS 7.5-Minute Series Topographic Map, Anahola Quadrangle, showing the location of the project area. Map created by Cultural Surveys Hawai‘i.

3.1.2 Soils

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) conducted a soil survey for an approximately 8-acre area surrounding the project site, and the full report is included as Appendix D. The vast majority of the project area is composed of soils categorized as LhE2 (Lihue silty clay, 25- to 40-percent slopes) (5.1 acres) (NRCS 2013). The remaining area is made up of rRo (rock outcrop) (2.2 acres) and LhD (Lihue silty clay, 15- to 25-percent slopes) (0.4 acres) (NRCS 2013).

3.1.3 Water

The project area is indicated to receive approximately 60 inches of annual rainfall, with increased rainfall at higher elevations (Giambelluca et al. 1986). There are no natural waterways, such as streams, within the project site. The Pacific Ocean is adjacent to the project area at the base of steep cliffs. Existing conditions around the project site involve noticeable runoff and erosion after major rain events.

3.1.4 Air

There are no data on ambient air quality specific to the project site. However, due to tradewinds experienced year-round as well as the low population and development on the island, air quality on Kaua‘i is not considered a problem.

3.2 Biological Environment

3.2.1 Threatened and endangered species: nēnē

The endangered Hawaiian goose, or nēnē, is observed within the project area with regularity. Five nests have been discovered within the proposed fence area. All nests have been monitored weekly as part of the pre-project biological monitoring that began in November 2012, and it is believed that all 5 nests successfully hatched at least 1 chick.

The endangered nēnē is a member of the waterfowl family (Anatidae) and closely related to the Canada goose *(Branta canadensis*). Though similar in appearance, the gander is usually slightly larger than the goose. It is light gray-brown with a mostly black head, cream-colored neck with distinctive dark furrows, and black tail and feet. In the 1950s, the nēnē population declined to about 30 birds on Hawai‘i because of introduced predators, historic over-hunting, and habitat loss. In 2011, there were an estimated 2,457 - 2,547 nēnē on four islands including growing numbers on Kaua‘i which supports 1,421- 1,511 birds or 59% of the State population (USFWS unpublished data). Nearly all birds are the result of an aggressive captive propagation and release program which was initiated by the then territorial government in 1949. This program is credited with bringing nēnē back from the brink of extinction. However, despite a comeback, nēnē still face major obstacles on the road to recovery. Current threats include depredation by predators, inadequate nutrition, lack of suitable lowland habitat, human-related disturbance and mortality, behavioral problems, lack of genetic diversity, and disease (USFWS 2004).

Habitat types frequently used by nēnē at Kīlauea Point NWR include grasslands dominated by introduced species (e.g., saltgrass (*Distichlis spicata*), Kikuyu grass (*Cenchrus clandestinus*), open-understory shrublands (e.g., naupaka (*Scaevola gaudichaudii*), koa haole (*Leucaena leucocephala*)), and sea cliffs. Nēnē build nests on the ground usually under woody and herbaceous plants with an open canopy. Nesting habitats range widely but generally is associated with woody vegetation. Species composition varies by availability; for instance, in highlands native shrubs (e.g., ʻaʻaliʻi (*Dodonaea viscosa*), ʻōhelo (*Vaccinium reticulatum*), pūkiawe *(Styphelia tameiameiae*)*,* small ʻōhiʻa (*Metrosideros polymorpha*)) predominate, but in lowlands on Kauaʻi both native (e.g., naupaka, pōhinahina) and non-native (e.g., lantana (*Lantana camara)*, Christmasberry, koa haole, Guinea grass (*Megathyrsus maximus)*) plants are used. Nēnē mate for life. The average clutch size is 3 eggs (range 1-6), incubation is usually 30 days (range 29-32), and goslings fledge at 10-14 weeks (Banko et al. 1999). Breeding occurs mainly October to March and molting March to June, which is when adults become flightless for 4 to 6 weeks while they grow new flight feathers. During this period, they become secretive, and are extremely vulnerable to attacks by introduced predators. During the rest of the year, from June to September, nēnē disperse or flock with other family groups in non-breeding areas where young nēnē have opportunities to find mates. Historically, nēnē are believed to have bred and molted in the lowlands during the winter and to have moved to higher elevations in the summer. Today, birds move daily between feeding and roosting areas and seasonally between breeding and non-breeding areas, but altitudinal patterns are less apparent (USFWS 2004).

Nēnē are browsing grazers eating the leaves, seeds, fruits, and flowers of grasses, sedges, forbs, and shrubs (Banko et al. 1999), and occasionally climb into or perch in bushes to reach berries (e.g., naupaka, māmaki (*Pipturus albidus*)). In many areas nēnē feed on cultivated grasses. In mid-elevation Hawaiʻi, birds select forage with high water and protein content such as the young shoots of a Kikuyu grass–Spanish clover grassland. They prefer sward-forming (turf-like growth) over bunch grasses and short (2-4 inches) over tall grasses and use grasslands less during drought (Woog and Black 2001).

In partnership with the State Department of Land and Natural Resources (DLNR) and USFWS Ecological Services, 38 nēnē were reintroduced to Crater Hill on the Refuge between 1991 and 1994. By 2002, the population was estimated to be 238 birds (USFWS 2004). In 2011, the population estimate for Hanalei, Princeville, and Kīlauea Point was 791-811 birds.

In 2010, the average number of nēnē during the breeding season (October - May) and flocking season (June – September) was 82 and 158, respectively, with a high count of 214 birds in July. During the 2010-2011 breeding season, the Refuge supported a minimum of 156 nēnē breeding pairs, 224 goslings, and 131 fledglings. Of 105 located nests, 85 (81%) hatched at least 1 egg. Of 298 eggs of located nests, 215 (72.2%) hatched. Of these 215 goslings, 91 (42.3%) fledged. However, the fledging rate is biased low because of the difficulty in collecting reliable gosling data on un-habituated, more secretive birds at Crater Hill and Mōkōlea Point.

3.2.2 Threatened and endangered species: ʻōpeʻapeʻa

In fall of 2010, a single Hawaiian hoary bat, or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) was sighted flying over Crater Hill at sunset on a calm evening (USFWS unpublished data). Occurrence frequency within the Refuge is unknown; however, forested edges near Kāhili Beach and Kīlauea River mouth likely provide suitable habitat (USFWS in prep.). No bats were observed in the project area during pre-project biological monitoring.

The ʻōpeʻapeʻa is a medium-sized member of the vesper bat family (Vespertillionidae) which consists of nocturnal, mostly insect-eating bats. It is an endemic and endangered subspecies of the North American hoary bat, a solitary tree-rooster. The ʻōpeʻapeʻa is Hawaiʻi's only native terrestrial mammal. Males and females have a wingspan of about 1 foot, and females are typically larger than males. Both sexes have brown and gray fur. Individual hairs are tipped or frosted with white; "hoary" means frosted. The Hawaiian name refers to a half taro leaf or canoe sail shape; these being similar to the shape of the bat. Fur color, frosted or reddish, may be related to location or age.

The ʻōpeʻapeʻa is a major predator of night-flying insects such as moths, beetles, and termites. Bats forage in open and wooded landscapes and linear habitats such windbreaks and riparian zones, and roost in trees with dense foliage and with open access for launching into flight. Females are believed to give birth to twins May - August and rear pups May - September. Pups fledge from about July - September, which is a critical time in the reproductive cycle (Menard 2001, Bonaccorso et al. 2008). The population size is unknown. Resident populations occur on Kauaʻi, Maui, and Hawaiʻi and possibly other main islands, with the highest abundance on Kauaʻi and Hawaiʻi. Threats are largely unknown but may include roost disturbance, introduced predators, obstacles to flight (e.g., barbed wire fences, vehicles), and pesticides (USFWS 1998).

3.2.3 Vegetation

Botanical surveys were performed in 2013, including an overall plant inventory in March 2013, as part of pre-project biological monitoring. The project area is densely covered with invasive species, particularly Christmasberry, which occupies over 50% of the shrub and canopy layer within the majority of survey plots. The project area also contains exotic grasses, ironwood (*Casuarina equisetifolia*), and koa haole.

Almost hidden among the invasive species, 7 species of native plants have been detected within the project area: hala (*Pandanus tectorius*), nehe (*Lipochaeta succulenta*), ʻākulikuli (*Sesuvium portulacastrum*), `akoko (*Chamaesyce celastroides var. stokesii*), nanea (*Vigna marina*), naupaka kahakai (*Scaevola taccada*), and ʻūlei. However, none are dominant within survey plots, and overall, native plants represent approximately 5% of the current plant cover within the project site. A species list of plants observed within the project area is included as Appendix B.

3.2.4 Seabirds

3.2.4.1 Breeding seabirds: mōlī

Four nests of mōlī (Laysan albatross) were discovered within the project area, with another five discovered in the surrounding area. All nests have been monitored weekly as part of the pre-project biological monitoring that began in November 2012, and as of April 2013, all mōlī nests remained active.

The mōlī is a large seabird (Family: Diomedeidae) whose breeding range is centered in the NWHI. Adults are mostly white with black wings and tail; the upperwings are entirely dark, and the underwings are mostly white with variable amounts of black especially along leading and trailing edges. The bill is pink with gray, hooked tip; legs and feet light pink. Mōlī are accomplished fliers using dynamic soaring to cover great distances; they mainly feed at night and often far from breeding colony (1,100 miles). In Hawai‘i, their diet consists primarily of squid, deep-water crustaceans, fish and flying fish eggs (Awkerman et al. 2009).

Like most seabirds, mōlī breed in colonies, have long-term pair bonds and high site fidelity, lay only 1 egg per season, and both parents participate in all aspects of raising young. Pairs engage in long, noisy, ritualized courtship dances. Typically they select nest sites close to vegetation and nests vary from a scrape to a ring-like structure comprised of sand, vegetation, and debris. Eggs are laid November - December and chicks fledge in July; no post-fledgling care is provided by parents. Young birds do not return to land until their third year after fledging. These birds do not breed, but dance, build nests, and prospect for mates. Birds first breed between 8-9 years of age, and the oldest known individual is currently 62 years old (Awkerman et al. 2009, USFWS unpublished data).

Mōlī breed throughout the NWHI and on the MHI of Kaua‘i and O‘ahu and Lehua Island off Ni‘ihau. Outside of Hawai‘i, mōlī breed on islands off of Japan and Mexico. Outside the breeding season, mōlī disperse widely throughout the North Pacific (Young et al. 2009a). In the Hawaiian Archipelago, the population is estimated at more than 590,000 pairs with largest colonies occurring on Midway Atoll NWR (441,000 pairs) and Laysan Island, Hawaiian Islands NWR (145,000 pairs). Total population of all MHI colonies is less than 500 pairs; worldwide population is estimated at 630,000 breeding pairs (Arata et al. 2009). Historical threats including feather and egg harvesting and military operations on Midway Atoll in the NWHI. Current threats to mōlī include bycatch in fisheries operations, contaminants ingestion, sea level rise in the NWHI, and predation on breeding colonies in the MHI. Mōlī are vulnerable to climate change because their limited global range and breeding distributions are predominantly located in the low-lying NWHI (Reynolds et al. 2012).

The first 3 mōlī chicks fledged from Mōlī Hill on the Refuge in 1986 (KPNHA 1986). Currently, mōlī are found in the densest concentrations on Mōlī Hill (55 breeding pairs in 2011-2012 season), and the rest are distributed on the eastern third of the Refuge towards Mōkōlea Point for a total of 115 pairs in the 2011-2012 season. From 2002-2012 the number of breeding pairs appears to be steadily increasing each year as a result of predator control, natural recruitment,

and immigration from other breeding sites; the number of chicks and fledglings appears to be stable or slightly decreasing. Over the past decade, the Refuge has fledged 50 mōlī per year, on average.

3.2.4.2 Overflying seabirds

Various seabirds have been observed overflying the project area, including koaʻe ʻula, koaʻe kea, ʻā, ʻuaʻu kani, and the ʻiwa (great frigatebird, *Fregata minor*). None have been observed nesting within the project area, but natural colonization may occur after restoration of native vegetation and complete removal of mammalian predators. The ʻā has been observed nesting in the nearby cliff-side and as such, it and the ʻuaʻu kani are the most likely to initiate re-colonization.

The ʻā or red-footed booby is the smallest booby (Family: Sulidae), and has a pantropical distribution. Individuals have long pointed wings and a relatively long, wedge-shaped tail. Several color phases exist, ranging from all brown to all white; almost all Hawaiian birds are white. Adult male and females are overall white, except for brownish black primary and secondary wing feathers; females are larger than males. Feet and legs are orange to red, bill bluish except for base of lower mandible which is pinkish, and facial skin around bill ranges from pink to red and blue. Flight is characterized by strong flapping interspersed with gliding and they may glide for long distances depending on wind conditions (Schreiber et al. 1996).

ʻĀ forage alone or in mixed species feeding flocks, generally feeding further from land than their congeners. ʻĀ capture prey by plunge-diving generally from 13-26 feet over the water. In Hawaiʻi, diet is mainly comprised of flying fish and squid, but also includes mackerel, scads, saury, and anchovies (Schreiber et al. 1996).

ʻĀ breed on small islands or islets, both on low-lying coralline sand islands and high volcanic islands. They tend to nest in bushes or trees, including beach naupaka and beach heliotrope. They will occasionally nest on deserted man-made structures, on bare ground, or on low piles of vegetation. ʻĀ build nests of twigs, grass, and other vegetation. ʻĀ breed in colonies ranging from 10-10,000 pairs. Pairs generally retain mates throughout several breeding seasons. In Hawaiʻi, breeding season is synchronous, but can occur throughout the year. Egg laying peaks in February - April, and most young have fledged by September. Both parents incubate the egg, and brood and feed the chick. Adults continue to feed young up to 4 months after fledging. Birds first breed at 3 - 4 years of age and the oldest known individual was 22 years old (Schreiber et al. 1996).

ʻĀ breed throughout the NWHI and at a limited number of sites on MHI including Kīlauea Point NWR, the cliffs of Ulupaʻu Head at the Kāneʻohe Bay Marine Corps Base on Oʻahu, and on offshore islets including Moku Manu and Lehua. Outside of Hawaiʻi, ʻā breed on islands in the tropical waters of the Pacific, Indian, and Atlantic oceans, Caribbean Sea, and seas north of Australia. Little is known about the movements of the ʻā outside nesting season, but birds in Hawaiʻi appear to disperse eastward and move between islands (USFWS 2005).

Threats include poaching of eggs, chicks, and adults for food, degradation of habitat from human development of coastal zones and introduced sheep, goats, and pigs, and disturbance at nest sites. ‘Ā has been described as sensitive to human activities, including eco-tourism (Burger and Gochfeld 1993). This species may tolerate short-term, infrequent human disturbance, but typically does not breed in close proximity to humans (Schreiber et al. 1996). Up until the mid-1960s, hundreds of ‘ā nested around Kīlauea Point peninsula (by the lighthouse), and it is suspected that the colony shifted to its current Crater Hill location because of threats from dogs (G. Smith, pers. comm.). Kīlauea Point peninsula has largely been free of dogs for about two decades; however, the ‘ā have not returned to nest there.

In Hawai‘i, the population is estimated at between 7,000 - 10,500 breeding pairs. The worldwide population is estimated at less than 300,000 breeding pairs, with the majority residing in the eastern Pacific (USFWS 2005). ‘Ā occur year-round at the Refuge, but breeding has only been documented February - October. Currently, breeding occurs only on the windward slopes of Crater Hill where birds build nests in ironwood and Christmasberry trees. Between 2004-2008, the Refuge supported an annual average of 1,882 breeding pairs of ‘ā.

The ‘ua‘u kani or wedge-tailed shearwater is a large, abundant seabird (Family: Procellaridae) that produces a variety of wails and moans that inspired the Hawaiian name of this bird which means “calling or moaning petrel.” Individuals have long, sleek wings, a wedge-shaped tail, and a hooked bill. ‘Ua‘u kani are polymorphic, having two color phases, dark or light, and sexes are similar; approximately 90% of the birds breeding in Hawai`i are light-phase. Light-phase adults are grayish brown above with white underparts except for dark trailing edges of wings and tail. Dark-phase adults are uniformly sooty brown. Flight is similar to that of albatross but flaps wings with greater frequency (Whittow 1997).

‘Ua‘u kani often forage in large, mixed species flocks associated with schools of large predatory fishes (such as ‘ahi and mahi mahi) which drive smaller prey species to the surface. ‘Ua‘u kani use a variety of foraging techniques, most frequently plunges head into water while on the wing or seizes prey while sitting on the water; they often follow fishing vessels. In Hawai‘i, diet primarily consists of larval goatfish, flying fish, squirrelfish, and squid. Like most seabirds ‘ua‘u kani breed in their natal colonies, form long-term pair bonds, have high site fidelity, lay only 1 egg per season, and both parents participate in all aspects of raising young. ‘Ua‘u kani nest in excavated burrows or rock crevices or under vegetation. In Hawai‘i, breeding is very synchronous, and most eggs are laid in June with most young fledging in November. Birds first breed at 4 years of age, and the oldest known individual was 29 years old (Whittow 1997). At the Refuge, ‘ua‘u kani typically arrive in late February - early March. The first eggs are laid in early June, with a peak in laying mid-June, and most egg laying completed by the end of June. Hatching begins in late July with most chicks hatched by mid-August. Fledging begins in early November peaking in mid- to late November. The average incubation period on site is 53 days, and nestling period is 103-115 days (Byrd et al. 1983).

‘Ua‘u kani breed on low, flat islands and sand spits with little or no vegetation, but also excavate burrows on the slopes of extinct volcanoes and in old volcanic craters. Burrows require firm soil or plant roots to stabilize loose soil, generally nesting habitat is devoid of tall woody plants. In

locations where nest sites are scarce or the ground is too hard to excavate burrows individuals will nest in rock crevices or above ground. ʻUaʻu kani breed throughout the NHWI and on offshore islets of most of the MHI. Outside of Hawaiʻi, ʻuaʻu kani breeds on islands throughout the tropical and subtropical Indian and Pacific oceans. Outside the breeding season, ʻuaʻu kani migrate to the eastern Pacific. In Hawaiʻi, the population is estimated at 270,000 breeding pairs with approximately 210,000 of those occurring in the NWHI. The population in the MHI is estimated at between 40,000 - 60,000 breeding pairs with the largest colonies occurring on the offshore islands of Mānana (10,000 - 20,000 pairs), Moku Loa (10,000 - 20,000 pairs), Lehua (23,000 pairs), Kīlauea Point NWR (ca. 10,000 pairs), and Kaʻula (1,500 - 2,500 pairs). Smaller populations occur on Moku Manu, Mokuʻauia, Kāpapa, Molokini, Mōkapu Peninsula, and Kaʻena Point NAR on Oʻahu. Worldwide population is estimated at over 1,000,000 breeding pairs (USFWS 2005).

Threats to ʻuaʻu kani include food reduction through overfishing of the large predatory fishes (ʻahi) that bring their prey to the surface; depredation by introduced predators in MHI breeding colonies, light attraction, and human disturbance. A pilot study on stress hormone levels and chick sizes in relation to their proximity to the Refuge's lighthouse trail suggested ʻuaʻu kani chicks near the trail (e.g., <12 feet) may be exposed to higher chronic levels stress from visitation (Kitaysky et al. 2004). In 2010 at the Refuge, more than 75 adult ʻuaʻu kani were found preyed upon by owls (compared with about 5 in 2009), and carcass recoveries subsided after removal of 4 introduced barn owls (*Tyto alba*) (USFWS unpublished data). Ongoing losses from depredation could affect local populations because adult survival is an important factor regulating seabird populations.

ʻUaʻu kani is the most abundant bird species on the Refuge with dense concentrations on Mōlī Hill, near the lighthouse, Crater Hill, and Mōkōlea Point where habitat is suitable. Byrd et al. (1983) estimated that between 1978 - 1981, 520 fledglings from 700 breeding pairs fledged annually from the accessible 10-45 degree slopes of Kīlauea Point peninsula. In 2004, average hatching success of 10 plots was 73% (range 20-100%) and nest density was 0.36 nests per square yard (range 0.09-0.86) (Zaun 2004). Although the number of breeders and prospectors is unknown, the Refuge probably supports roughly 10,000 breeding pairs (B. Zaun, pers. comm.).

3.2.5 Invertebrates

Little documented information exists regarding native invertebrates within the project area. As part of the pre-project biological monitoring (February 2013), a variety of methods were used to capture animals foraging by different methods (i.e., winged vs. non) and in different levels of habitat (i.e., leaf litter vs arboreal). Sampling was done at each grid point, and all insects gathered were stored in ethanol for future sorting. Ants had a separate protocol to monitor for their presence as they are a documented threat to nesting seabirds at Kīlauea Point NWR. Index cards were baited with either peanut butter or Spam and left at each grid point for up to 2 hours, following protocols developed by the USFWS. Each card was then collected, and the number of ants was noted and the species identified. Species that were not identifiable were sent for further analysis. Preliminary results indicate that non-native invertebrates are dominant within the project site.

3.2.6 Invasive species

Invasive species are one of the most serious problems in conserving and managing natural resources, and the most problematic invasive species in the project area include predators (primarily cats and rats) and habitat-modifying plants. As noted earlier, predators pose a direct threat to ground-nesting birds and are known to uproot and/or eat native plants. Invasive plants convert native habitat, making it less suitable as habitat for native birds or rare plants.

Predation has not been directly observed in the project area, but birds nesting in the project area remain vulnerable to random predation by dogs (‘īlio) or cats (pōpoki). Dog and feral pig entry through the perimeter hogwire fence surrounding southern portions of the Refuge may occur through holes from vandalism or degradation, allowing sporadic and random dog presence within the project area. Cat presence within the project area has been documented using trail cameras, and at least 2 cats have been trapped within the project area since pre-project biological monitoring began in early 2013.

Rodent monitoring was conducted in early 2013, by spacing rat snap traps on grid points and mice live traps on grid points and every 25 meters between grid points. Track tunnels were used in coordination with the traps during the pre-baiting stage. Rodent track rates were 0.125 per trap night; rat catch rates were 0.1 per trap night; and mouse catch rates were 0.00 per trap night.

Small Indian mongoose have not been observed within the project area. However, credible mongoose sightings occurred in 2012-2013 all over Kaua‘i, from Polihale to Līhu‘e to Kīlauea, indicating that mongoose could eventually be detected within the Refuge.

Barn owl have not been observed within the project area. However, it is a known predator of seabirds (including confirmed predation events of both ‘a‘o and ‘ua‘u) and has been documented killing large numbers of ‘ua‘u kani in the Refuge. Once the fence is in place, the barn owl will be the one species which will not be excluded by the proposed predator-proof fence nor prevented from preying on seabirds breeding within the restoration area.

3.3 Cultural and Historic Resources

The following steps were taken to determine the cultural and historical significance of the project area: (1) preparation of an Archaeological Assessment in May 2013 by Cultural Surveys Hawai‘i; (2) review of a previous Archaeological Inventory Survey completed in 1989 for Kīlauea Point NWR expansion; and (3) informal consultation with a variety of organizations and individuals who might have information regarding the project area, including the Kīlauea Point Natural History Association, Office of Hawaiian Affairs, State Historic Preservation Division, and others.

No cultural resources were found within the project's area of potential effect. The full Assessment is included as Appendix C.

In summary, the assessment concluded:

> *"Based on traditional and historic accounts, the project area is located within a portion of Kīlauea Ahupuaʻa that is not well documented. In the Māhele of 1848, Kīlauea Ahupuaʻa was retained as Government Lands and there were no entries for commoner land claims. Eleven of the LCA awards in adjacent Kāhili, however, provide a picture of what settlement near the project area might have been like at the time. These 11 LCA awards in Kāhili are clustered along the south side of Kīlauea Stream, lying in a low, wide terrace next to the stream, which is evidently well watered and well suited for maintenance of taro loʻi. Virtually all claims involve a house lot, a few include loʻi, and several claims mention "kula" (pasture) with wauke (paper mulberry), noni (Indian mulberry), and orange trees being cultivated.*
>
> *Lands adjacent to the project area were cultivated with sugar cane in historic times by the Kīlauea Sugar Company. The sugar company modified water resources in the uplands with dams, reservoirs, ditches, and flumes (Joesting 1984), which may have damaged and ended large-scale native agricultural practices in Kīlauea and its vicinity. The Kīlauea Sugar Company ended its operations in 1971. According to background research and historic maps, the project area might have been utilized as pastureland during the twentieth century. It is possible that any remnant cultural resources were either removed or destroyed by the Kīlauea Sugar Company and/or livestock.*
>
> *No cultural resources were observed within the survey area. Therefore, CSH recommends no further archaeological work for the proposed project. Based on background research and the current study, it is unlikely that surface cultural resources associated with pre- and post-Contact land use are present within the project area. In the unlikely event that previously unidentified cultural resources are encountered by project construction, the project proponents should immediately stop work in the vicinity and contact DLNR/SHPD"* (Cultural Surveys Hawaiʻi 2013).

Although no specific resources have been found in the project area, the general area is of cultural significance. For example, in *Kīlauea Point and Kauai's National Wildlife Refuges,* Boynton relates a legend about Crater Hill:

> "*Rising several hundred feet above Kīlauea Point (Wowoni), the northernmost tip of Kauaʻi, layers of rock clearly reveal the volcanic origins of Crater Hill (Nihokū). It was here that Pele, the volcano goddess, came to search for a home where she might live with Lohiʻau, a strong and handsome chief of Hāʻena. Striking her staff into the ground, Pele brought forth a powerful eruption... enormous clouds of steam boiled up from the lava as it met cool ocean water, exploding into ash and cinder to form the crater. But these efforts were thwarted by her jealous sister Nāmakaokahaʻi. In anger, the sea goddess generated huge ocean waves that broke away the windward wall of the crater, thus extinguishing Pele's fiery abode. Kauaʻi was not to be her home.*
>
> *Three huge stones are perched near the top of Kīlauea's Crater Hill, a reminder of Pele's anger. Three sisters – Kalama, Pua, and Lāhela – had the audacity to laugh*

> *when raging surf was sent forth to douse Pele's fires. Repeating the sisters' names with anger, Pele turned each one to stone with a touch of her staff. Like other legendary stone figures at Hā'ena and on the rim of Kalalau Valley, they stand as a warning of the perils of disrespect"* (Boynton 2004, *citing F.B. Wichman, Kaua`i Ancient Place Names and Their Stories, 1998)).*

In addition, the refugium that the area provides to nesting seabirds has cultural significance. Seabirds were valuable to Native Hawaiians for feathers and food (Boynton 2004, Xamanek Researches 1989). They continue to play a role for skilled fishermen, as the behavior of seabirds at sea tells what is happening in the ocean miles away, providing valuable information for a successful fishing trip (Boynton 2004).

3.4 Social and Economic Conditions

3.4.1 Visual resources

While the project area has stunning views of the ocean, the project area itself is not visible from any public viewing area, due to its location within the Refuge. Based on trial staging with a full-height fence model, the fence as constructed would not be visible from nearby housing (e.g., Seacliff Plantation), due to topography.

3.4.2 Recreational use

Kīlauea Point NWR hosts over 500,000 visitors a year and is among the top 5 in public visitation for all national wildlife refuges. However, few Refuge visitors legally visit the project area, as it is closed to the public, is some distance from the Lighthouse (the primary visitor attraction at the Refuge), and is accessible only via a gated roadway. The gated road is used by Refuge staff.

3.4.3 Illegal use

There are anecdotal reports of occasional trespassing in the general project area, primarily by fishermen or surfers crossing the project area to get to the ocean.

3.4.4. Economic resources

There is no specific economic use associated with the project area; it is currently managed similar to other remote portions of the Refuge, with occasional biological monitoring, limited predator control, and guided hikes during National Wildlife Refuge week.

Chapter 4. Environmental Effects Analysis

4.1 Overview of Effects Analysis

This chapter provides an analysis of the environmental consequences of implementing the alternatives described in Chapter 2. Impacts are described for the main aspects of the environments described in Chapter 3, including physical, biological, cultural, and socio-economic resources. The potential effects to these resources as a result of implementing each alternative are then assessed. In addition to Chapter 3, Refuge staff experience, existing databases and inventories, relevant plans, studies, and past and current research were used for this analysis. We also used information gained through public scoping to assess effects.

For the most part, boundaries for analysis (direct, indirect, and cumulative) were at the project area level. Cumulative impacts, including impacts to Refuge resources from reasonably foreseeable events and impacts resulting from interaction of Refuge actions with actions taking place outside the Refuge, are addressed in the final section of this chapter.

Effects were assessed for scope, scale, and intensity of impacts. Although the analysis shows that neither of the alternatives would be expected to result in significant positive (beneficial) or negative (adverse) effects, some positive or negative effects are expected. The qualitative terms intermediate, minor, and negligible are used to describe the magnitude of the effect. To interpret these terms, intermediate is a higher magnitude than minor, which is of a higher magnitude than negligible. The word negligible is used to describe a neutral or unnoticeable effect compared to the current situation.

Scope, scale, and intensity can be defined on a range from negligible to major.

Negligible. Resources would not be affected, or the effects would be at or near the lowest level of detection. Resource conditions would not change or would be so slight there would not be any measurable or perceptible consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource.

Minor. Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.

Intermediate. Effects would be readily detectable and localized; with consequences to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset adverse effects and would be extensive, moderately complicated to implement, and probably successful.

Major (significant). Effects would be obvious and would result in substantial consequences to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource within the local area and region. Extensive mitigating measures may be needed to offset

adverse effects and would be large scale in nature, very complicated to implement, and may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as follows.

Short-term or Temporary. An effect that generally would last less than 1 year or season.

Long-term. A change in a resource or its condition that would last longer than a single year or season.

4.2 Summary of Effects

The alternatives are compared side by side under each topic, and both the positive and negative effects of implementing each alternative are described. Table 4-1 provides an overview of the effects under each alternative by indicator. The effects related to implementing each alternative are described in terms of the change from current conditions (i.e., the environmental baseline). Alternative A, the "no-action" alternative would continue present management actions. However, the consequences of implementing Alternative A may have positive, negligible, or negative effects. For example, current management does not include predator control for small Indian mongoose. Should the small Indian mongoose become firmly established on Kaua'i and established within the Refuge, implementation of Alternative A may result in an overall minor to intermediate negative impact on native seabird species.

Table 4-1. Summary of Effects

	Alternative A (No Action)	Alternative B (Preferred)
EFFECTS TO PHYSICAL ENVIRONMENT		
Effects to Soils	Negligible	Short-term, minor to intermediate, negative Long-term, minor, positive
Effects to Water	Negligible	Short-term, minor to intermediate, negative Long-term, minor, positive
Effects to Air Quality	Negligible	Negligible
EFFECTS TO BIOLOGICAL ENVIRONMENT		
Effects to Federally Listed Species		
Effects on nēnē	Minor, negative	Short-term, minor, negative Long-term, intermediate, positive

	Alternative A (No Action)	Alternative B (Preferred)
Effects on ‘ōpe‘ape‘a	Negligible	Negligible
Effects on ‘a‘o	Long-term, minor to intermediate, negative	Long-term, minor to intermediate, positive
Effects to Vegetation	Negligible for non-native vegetation; long-term, minor and negative for native vegetation	Short-term, minor, negative for non-native vegetation Long-term, minor to intermediate, positive for native vegetation
Effects to Seabirds	Long-term, minor, negative	Short-term, minor, negative Long-term, minor to intermediate, positive
Effects to Invertebrates	Negligible	Short-term, minor, negative Long-term, minor, positive
Effects to Invasive Species	Negligible	Localized: long-term, intermediate, negative Globally: short-term, minor, negative
EFFECTS TO CULTURAL AND HISTORIC RESOURCES		
Effects to Cultural and Historic Resources	Negligible	Negligible
EFFECTS TO SOCIAL AND ECONOMIC RESOURCES		
Effects on Visual Resources	Negligible	Negligible
Effects on Recreational Use	Negligible	Negligible
Effects to Illegal Use	Negligible	Negligible
Effects to Economics	Negligible	Long-term, minor, positive
CUMULATIVE EFFECTS		
Creation of Predator-free Areas	Negligible	Long-term, minor, positive

	Alternative A (No Action)	Alternative B (Preferred)
Climate Change	Negligible	Long-term, minor, positive

4.3 Effects to the Physical Environment

Topics addressed under the physical environment section include effects (direct and indirect) to soils, water quality, and air quality.

Continuing the current management (Alternative A) generally has negligible, if any, effects on the physical environment because no change to current conditions is proposed. The effects for Alternative B are described in terms of the change from current conditions.

4.3.1 Effects to soils

Under Alternative A, no disturbance to soils in the project area would occur. Thus, anticipated effects to soils from Alternative A would be negligible.

Under Alternative B, a predator-proof fence would be constructed, resulting in possible effects to the soils. Preparation for construction would require the use of heavy equipment and hand tools to clear and flatten the fence corridor, which would necessitate some movement of soils to create a level construction surface. Approximately 0.7 acres would be disturbed during fence corridor preparation. Installation of fence poles would further disturb existing soils within the fence corridor. The custom soil report (see Appendix D) conducted for the project area by NRCS evaluated the hazard of soil loss after disturbance activities that expose the soil surface, based on slope and soil erosion factor K (used by NRCS to indicate the susceptibility of a soil to sheet and rill erosion by water). The erosion hazard for LhE2 (66% of the project area) and LhD (5% of the project area) soils is considered moderate, indicating that some erosion is likely and erosion control measures may be needed. The erosion hazard for rRo soils (located on the seaward side of the project area; 29% of the project area) is considered severe, indicating that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised. Best management practices would be incorporated to minimize the potential for erosion and would include, for example, avoiding the use of heavy equipment in the steeper and more erosion-prone portion of the project area, phasing construction to reduce exposed ground areas, minimizing the length and steepness of disturbed areas, avoiding earthwork in inclement weather, using vegetative buffers for erosion control and soil stabilization, incorporating culverts to allow water to easily pass through during heavy rain events, and revegetating of bare areas with native coastal plants. It is anticipated that effects to soils from fence construction would be minor to intermediate, because the total amount of soils to be disturbed is less than 1 acre, approximately one-quarter of the disturbed area follows an existing disturbed route (the road), and best management practices would be incorporated. Effects would be temporary, as fence construction would only last 2-4 months.

In addition, under Alternative B, predator eradication and continued habitat monitoring would occur, resulting in possible effects to the soils from the equipment used and its installation. Examples of such equipment that may disturb soils include the stakes used to mark out a grid. The trampling of soils by those conducting the monitoring (e.g., 2 people for 100 days per year) may also either shift or compact the soils. Such activities (and therefore effects) would be long-term as constant monitoring would be necessary to maintain predator-free status. However, given similar monitoring activities already conducted at the Refuge, it is anticipated that effects to soils from predator eradication and habitat monitoring would be negligible.

Finally, under Alternative B, removal of non-native vegetation (primarily Christmasberry) and restoration of native vegetation may also have effects to soil through changes in vegetation cover type and input of guano by the birds. The objective would be to replace non-native vegetation with native vegetation, restoring native coastal habitat. This would have the additional benefit of improving nesting habitat within the fenced area. Temporary disturbance of the soil would occur when non-native plants are removed. To minimize soil disturbance and the potential for erosion, the primary removal method for Christmasberry (the dominant invasive plant in the project area) is manual cutting combined with application of herbicide, but leaving the root system in place to maintain soil stability and control erosion while the plant dies. Mechanical methods may be used where the risk of erosion is minor or to reduce the density of the Christmasberry prior to manual cutting or application of herbicide. Minor soil disturbance may occur when other non-native plants are removed and native plants reintroduced through activities such as uprooting and planting. In particularly sensitive areas, specific erosion control techniques, such as staking down fence cloths or utilizing vegetative buffers (e.g., coconut coir or straw bales) would be used for soil stabilization after removal of invasive plants. Given that non-native vegetation was not part of the original habitat, removal could be beneficial for soils in returning soil chemistry to a previous state. Moreover, if the restored native coastal habitat encourages more nesting seabirds, this would increase the amount of guano input into soils. It is anticipated that this would be a beneficial effect that could assist in restoring nutrient cycles and other ecosystem processes. Overall, effects on soils from habitat restoration are anticipated to be in the short term, minor to intermediate, and negative, and in the long term, minor, and positive.

Conclusion: Overall effects to soil from Alternative A would be negligible. The effects of the additional actions proposed under Alternative B would have varying effects: fence construction would have a minor to intermediate, short-term, negative effect; predator eradication and monitoring would have negligible effect; and habitat restoration would have short-term, minor to intermediate, negative effect and long-term, minor, positive effect.

4.3.2 Effects to water quality

Under Alternative A, no disturbance to soils or water runoff patterns in the project area would occur. Thus, anticipated effects to water quality in natural gullies and gulches and Refuge trails and roads from Alternative A would be negligible.

Under Alternative B, short-term soil disturbance would be unavoidable during site preparation and fence construction. However, no lasting changes to existing patterns of runoff or percolation

are expected, so impacts to marine water quality are expected to be negligible to minor. There are no perennial or intermittent streams in the project area, and normal patterns in the area consist mainly of stormwater runoff and percolation. All construction and operation activities are designed to comply with State water quality standards. In downslope areas of the fence, culverts may be installed on an as-needed basis to minimize erosion potential and channel potential runoff under the fence rather than through it. Best management practices would be incorporated to minimize the potential for erosion and encourage normal runoff patterns. These include avoiding the use of heavy equipment in the steeper and more erosion-prone portion of the project area, phasing construction to reduce exposed ground areas, minimizing the length and steepness of disturbed areas, avoiding earthwork during inclement weather, utilizing vegetative buffers for erosion control, incorporating culverts to allow water to easily pass through during heavy rain events, and revegetating bare areas with native coastal plants. Given the distance (in elevation) of the project site from the ocean, the small amount of land to be disturbed (less than one acre), the incorporation of best management practices, the underlying soil characteristics, the lack of streams in the project area, and existing patterns of runoff, no significant changes to the quality or quantity of existing discharges is anticipated. It is anticipated that effects to water quality would be minor to intermediate. Existing uses (recreational boating activity offshore; fishing) and the level of water quality necessary to protect these existing uses would be maintained.

Under Alternative B, predator removal operations would involve the use of diphacinone, a rodent toxicant. All use of pesticides under Alternative B would be consistent with the Refuge's existing IPM program. The proposed method of rodent removal involves the use of diphacinone bait stations rather than any type of broadcast, almost eliminating the possibility that bait could end up in water. Furthermore, diphacinone has low solubility in water and binds tightly to organic material in soil (USFWS 2008). Water sampling conducted after aerial application of diphacinone pellets to Mōkapu island in February 2008 found no diphacinone residues in any of the seawater samples (USFWS 2008). As such, impacts to water quality from predator removal are anticipated to be negligible.

Under Alternative B, removal of non-native vegetation (primarily the invasive plant Christmasberry) may have effects to water quality through soil disturbance during restoration efforts. The objective is to replace non-native vegetation with native vegetation to restore native coastal habitat. Temporary disturbance of the soil occurs when plants are removed or planted, providing the opportunity for changes to water runoff patterns. To minimize soil disturbance and the potential for erosion or changes to water runoff patterns, the primary removal method for Christmasberry is manual cutting combined with application of herbicide, but leaving the root system in place to maintain the soil stability and control erosion while the plant dies. Mechanical methods may be used where the risk of erosion is minor or to reduce the density of the Christmasberry prior to manual cutting or application of herbicide. All use of herbicides would be consistent with the Refuge's current IPM program. In particularly sensitive areas, specific erosion control techniques such as staking down fence cloths or utilizing vegetative buffers (e.g., coconut coir or straw bales) would be used for soil stabilization after removal of invasive plants. Given that non-native vegetation was not part of the original habitat, removal of non-native species could be beneficial to water quality over the long term as hydrologic and

nutrient cycles are restored through restoration of native plant and animal communities. Overall, effects on water quality from habitat restoration are anticipated to be in the short term, minor to intermediate, and negative, and in the long term, minor, and positive.

Conclusion: Overall effects to water quality from Alternative A would be negligible. The effects of the additional actions proposed under Alternative B would have varying effects on water quality: fence construction would have a minor to intermediate, short-term, negative effect; predator eradication would have negligible effect; and habitat restoration would have short-term, minor to intermediate, negative effect and long-term, minor, positive effect.

4.3.3 Effects to air quality

Under both Alternatives A and B, any activities conducted would follow Federal standards of ambient air quality to assess air quality effects. Actions that could have air quality effects are mainly related to fence construction or application of herbicides during habitat restoration. Fence construction would require the use of heavy equipment (e.g., bulldozer or grader) and small power tools to prepare the site and install the fence. Though it is anticipated that any use of herbicides would be directly applied to the target species (e.g., hand application or squirt bottles), should any spraying (e.g., backpack spraying) occur, to avoid spray drift, approved herbicides would be used in accordance with recommendations on the label attached to the product (e.g., applying large droplets for sufficient coverage, avoid application of herbicides on windy days or certain times of day).

Given the lack of data on ambient air quality specific to the project site, it is difficult to assess the magnitude of effects this action would have on air quality, especially since tradewinds dissipate any equipment emissions or spray. However, because use of heavy equipment and power tools would be temporary, because protocols are in place regarding use of herbicide spray, and given the narrow width and short distance of the fence corridor, it is anticipated the effects of implementing Alternative B on air quality would be negligible.

Conclusion: Effects to air quality from proposed management actions under both Alternatives A and B are negligible.

4.4 Effects to the Biological Environment

Topics addressed under the biological environment section include effects (direct and indirect) to federally listed species, native vegetation, seabirds, invertebrates, and invasive species.

4.4.1 Effects to federally listed species

Listed species receive special consideration in terms of Refuge management. Federally listed species are trust resources that require additional consultation whenever an activity conducted by or permitted by the Refuge may have an effect on these species or their habitats.

4.4.1.1 Effects to nēnē

Under Alternative A, existing nēnē populations are expected to remain stable and continue on their current trajectories of increasing populations on Kaua‘i in the short term. However, with the recent confirmations of mongoose on Kaua‘i, nēnē populations are expected to decline on Kaua‘i in the long term. Within the project area, current management efforts of predator control would reduce, but not eliminate, the possibility of predation. As such, Alternative A is considered to have a minor negative impact on nēnē in both the short and long term.

Under Alternative B, noise and activities associated with the construction of fencing (such as the movement of heavy equipment) may temporarily disrupt the activities of the nēnē, particularly if conducted during breeding (October - March) or molting season (March - June). To avoid such disruption, all construction activities are proposed to occur during the period June – August, during the nonbreeding season.

Under Alternative B, predator control would involve the use of diphacinone rodenticide in bait boxes. Diphacinone has been used safely with nēnē throughout the State, including within the Refuge, for decades without any known harmful effect. As such, the anticipated effect of predator control on nēnē is negligible.

Under Alternative B, predator control would involve the use of traps for cats. Live traps have been known to incidentally take nēnē. To minimize the possibility of incidental take, the following measures will be implemented for any use of live traps: mapping trap locations via GIS; conspicuous marking of trap locations with flagging or rebar; documentation of trap status (open or shut) each day of trapping to ensure every trap is closed prior to days off; checking live traps at least once every 24 hours; no use of dry cat food on floor of cages; placement of bait that may attract nēnē in jars with mesh covering; no placement of traps in known nēnē corridors; use of “nēnē guards” (barriers made of hardware cloth or similar) on live traps or relocation of trap from areas where nēnē are incidentally captured; and providing traps with cover with roofing shingles or alternative materials to provide shelter for trapped non-target species. In addition, the snap traps used for rat control can be a threat to nēnē; to minimize the potential for harm, the rat traps used in this project would be housed in wooden boxes with a small entry point to prevent nēnē adults and goslings from accidentally stepping on them or snapping them with their bill.

Under Alternative B, the widespread removal of invasive plant species may temporarily disrupt the activities of the nēnē, primarily by removing cover. To minimize impacts, invasive plant removal would be planned in stages and again, would occur during nonbreeding (June – August).

Finally, under Alternative B, concerns were brought up whether nēnē goslings hatched within the predator-free fenced unit created would have sufficient forage within the fenced area to last until they were flighted, and if not, if they would be able to get out of the fenced unit to access food sources. Mitigation options to address this issue include monitoring the chicks to ensure sufficient food supplies, providing native plants that are used as forage by nēnē as part of habitat restoration within the fenced unit so that overall food sources increase, and allowing nēnē to depart through the gate.

Overall, the actions proposed under Alternative B (fence construction, predator control, and habitat restoration) are anticipated to provide a net benefit to the endangered nēnē due to the increased protection from predators, as long as monitoring occurs to ensure goslings have adequate forage.

Conclusion: Effects to nēnē under Alternative A over the short and long term are anticipated to be minor and negative. Effects to nēnē under Alternative B are in the short term, minor, and negative and in the long term, intermediate, and positive.

4.4.1.2 Effects to ʻōpeʻapeʻa

Under Alternative A, no construction and no disturbance to vegetation in the project area would occur. Thus, anticipated effects to the ʻōpeʻapeʻa from Alternative A would be negligible.

Under Alternative B, noise and activities associated with the construction of fencing and habitat restoration may temporarily disrupt the activities of the ʻōpeʻapeʻa. However, because no ʻōpeʻapeʻa have been observed in the project area, because Christmasberry has not been documented as a roost site by bats, because ʻōpeʻapeʻa are crepuscular, and because construction would occur during the day, the opportunity for significant disturbance is remote. Because the fence design does not incorporate barbwire, which has been shown to hook bats, and because the hood is a continuous piece of metal, which should be easily noticed and avoided by the ʻōpeʻapeʻa, no significant disturbance is anticipated after construction. Overall, the impacts to the ʻōpeʻapeʻa under Alternative B are anticipated to be negligible.

Conclusion: Overall effects to the ʻōpeʻapeʻa under both Alternatives A and B are anticipated to be negligible.

4.4.1.3 Effects to ʻaʻo

Under Alternative A, no changes to existing management would occur, and ʻaʻo do not currently utilize the project area for nesting. From 1983 – 2008, there has been a 75% decline in ʻaʻo population indices (Day et al. 2003). Probable causes of the decline include predation, habitat loss and degradation, urbanization including collisions with powerlines and attraction to urban lights and subsequent disorientation/fallout, and natural catastrophes (Ainley et al. 1997). Under Alternative A, continued slow decline in the overall ʻaʻo population is anticipated. Moreover, should the mongoose become more firmly established on Kauaʻi, a sharp decline in, and possible extirpation of, the ʻaʻo population is anticipated because there are no breeding sites currently protected from mongoose predation. The effects of Alternative A are anticipated to be in the long term, minor to intermediate, and negative.

Under Alternative B, because no ʻaʻo currently use the area, ʻaʻo are not anticipated to be impacted by activities associated with construction, predator eradication, or habitat restoration. However, the creation of a fenced predator-free area could promote natural re-colonization of ʻaʻo and would provide a secure location for future translocation efforts. Further, the presence of

a predator-free breeding area would be important for the species' survival should the mongoose become firmly established on Kaua‘i. As no ‘a‘o currently use the area for nesting, the benefits to individual birds are speculative, but the creation of new protected areas for breeding is an important benefit to the population as a whole. Overall, the effects of Alternative B to ‘a‘o are anticipated to be in the long term, minor to intermediate, and positive.

Conclusion: The effects of Alternative A on ‘a‘o are anticipated to be long-term, minor to intermediate, and negative. The effects of Alternative B to ‘a‘o are anticipated to be long-term, minor to intermediate, and positive.

4.4.2 Effects to vegetation

Under Alternative A, no construction and no disturbance to vegetation in the project area would occur. Native vegetation constitutes a small proportion of the project area (approximately 5% of the total vegetation cover), and the project area has low native plant diversity. Under Alternative A, native plant diversity and percent cover within the project area would be expected to decline further due to continued competition from the existing invasive plant species. Thus, anticipated effects to native vegetation from Alternative A would be long-term, minor, and negative. Anticipated effects to non-native vegetation would be negligible.

Under Alternative B, fencing would involve removal and disturbance of vegetation during site preparation and construction, and habitat restoration would involve widespread plant removal. Outplantings as part of restoration include such activities as collection of seeds or immature seedlings and replanting them in identified areas. Predator eradication may temporarily increase physical disturbance from the use of traps and bait stations and monitoring efforts.

Because the number of and percent cover of native plants in the project area is quite low (approximately 5%), little to no overall damage to existing native plants is anticipated from the activities associated with Alternative B. Further, pre-project biological surveys have not identified any endangered plants within the project area. Though not anticipated, if any endangered plants are found during construction or habitat restoration, rare species protocols (e.g., flagging plants, identifying buffer zones, etc.) would be implemented to avoid impact to any rare plant species. Alternative B would be expected to provide a benefit to native plants, as native plants would be planted after the removal of Christmasberry, and the establishment of a predator-free fenced area would create an opportunity for rare plant restoration, guided by the needs of particular plant species.

Because the percent cover of non-native plants in the project area is high, the effect of Alternative B on these species would be greater than on native plant species. However, given that the non-native species were introduced to the Refuge, and that these species exist in sizable populations outside the Refuge, the negative effect on non-native vegetation is considered short-term and minor.

Conclusion: Overall, effects to native vegetation under Alternative A are long-term, minor, and negative, and negligible to non-native vegetation. Overall effects to native vegetation under Alternative B are long-term, minor to intermediate, and positive and to non-native vegetation, short-term, minor, and negative.

4.4.3 Effects on seabirds

Under Alternative A, no changes to existing management would occur. Existing populations of breeding mōlī on Kaua‘i would be expected to remain stable. Within the project area, current management efforts of predator control would reduce, but not eliminate, the possibility of predation. As such, Alternative A is considered to have a minor negative impact on mōlī in both the short and long term. Under Alternative A, overflying seabirds would be expected to continue to fly over the area and would not be expected to naturally recolonize the area or begin nesting.

Under Alternative B, noise and activities associated with the construction of fencing may temporarily disrupt the activities of mōlī. As noted previously, fence construction would be timed for June – August, to avoid the most sensitive periods of the breeding and fledgling season. Predator control would involve the use of trapping and diphacinone in bait boxes. These methods of control were used safely amongst mōlī at Ka‘ena Point with no detectable harmful effect (L. Young, pers. comm.) and as noted earlier, the rat traps used for this project would be housed in wooden boxes with a small entry point to prevent mōlī or other birds from accidentally stepping on them or snapping them with their bill. As such, the anticipated effect of predator control on mōlī is negligible. The widespread removal of invasive plant species may temporarily disrupt the activities of the mōlī, primarily by removing cover. To minimize impacts, invasive plant removal would be planned in stages and would not occur near active nests or chicks.

After construction, the presence of the fencing is considered unlikely to disorient seabirds based on observations of interactions (or lack of) between seabirds and the predator-proof fence at Ka‘ena Point (L. Young, pers. comm.). Like Ka‘ena Point, the fencing alignment has been specifically planned to follow natural landscape contours and maintain a reasonable distance from existing nēnē and mōlī nests, but the slope and design of this fencing differs (with full perimeter fencing on the ocean side of the project area). As such, monitoring during and after fence construction is planned to ensure that the disruption to seabirds is minimized.

Under Alternative B, predator control would involve the use of diphacinone rodenticide in bait boxes. The use of bait boxes eliminates the risk of bait pellets coming into direct contact with seabirds or their chicks, preventing accidental ingestion. Because seabirds feed on fish and marine organisms caught in the open ocean, the risk of indirect ingestion by eating rodents contaminated with diphacinone is extremely small.

Under Alternative B, noise and activities associated with construction and habitat restoration could discourage visitation by overflying seabirds. Over the long term, Alternative B is designed to transform underused coastal habitat into quality nesting habitat for seabirds. It is anticipated that the breeding population of the mōlī currently in the project area would double within 3 years of predator removal and habitat restoration based on nesting success at Ka‘ena

Point NAR. It is hoped that 1 or more species of seabird species which currently overfly the area would establish breeding colonies at Nihoku on their own once predators are removed. The most likely candidates are ʻā (known to nest nearby) and ʻuaʻu kani (known to nest in similar areas).

Over the long term, protecting and enhancing seabird nesting habitat on high islands including the Refuge is of particular importance to vulnerable species and displaced seabird colonies, as existing habitat located on low-lying atolls and islands remains at threat by rising sea levels and climate change (Arata et al. 2009, USFWS in prep.).

Conclusion: Overall effects to seabirds under Alternative A are minor and negative. Effects to seabirds under Alternative B are in the short term, minor, and negative, and in the long term, minor to intermediate, and positive.

4.4.4 Effects to invertebrates

Given the lack of data on invertebrate numbers in the project area and their habitat needs, it is difficult to assess the magnitude of effects this action would have on native or non-native invertebrate populations. Existing invertebrates could be disturbed by construction and habitat restoration activities, but because the total acreage to be disturbed is low and the habitat in the surrounding area is similar to that of the project area and could host any displaced invertebrate populations, the short-term negative impacts are expected to be minor. Because Alternative B involves the removal of invasive plants and restoration of native habitat, it is anticipated that the long-term effects to native invertebrates would be positive and minor.

Conclusion: Overall effects to invertebrates from Alternative A are negligible. Effects to invertebrates from Alternative B are in the short term, minor and negative and in the long term, minor and positive.

4.4.5 Effects to invasive species

Under Alternative A, no changes to existing management would occur. Under Alternative A, invasive plant species would continue to dominate the project area and invasive mammals would continue to move freely throughout the project area. Thus, anticipated effects to invasive species from Alternative A would be negligible.

Alternative B has components of either controlling or eradicating invasive species (both flora and fauna), specifically Christmasberry, cats, and rodents. Control of these pests is identified in various Recovery Plans as necessary for the recovery of listed species and continuation of other native species at the Refuge (USFWS in prep., USFWS 2004, USFWS 1995, USFWS 2005). Eradication would involve any number of tools from hand-pulling plants, to traps, to chemicals such as herbicides or rodenticides. The increased level of effort under Alternative B would be more beneficial to native habitats and species than A and implements the Refuge's mission to protect and conserve these resources. While the localized effect on invasive species would be intermediate (because it would be readily detectable within the project area), given that the non-native species were introduced to the Refuge, that these species exist in sizable populations

outside the Refuge, and that these invasive species would continue to persist in other places on the Refuge, on Kaua‘i, and throughout the State, the overall effect of Alternative B on invasive species would be minor.

Conclusion: Effects to invasive species under Alternative A are negligible. Under Alternative B, localized negative effects on invasive species would be long-term and intermediate, while effects across the entire distribution of the invasive species populations would be short-term, minor, and negative.

4.5 Effects to Cultural and Historic Resources

The NHPA, as amended, establishes the Federal Government's policy on historic preservation and the programs through which that policy is implemented. An impact to cultural resources would be considered significant if it adversely affects a resource listed in or eligible for listing in the National Register of Historic Places. In general, an adverse effect may occur if a cultural resource would be physically damaged or altered, isolated from the context considered significant, or affected by project elements that would be out of character with the significant property or its setting. Title 36 CFR Part 800 defines effects and adverse effects on historic resources.

An Archaeological Inventory Survey completed in May 2013 concluded that there are no cultural resources within the project area and recommended "that the proposed project will have no effect on cultural resources and a project-specific effect determination of 'no cultural resources affected' is warranted" (Cultural Surveys Hawai‘i 2013). A Section 106 consultation will occur as necessary to confirm that Alternative B would have no adverse effect on the historic resources within the Refuge, and mitigation requirements, if any, resulting from this process would be incorporated and implemented as appropriate.

Currently, no resources are eligible or listed on the National Register of Historic Places within the project site. Should evidence of any archaeological or cultural properties be encountered during construction, vegetation clearing and fence construction would immediately cease and the appropriate parties would be consulted immediately. Wherever possible, cultural resources would be avoided. Minimization options, in addition to site avoidance by relocating activities, would include data recovery, using either collection techniques or *in-situ* site stabilization protection.

The purpose of the project is the long-term restoration of Nihoku and its unique natural resources, including the eradication of introduced mammalian predators. To some in the community, natural resources are cultural resources, and a project designed to enhance native seabird and plant populations has a positive impact on cultural resources.

Conclusion: Effects to cultural and historic resources under both Alternative A and B are negligible.

4.6 Effects to Social and Economic Resources

Topics addressed under this section include effects (direct and indirect) to visual resources, recreational use, illegal use, and economic resources.

Continuing the current management (Alternative A) generally has negligible, if any, effects because little or no change to current conditions is proposed. The effects for Alternative B are described in terms of the change from current conditions.

4.6.1 Effects to visual resources

The remote, undeveloped nature of Kīlauea Point proper (31 acres with public visitation) with views of the historic lighthouse, cliffs, and the ocean is one of the primary attractions for those visiting the island of Kaua‘i. Under Alternative A, no construction would occur in this area; thus, anticipated effects to visual resources under Alternative A would be negligible.

Under Alternative B, the planned fence alignment and design is designed for minimal interference to view planes. Due to landscape contours, the fencing would not be visible from any public viewing point, including the lighthouse or any public roadways, and it would be located in a portion of the Refuge that is not open to or traversed by the public. Further, even if the fence were visible, the visual impact of the fence once constructed would be negligible to minor, based on the experiences at Ka‘ena Point, a remote but highly visited coastal area with prized coastal views. There has been little to no public complaint about the impact of the fence on the visual beauty of Ka‘ena Point despite unavoidable interference with the scenic vistas where the fence crosses a public trail. Because the proposed fencing at Kīlauea Point is planned for a more remote area with less visitation, the impact on visual resources is considered negligible.

Conclusion: Effects to visual resources under both Alternatives A and B are negligible.

4.6.2 Effects on recreational use

The project area is located in a portion of the Refuge that is not currently open for public visitation, is not currently planned for recreational use, and is not along the transit route to areas that are open for public visitation (e.g., Kīlauea Lighthouse). Construction activities such as the movement of heavy equipment and materials would be timed to minimize inconvenience to visitors to the Refuge. As such, Alternative A has no effect on recreational use, and implementing Alternative B would not be expected to have an effect on recreational use.

Conclusion: Effects to recreational use under both Alternatives A and B are negligible.

4.6.3 Effects on illegal use

The project area is located in a portion of the Refuge that is not currently open for public visitation. However, there are occasional incidents of trespass by surfers or fishermen accessing

the ocean. Under Alternative B, the fence alignment would not cut off access to the ocean. Instead, because the fence alignment would follow landscape contours and site preparation would involve creating a level fencing corridor, Alternative B may make it easier for Refuge staff to identify illegal trespass if trespassers choose to follow the fence as a route. At the same time, because the fencing would not be visible from adjacent properties or from the open areas of the Refuge, the fencing is not anticipated to attract new trespassers. As a result, illegal use is not anticipated to change significantly due to the actions associated with Alternative B.

Conclusion: Effects to illegal use under both Alternatives A and B are negligible.

4.6.4 Effects on economic resources

Under Alternative A, no change to existing management would occur. Because the project area is designated for habitat restoration and not for public use, no specific economic activity is associated with Alternative A.

Under Alternative B, fence construction, habitat restoration, and predator eradication are proposed to provide safe nesting habitat for seabirds and the endangered nēnē and to restore native coastal habitat. As part of the project, a specifications and materials manual would be developed to create the capacity to build and price these predator-proof fences locally, for this project and for future predator-proof fences within the state. This would provide an economic opportunity for local fencing companies and reduce the need to import materials and/or workers from out of the country.

Estimated costs associated with Alternative B include approximately $300,000 for fence materials and construction and $200,000 for biological monitoring, predator eradication, post-eradication monitoring, and habitat restoration. In addition, the protected area would be expected to encourage additional future conservation spending associated with rare plant reintroduction, ʻaʻo translocation, research, or other conservation projects.

Some local purchases would include rental of heavy equipment, lodging for fence construction crews, food, and other supplies. Salary spending associated with biological monitoring, fence construction, predator eradication, and habitat restoration could generate secondary benefits by providing jobs in other industries where monies are spent. Personal spending could include rent, utilities, food, entertainment, food services, gas, etc.

This project is conducted collaboratively with other agencies or educational institutions. Current funding for the project includes a grant awarded by the National Fish and Wildlife Foundation to the American Bird Conservancy, private funds raised by American Bird Conservancy, funding from mitigation agreements relating to ESA Section 7 consultations on Federal actions on Kauaʻi with real or potential impacts to seabirds, and funding from criminal and civil settlements relating to illegal take of endangered seabirds on Kauaʻi. USFWS is providing in-kind donations of staff time and equipment during the planning process.

The project is not expected to have any negative economic impacts. Positive economic impacts would result from the release of project funds into the State economy, the opportunity for training in the methods for building predator-proof fences, and the encouragement of additional related conservation spending.

Conclusion: Effects to economic resources from Alternative A are negligible. Effects to economic resources from Alternative B are positive and long term. However, given the size of the project relative to the overall Refuge budget or to other economic inputs into the local economy, effects to economic resources are minor.

4.7 Cumulative Effects

The Council on Environmental Quality (CEQ) regulations for implementing the provisions of NEPA defines several different types of effects that should be evaluated in an EA including direct, indirect, and cumulative. Direct and indirect effects are addressed above. This section addresses cumulative effects. The CEQ (40 CFR § 1508.7) provides the following definition of cumulative effects:

> *"The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."*

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can "accumulate" spatially, when different actions affect different areas of the same resources. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially canceling out each other's effect on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource. In addition, sometimes the overall effect is greater than merely the sum of the individual effects, such as when one more reduction in a population crosses a threshold of reproductive sustainability, and threatens to extinguish the population.

A thorough analysis of impacts always considers their cumulative aspects, because actions do not take place in a vacuum; there are virtually always some other actions that have affected that resource in some way in the past, or are affecting it in the present, or will affect it in the reasonably foreseeable future. So any assessment of a specific action's effects must in fact be made with consideration of what else has happened to that resource, what else is happening, or what else will likely happen to it.

The Refuge staff is not aware of any past, present, or planned actions that would result in a significant cumulative impact when added to the Refuge's proposed action, as outlined in Alternative B.

4.7.1 Creation of predator-free areas

While the proposed NERP will be the first project of its kind on Kaua‘i, it will add to an existing small network of predator-free areas found within the State. In addition to Ka‘ena Point NAR (discussed earlier in this EA), a few offshore islands are considered predator free, including Mōkapu (10 acres) and Mokoli‘i (12.5 acres) (Hess 2011). Each of these spaces alone is insufficient to support the recovery of listed and rare seabirds and endangered plants. At some point, the network of protected predator-free areas would be able to support reproductively sustainable populations, although the necessary size of the network would vary dependent on the species and the threats faced by that species. As illustration, recent modeling estimated protected habitat requirements to predict a 95 percent or greater probability of survival over 100 years for ‘a‘o and concluded that over 2,700 acres of rodent-free land is needed (USFWS undated). As this project covers approximately 7 acres, the cumulative effect of this fence on ‘a‘o recovery would be minor. For rare plants endemic to Kaua‘i, similar modeling efforts are not complete. Some rare plants are located within fenced areas free of hooved animals, so already receive some limited protection from threats. While small, this fence would increase the acreage of protected habitat and provide additional protection from seed and fruit predation by rats. As such, the cumulative benefit to rare plants would be considered minor.

Conclusion: Cumulative effects are minor and beneficial.

4.7.2 Climate change

Global climate change is supported by a continuously growing body of unequivocal scientific evidence. Global forecasting models offer a variety of predictions based on different emission scenarios. The U.S. Government agency Overseas Private Investment Corporation (OPIC) suggests that a further increase in greenhouse gas emissions could double atmospheric concentrations of CO2 by 2060 and subsequently increase temperatures by as much as 2-6.5°F over the next century. Recent model experiments by the IPCC show that if greenhouse gases and other emissions remain at 2000 levels, a further global average temperature warming of about 0.18°F per decade is expected. Sea level rise is expected to accelerate by two to five times the current rates due to both ocean thermal expansion and the melting of glaciers and polar ice caps. Recent modeling projects sea level to rise 0.59-1.93 feet by the end of the 21st century. These changes may lead to more severe weather, shifts in ocean circulation (currents, upwelling), as well as adverse impacts to economies and human health. The extent and ultimate impact these changes will have on Earth's environment remains under considerable debate (Buddemeier et al. 2004, Solomon et al. 2007, IPCC 2007).

Small island groups are particularly vulnerable to climate change. The following characteristics contribute to this vulnerability: (1) small emergent land area compared to the large expanses of surrounding ocean; (2) limited natural resources; (3) high susceptibility to natural disasters; and (4) inadequate funds to mitigate impacts (IPCC 2007). Thus, Hawai‘i is considered to have a limited capacity to adapt to future climate changes.

Though Alternative B would not have an impact on climate change, the activities associated with Alternative B (fence construction, predator removal, habitat restoration) would provide enhanced protection for Refuge species from some of the anticipated effects of climate change, including the anticipated loss of habitat associated with sea level rise. Alternative B would also help restore ecosystem and species resilience to climate change by reducing or eliminating other stressors (e.g., pest species).

Conclusion: Cumulative effects are negligible to minor and beneficial.

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Appendix A: Common Acronyms and Abbreviations

CCP	Comprehensive Conservation Plan
CWCS	Comprehensive Wildlife Conservation Strategy
CFR	Code of Federal Regulations
DM	Departmental Manual
DLNR	Hawai‘i Department of Land and Natural Resources
DOFAW	Hawai‘i DLNR Division of Forestry and Wildlife
DOI	Department of the Interior
EA	Environmental Assessment
EO	Executive Order
ES	U.S. Fish and Wildlife Service Ecological Services
ESA	Endangered Species Act of 1973
FONSI	Finding of No Significant Impact
Ft	Feet (foot)
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
KESRP	Kaua‘i Endangered Seabird Recovery Project
KPNWR, the Refuge	Kīlauea Point National Wildlife Refuge
KNWRC	Kaua‘i National Wildlife Refuge Complex
LhD	Lihue silty clay, 15- to 25-percent slopes, soil type
LhE2	Lihue silty clay, 25- to 40-percent slopes, soil type
MBTA	Migratory Bird Treaty Act
MHI	main Hawaiian Islands
Mi	Mile(s)
NAR	Natural Area Reserve
NEPA	National Environmental Policy Act
NERP	Nihoku Ecosystem Restoration Project
NGO	Nongovernmental Organization
NHPA	National Historic Preservation Act
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
NWHI	Northwestern Hawaiian Islands
RM	National Wildlife Refuge System Manual
rRo	Rock outcrop soil type
T&E	Threatened and Endangered
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS, FWS, the Service	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Appendix B: Species Lists

Scientific name	Common name	Hawaiian name
Native Wildlife Species		
Lasiurus cinereus semotus	Hawaiian hoary bat	ʻōpeʻapeʻa
Branta sandvicensis	Hawaiian goose	nēnē
Phoebastria immutabilis	Laysan albatross	mōlī
Puffinus pacificus	Wedge-tailed shearwater	ʻuaʻu kani
Phaethon lepturus dorotheae	White-tailed tropicbird	koaʻe kea
Phaethon rubricauda	Red-tailed tropicbird	koaʻeʻula
Sula sula rubripes	Red-footed booby	ʻā
Fregata minor	Great frigatebird	ʻiwa
Non-Native Wildlife Species		
Canis familiaris	Dog	ʻīlio
Felis catus	Cat	pōpoki
Rattus exulans	Polynesian rat	ʻiole
Rattus norvegicus	Norway rat	ʻiole
Rattus rattus	Black rat	ʻiole
Mus musculus	House mouse	ʻiole

Native Plant Species		
Scientific name	**Common Name**	**Hawaiian name**
Asteraceae - Sunflower		
Lipochaeta succulenta		nehe
Aizoaceae - Ice Plant		
Sesuvium portulacastrum	Sea purslane	ʻākulikuli
Euphorbiaceae - Spurge		
Euphorbia celastroides var. stokesii		ʻakoko, koko, ʻekoko, kōkōmālei
Fabaceae - Pea		
Vigna marina	Beach pea	nanea

Goodeniaceae - Goodenia		
Scaevola taccada		naupaka kahakai, huahekili
Pandanaceae - Screw Pine		
Pandanus tectorius	Pandanus	hala, pū hala
Rosaceae - Rose		
Osteomeles anthyllidifolia		ʻūlei
Non-Native Plant Species		
Anagallis arvensis	Scarlet pimpernel	
Ardisia elliptica	Shoebutton ardisia, inkberry	
Asparagus densiflorus	Asparagus fern, foxtail asparagus	
Asystasia gangetica	Chinese violet	
Bidens pilosa		kī, kī nehe, kī pipili, nehe
Bidens alba radiata	Beggartick	
Blechnum appendiculatum	Blechnum	
Bothriochloa pertusa	Pitted beardgrass	
Canavalia cathartica		
Casuarina equisetifolia	Common ironwood	paina
Cenchrus clandestinus	Kikuyu grass	
Chamaecrista nictitans	Sensitive partridge pea	
Chrysophyllum oliviforme	Satin leaf	
Cocos nucifera	Coconut palm	niu
Commelina diffusa	Dayflower	honohono
Conyza canadensis	Horseweed	Lani wela
Cynodon dactylon	Bermuda grass	
Desmodium incanum	Spanish clover	
Digitaria insularis	Sourgrass	
Hyptis pectinata	Comb Hyptis, bushmints	
Ipomoea obscura	Obscure morning glory	
Lantana camara	Lantana	
Leucaena leucocephala	Lead tree	koa haole

Megathyrsus maximus	Guinea grass	
Mimosa pudica	Sensitive plant, sleeping grass	pua hilahila
Momordica charantia	Bitter melon	
Oxalis corniculata	Yellow wood sorrel	‘ihi ‘ai, ‘ihi ‘awa
Passiflora foetida	Love in a mist	
Phyllanthus debilis	Niruri	
Phymatosorus grossus	Maile scented fern	laua‘e
Plantago lanceolata	Narrow-leaved or English plantain	
Pluchea carolinensis	Sourbush	
Portulaca oleracea	Pigweed, yellow flower	
Portulaca pilosa	Pigweed, purple flower	‘ākulikuli (Ni‘ihau)
Psidium cattleianum	Strawberry guava	
Psidium guajava	Common guava	kuawa, kuawa ke‘oke‘o
Rivina humilis	Coral berry	
Schinus terebinthifolius	Christmasberry	
Senna pendula	Pendant senna, scrambled egg	
Setaria parviflora	Yellow foxtail	
Sigesbeckia orientalis	Small yellow crown beard	
Solanum americanum san.	Glossy nightshade	pōpolo ‘aiakeakua, pōpolo
Solanum seaforthianum	Seafoam, vining solanum	
Sphagneticola trilobata	Wedelia, yellow daisy	
Sprorobolus africanus	Rat's tail grass	
Stachytarpheta cayennensis	Vervain	
Syzigium cumini	Java plum	
Urochloa mutica	California grass	
Urochloa plantaginea	Brachiaria	
Waltheria indica		uhaloa

Appendix C: Draft Archaeological Assessment for the Kīlauea Point National Wildlife Refuge Fencing Project

Draft
Archaeological Assessment for the Kīlauea Point National Wildlife Refuge Fencing Project, Kīlauea Ahupuaʻa, Hanalei District, Island of Kauaʻi TMK: (4) 5-2-004:103 por.

Prepared for

Pacific Rim Conservation

Prepared by

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Management Summary

Reference	Archaeological Assessment for the Kīlauea Point National Wildlife Refuge Fencing Project Kīlauea Ahupua‘a, Hanalei District, Island of Kaua‘i TMK: (4) 5-2-004: 103 por.
Date	May 2013
Project Number (s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: KILAUEA 7
Investigation Permit Number	The fieldwork component of the archaeological assessment was carried out under archaeological permit number 13-06 issued by the Hawai‘i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai‘i Administrative Rules (HAR) Chapter 13-282.
Project Location	The Kīlauea Point National Wildlife Refuge is located at the northernmost tip of the Island of Kaua‘i between Kīlauea Point and Mokolea Point. The fencing project area is just south of Makapili Rock, approximately 1.5 km northeast of Kīlauea Town and 200 m east of Crater Hill. The project area consists of a 6.67-acre parcel of sloping land abutting precipitous sea cliffs on the northeastern end. The project area is depicted on the U.S. Geological Survey 7.5-Minute Series Topographic Map, Anahola Quadrangle (1996).
Land Jurisdiction	Federal Government (U.S. Fish and Wildlife Service; Department of the Interior)
Agencies	State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR)
Project Funding	Pacific Rim Conservation
Description	Proposed development within the project area consists of the installation of a fence to protect the habitat of ground nesting birds within the National Wildlife Refuge.
Project Acreage	6.67 acres
Area of Potential Effect (APE)	For the purposes of this archaeological assessment, the APE is defined as the approximately 6.67-acre project area.
Survey Area	For the current archaeological assessment investigation the survey area consisted of the majority of the 6.67-acre project area, within the limits of the rugged terrain and dense vegetation.
Historic Preservation Regulatory Context	The proposed project is subject to Hawai‘i State environmental and historic preservation review legislation (Hawai‘i Revised Statutes [HRS] Chapter 343 and HRS 6E-8/Hawai‘i Administrative Rules [HAR] Chapter 13-275, respectively). Due to the involvement of federal lands (Kīlauea Point National Wildlife Refuge) the project is

	also subject to the federal historic preservation and environmental review process, requiring compliance with Section 106 of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA). In consultation with the Hawai‘i State Historic Preservation Division (SHPD), the archaeological assessment investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276.
Fieldwork Effort	The fieldwork component of the archaeological assessment was conducted on April 9, 2013 by two CSH archaeologists, Ena Sroat, B.A., and Veronica Morriss, M.A., under the general supervision of Hallett H. Hammatt, PhD. The fieldwork required approximately one person-day, or eight hours, to complete.
Number of Cultural Resources Identified	None
Cultural Resources Recommended Ineligible to the Hawai‘i Register	None
Effect Recommendation	Based on the current investigation, there are no cultural resources within the project’s APE. Accordingly, it is recommended that the proposed project will have no effect on cultural resources and a project-specific effect determination of “No cultural resources affected” is warranted.
Mitigation Recommendation	Based on background research, it is unlikely that surface cultural resources associated with pre- and post-Contact land use are present within the project area. CSH recommends no further work in the project area. To mitigate the potential of effect on unidentified historic properties, it is recommended that any ground disturbance activities related to the current project be contained within the project area. Should unforeseen ground disturbing activities be required outside the current surveyed project area, additional survey coverage is recommended. In the unlikely event that previously unidentified cultural resources are encountered by project construction, the project proponents should immediately stop work in the vicinity and contact the SHPD.

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Section 1 Introduction

1.1 Project Background

At the request of Pacific Rim Conservation, Cultural Surveys Hawai‘i, Inc. (CSH) completed this archaeological assessment for the Kīlauea Point National Wildlife Refuge Fencing Project, Kīlauea Ahupua‘a, Hanalei District, Island of Kaua‘i TMK: (4) 5-2-004:103 por. The Kīlauea Point National Wildlife Refuge is located at the northernmost tip of the Island of Kaua‘i between Kīlauea Point and Mokolea Point. The fencing project area is just south of Makapili Rock, approximately 1.5 km northeast of Kīlauea Town and 200 m east of Crater Hill. The project area consists of a 6.67-acre parcel of sloping land between 140 and 250 ft AMSL, abutting precipitous sea cliffs on the northeastern end. The project area is depicted on the U.S. Geological Survey 7.5-Minute Series Topographic Map, Anahola Quadrangle 1996 (Figure 1), Tax Map Key (Figure 2), and two aerial photos (Figure 3 and Figure 4).

The project area is federally owned and administered by the U.S. Fish and Wildlife Service/ Department of the Interior. Proposed development within the project area consists of the installation of a fence to protect the habitat of ground nesting birds within the National Wildlife Refuge. For the fence construction, ground-disturbing activities will include removing all vegetation within a 4 m-wide path along the fence line and smoothing that area with minor grading. To secure the fence, 30 cm-wide post holes will be augured 1 m deep every 3 to 4 m. After fence construction, the refuge staff will remove the non-native vegetation within the fenced area (the majority is non-native), which should involve minimal ground disturbance.

This document was prepared to support the proposed project’s historic preservation review under Hawai‘i Revised Statutes (HRS) Chapter 343 and HRS 6E-8/Hawai‘i Administrative Rules (HAR) Chapter 13-275, respectively. Due to the involvement of federal lands (Kīlauea Point National Wildlife Refuge), the project is also subject to the federal historic preservation and environmental review process, requiring compliance with Section 106 of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA). In consultation with the Hawai‘i State Historic Preservation Division (SHPD), the archaeological assessment investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276.

1.2 Scope of Work

The following scope of work satisfies the Hawai‘i state requirements for archaeological inventory surveys (Hawai‘i Administrative Rules [HAR] Chapter 13-276 and Chapter 13-275/284):

1) Historic and archaeological background research, including a search of historic maps, written records, Land Commission Award documents, and the reports from prior archaeological investigations. This research will focus on the specific project area’s past land use, with general background on the pre-Contact and historic settlement patterns of the *ahupua‘a* and district. This background information will be used to compile a predictive model for the types and locations of cultural resources that could be expected within the project area.

Figure 1. 1996 U.S. Geological Survey 7.5-Minute Series Topographic Map, Anahola Quadrangle, showing the location of the project area

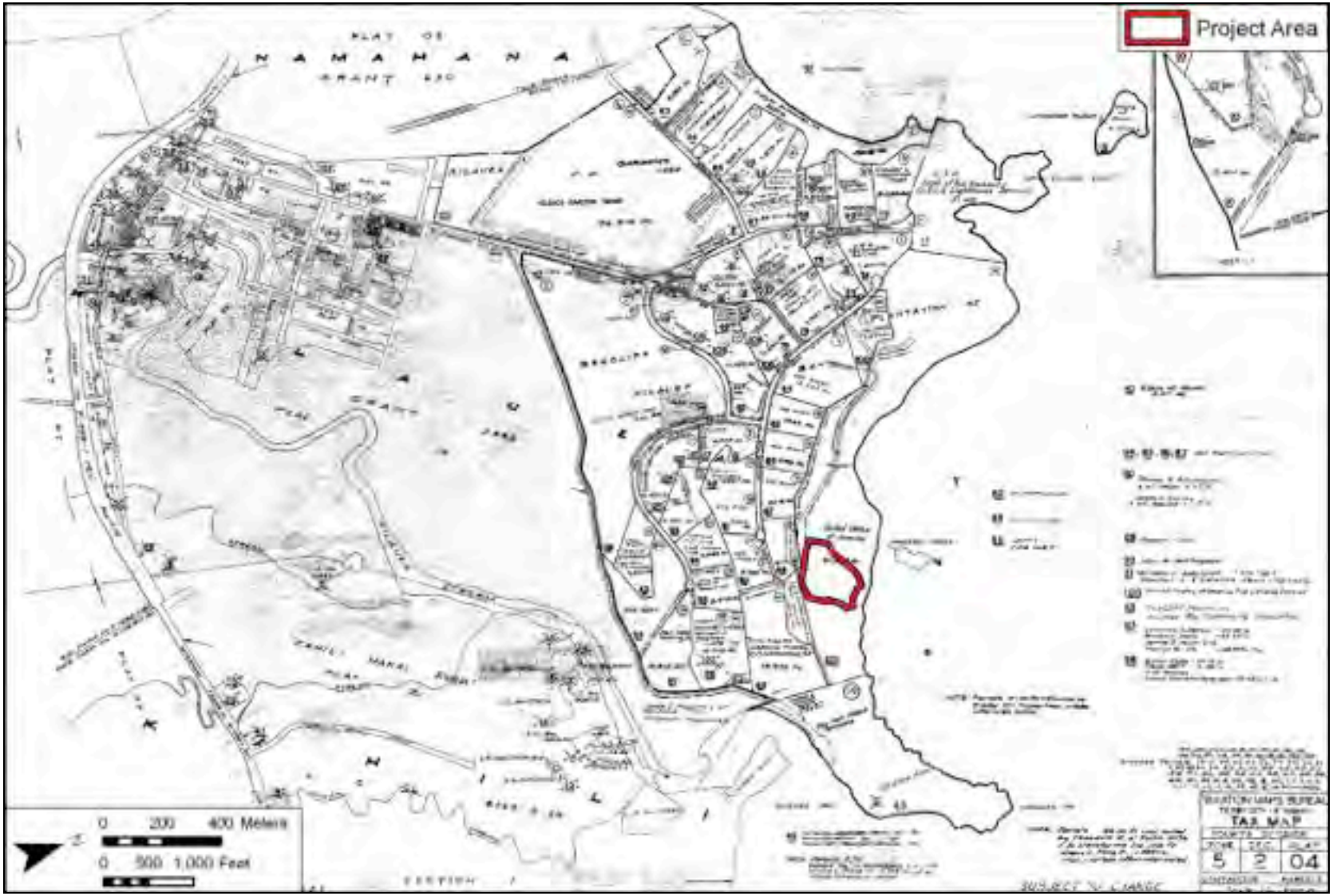


Figure 2. Tax Map Key (TMK) (4) 5-2-004, showing the location of the project area (Hawai‘i TMK Service 2010)

Figure 3. Aerial photograph showing the general location of the project area (Google Earth 2010)

Figure 4. Aerial photograph showing the project area (Google Earth 2010)

2) A complete (100 %) systematic pedestrian inspection of the project area, with a target width of 10 m spacing, to identify any potential surface cultural resources. This spacing may need to adapt to steep slopes and any vegetation that is exceedingly dense. Surface cultural resources will be recorded with an evaluation of age, function, interrelationships, and significance. Documentation will include photographs, scale drawings, and, if warranted, limited controlled excavation of select sites and/or features.

3) Based on the project area's environment and the results of the background research, subsurface testing with a combination of hand and backhoe excavation may be used to identify and document subsurface cultural resources that would not be located by surface pedestrian inspection. Appropriate samples from these excavations will be analyzed for cultural and chronological information. All subsurface cultural resources identified will be documented to the extent possible, including geographic extent, content, function/derivation, age, interrelationships, and significance.

4) As appropriate, consultation with knowledgeable individuals regarding the project area's history, past land use, and the function and age of the cultural resources documented within the project area.

5) As appropriate, laboratory work to process and gather relevant environmental and/or archaeological information from collected samples.

6) Preparation of an inventory survey report, which will include the following:

   a) A project description;

   b) A section of a USGS topographic map showing the project area boundaries and the location of all recorded cultural resources;

   c) Historical and archaeological background sections summarizing prehistoric and historic land use of the project area and its vicinity;

   d) Descriptions of all cultural resources, including selected photographs, scale drawings, and discussions of age, function, laboratory results, and significance, per the requirements of HAR 13-276. Each cultural resource will be assigned a Hawai‘i State Inventory of Historic Properties number;

   e) If appropriate, a section concerning cultural consultations [per the requirements of HAR 13-276-5(g) and HAR 13-275/284-8(a)(2)].

   f) A summary of cultural resource categories, integrity, and significance based upon the Hawai‘i and National Register of Historic Places criteria;

   g) A project effect recommendation;

   h) Treatment recommendations to mitigate the project's adverse effect on any cultural resources identified in the project area that are recommended eligible to the Hawai‘i Register of Historic Places.

1.3 Environmental Setting

1.3.1 Natural Environment

The 203-acre Kīlauea National Wildlife Refuge is located along the Kīlauea shoreline, on the northern tip of Kaua‘i Island, and was created largely as a preserve for various seabird species (Figure 5). The curving shoreline here is the remnant of an ancient volcanic cone which has been eroded by the heavy surf common to the area. A popular guidebook notes:

> Along the backshore, the lower reaches of Kīlauea Stream form one of the most pristine estuaries in the state. In former times it supported an important mullet fishery. Mullet and other fish are still found there, but are not fished commercially. [Clark 1990:22]

The project area encompasses sloping land from about 140- to about 250-ft elevation AMSL within the Kīlauea National Wildlife Refuge; the northeastern boundary of the project area approaches the sea cliffs (Figure 6).

The vast majority of the project area contains Lihue Silty Clay: 25- to 40-percent slopes (LhE2) and 15- to 25-percent slopes (LhD), while the seaward portion is dominated by Rock Outcrop (rRO) (Figure 7). Soils of the Lihue Series are described as “well-drained soils on uplands . . . developed in material weathered from basic igneous rock” (Foote et al. 1972).

The project area is indicated to receive approximately 1,500 mm (60 in) of annual rainfall, with increased rainfall at higher elevations (Giambelluca et al. 1986). This is more than sufficient for most non-irrigated agriculture and supports luxuriant and diverse vegetation (Figure 8 and Figure 9). The vegetation within the project area is almost entirely exotic and includes exotic grasses, ironwood (*Cassuarina equisetifolia*), Christmasberry (*Schinus terebinthifolius*), *naupaka* (*Scaevola sericea*), *koa haole* (*Leucaena leucocephala*), ‘*akoko* (*Chamaesyce celastroides*), and *hala* (*Pandanus* sp.). There are also extensive areas of thorny exotic vegetation. The only native plants observed were *hala* and ‘*akoko*.

1.3.2 Built Environment

The project area is comprised of former sugar cane land previously owned by the Kilauea Sugar Company from 1880 to 1971. Given that the terrain around Crater Hill and within the project area was too steep to be cultivated with sugar cane, it was primarily utilized as pasture land (Fredericksen and Fredericksen 1989:9). Since the closure of Kilauea Sugar Company, the land has remained undeveloped. The surrounding area contains a luxury housing development.

Figure 5. A photograph of an albatross pair that recently nested in the project area

Figure 6. A photograph of nesting birds on the steep terrain along the western boundary of the project area

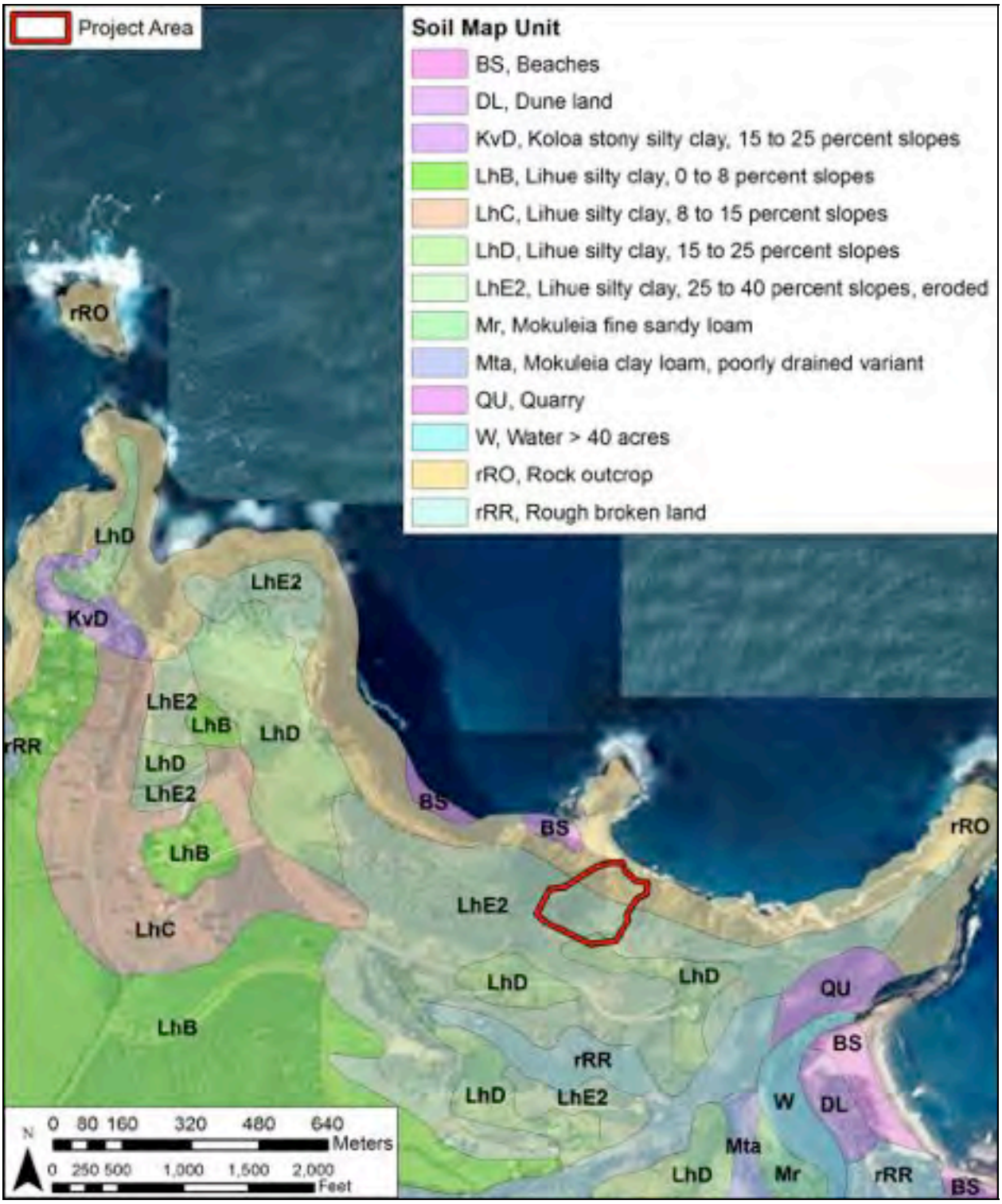


Figure 7. Overlay of Soil Survey of the State of Hawai‘i (Foote et al. 1972), indicating soil types within the project area

Figure 8. A photograph of the *koa haole* trees within the project area

Figure 9. A photograph of the Christmasberry and *hala* plants within the project area

Section 2 Methods

2.1 Field Methods

The fieldwork component of the archaeological assessment was conducted on April 9, 2013 by two CSH archaeologists, Ena Sroat, B.A., and Veronica Morriss, M.A., under the general supervision of Hallett H. Hammatt, Ph.D. The fieldwork required approximately one person-day, or eight hours, to complete. Fieldwork consisted of a 100-percent systematic pedestrian survey of the project area, within the limits of the rugged terrain and dense vegetation.

The ground survey of the project area was undertaken for the purpose of cultural resource identification and documentation. CSH archaeologists walked the project area in systematic sweeps with a target width of 10 m spacing, wherever the vegetation permitted (Figure 10). In areas of thick and impenetrable underbrush, this interval was often extended (Figure 11 and Figure 12). Portions of the project area were only accessible by means of crawling through the dense underbrush (Figure 13). No surface archaeological cultural resources were encountered during the pedestrian inspection. Accordingly, no subsurface testing was deemed necessary.

2.2 Archival Research

Historical documents, maps, and existing archaeological information pertaining to Kīlauea were researched at the CSH library and other archives including the University of Hawai‘i at Mānoa’s Hamilton Library, the State Historic Preservation Division (SHPD) library, the Hawai‘i State Archives, the State Land Survey Division, and the Bishop Museum Archives. Previous archaeological reports for the area were reviewed, as were historic maps and photographs and primary and secondary historical sources. Information on Land Commission Awards (LCAs) was accessed through Waihona ‘Aina Corporation’s Māhele Database (www.waihona.com), as well as a selection of CSH library references. Research for the Cultural and Historical Background section centered on the following cultural and historic resources, practices, and beliefs: traditional subsistence land use and settlement patterns; gathering practices and agricultural pursuits; *wahi pana* (storied places) and associated *mo‘olelo* (stories, oral traditions), *mele* (songs), *oli* (chants), and *‘ōlelo no‘eau* (proverbs).

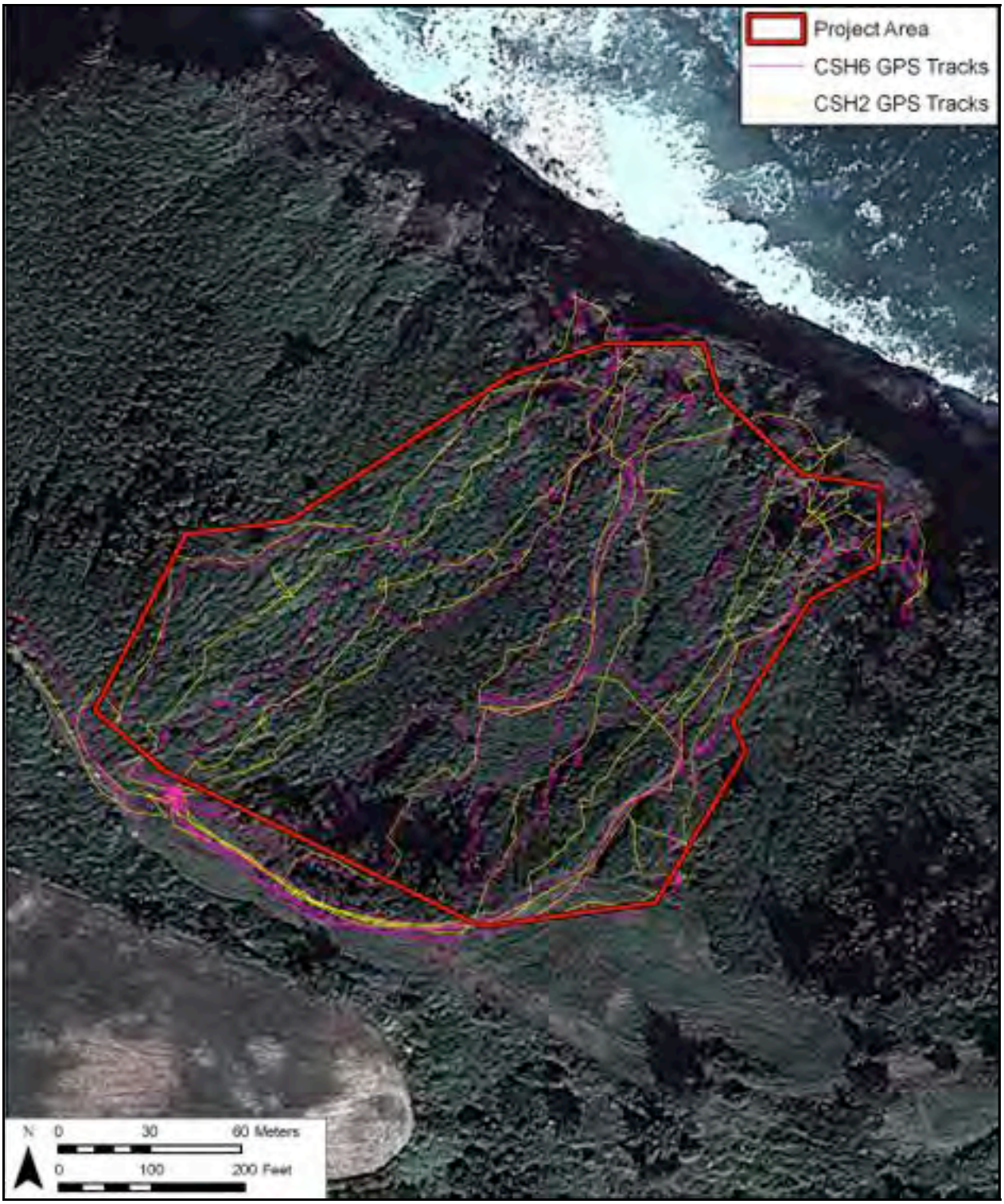


Figure 10. Aerial photograph of the project area depicting the GPS tracks that were completed by the CSH archaeologists during the pedestrian survey (Google Earth 2010)

Figure 11. Photograph of the dense vegetation within the project area

Figure 12. Photograph of the dense vegetation within the project area

Figure 13. Photograph of an area of dense underbrush that could only be accessed by means of crawling

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 The Land of Kīlauea

The project area lies on the *makai* (seaward) portion of the traditional Hawaiian land division of Kīlauea Ahupua‘a. The name “Kīlauea” is understood as meaning “spewing, much spreading” (Pukui et al. 1974:111). In the case of the best known “Kīlauea” at Ka‘ū District, Hawai‘i Island (Hawaii Volcanoes National Park), the name is typically understood as referring to volcanic steam clouds or aerial fountains of volcanic eruptions. Wichman (1998:102) explains the name as referring to “spewing many vapors” and traces it rather generically to the streams of Kīlauea that flow between the Makaleha Mountains and the Kamo‘okoa Ridge. The name may have originally been in reference to Kīlauea Falls itself. The relatively large volume of water flowing over a relatively wide and high drop against the prevailing trade winds (blowing approximately straight up the lower stretch of the valley) can create a large volume of diffuse mist that may have inspired the name of the land. We see some support for this theory in that the portion of Kīlauea Stream that lies within Kāhili Ahupua‘a (which does not include Kīlauea Falls) was evidently universally called Kāhili Stream by Hawaiian residents in that area. The name could however be in reference to the sea spray at Kīlauea Point and the Crater Hill cliff—or it could be in reference to all of the above.

3.1.2 Mythological and Traditional Accounts

An exhaustive search of Hawaiian legends and myths in print produced only four mythological references.

Dole (1892) relates a somewhat vague account that at Kīlauea there were the remains of three long, ancient, and parallel irrigation ditches attributed by the Hawaiians to the claw marks of a *mo‘o* (lizard, reptile). “The lizard had been ordered by [the famous ruling chief] Mano-ka-lani-pō to open Kīlauea’s upper regions for agriculture” (Wichman 1998:102). In context, the *mo‘o* is associated with the “brave lizard” Ka-mo‘o-koa, after whom a ridge of the Makaleha Mountains is named.

Wichman (1998:102) relates an account (which may have originated in a 1939 story contest—Juliette Ferreira’s “Pele the Goddess of Fire”—for the Martha W. Beckwith Prize, Kamehameha School for Girls) that near the top of a volcanic cone open to the ocean:

> Once stood three huge stones that have since been moved, with great difficulty, to make room for sugarcane. These three stone sisters of great beauty, were a warning that Pele, the volcano goddess, was not to be trifled with. . . . Pele [seeking to establish a home for herself and her Kaua‘i lover Lohiau] caused an eruption here, but it was soon extinguished when the sea goddess [Nā-maka-o-kaha‘i] broke down the walls of the crater, drowning the fire with the ocean. The laughter of the three beautiful sisters enraged Pele. They had seen Pele defeated and shamed. Their scorn was not to be endured. “What are your names?” Pele asked. And one replied “I am Kalama, this is Pua, and this is Lāhela.” Pele repeated their names, touching them

> with her staff as she did so, turning them to stone. They were a mute and visible warning not to laugh at or ridicule Pele. [Wichman 1998:103]

In a slight variant of the story, Pele is motivated by jealousy of the three girls' beauty and by fear that they will make Lohiau fall in love with them, and thus she turns them to stone to protect her love interest.

A third mythological account of Kīlauea related by Rice (1923; see also Wichman 1998:104) concerns the creation of a swath of boulders between the islet of Moku‘ae‘ae and Kīlauea crater:

> Traveling on the Menehune moved a big stone to Kahili, below Kilauea, which they used to dive from. At Mokuaeae, the island off the present Kilauea lighthouse, they began to fill in the channel between the island and the mainland. They were just able to touch the bottom with a paddle when morning dawned, and their task was left unfinished. [Rice 1923:38]

The Story of Lonomakahiki is a passing reference to the ruling chief Lonoikamakahiki traveling with a companion at Kīlauea and Kalihi (Kalihiwai, Kalihikai), Kaua‘i. The account makes reference to "days of hunger," in which their hunger was appeased by eating the ripe flowers (or possibly fruit) of pandanus trees ("*hele aku a ai i ka pua pala o ka hala, hala ia la poloi o ka ua ilaila, e ka hoa, he hoa i ka nahele lauhala loloa, mai Kilauea a Kalihi la*"). The account emphasizes the great *lauhala* tracts and "the heavy and wind-blown rain, the ceaseless and general rain" (Fornander 1917:358-359). The "ae-kai" is said to be the name of a wind specific to the vicinity of Moku‘ae‘ae Island and "the Wai-mio is the wind of Kilauea" (Aikin 1988:7). The wind name for the Ko‘olau District of Kaua‘i between Moloa‘a and Kalihikai was the "Kiukainui" (Nakuina 1990:54).

3.1.3 Population

Our best data on the population of north Kaua‘i comes from a census in the spring of 1847 (Table 1). For the purposes of the census, Kīlauea was lumped with adjacent Kāhili Ahupua‘a. Even given this conflation of the two, it may be noted that the recorded population of 240 is relatively large—larger than the combined populations of Kalihiwai and Kalihikai to the west, and larger than the combined populations of Waiakalua, Pāpa‘a, Waipāke, and Lepeuli to the southeast. The population is larger than that of the huge valleys of Kalalau or Wainiha. The population density of Kīlauea/Kāhili thus would appear to have been relatively high for the Ko‘olau District in 1847. This pattern of being relatively well-populated most likely would have continued back well into pre-Contact times.

Table 1. 1847 population of northern Kaua‘i , indicating a relatively large population and a high population density at “Kilauea and Kahili” (Schmitt 1969:229)

TABLE 1. POPULATION OF NORTHERN KAUAI, BY AHUPUAA: SPRING 1847

*Ahupuaa**	*Population*
Total	2,698
Kalalau	190
Haena	162
Wainiha	154
Lumahai	123
Waikoko	5
Waipa	66
Waioli	159
Hanalei	637
Kalihikai	87
Kalihiwai	78
Kilauea and Kahili	240
Waiakalua	43
Papaa	22
Pilaa	51
Waipake	60
Lepeuli	23
Moloaa	104
Papaa	23
Anahola	280
Hoomaikawaa	32
Kumukumu	21
Kealia	143

* Listed from west to east. Two different areas are named ‘‘Papaa’. See text and footnote 3 for further comment.

3.1.4 Early Historic Records

Few early narratives exist for the vicinity of the project area. In 1849, William DeWitt Alexander wrote the following passing account:

> A little farther on we entered groves of hala, through which we continued to ride for the rest of our journey. We turned from the road to see the falls of the Kahili River. Though not large they are beautiful. Here the river falls in a jet of foam over a precipice of about 40 feet into a broad clear basin below…. [Alexander 1991:124]

3.1.5 Māhele Records

In the great land division, or Māhele, of 1848, Kīlauea Ahupua‘a was retained as Government Lands. In the records for Land Commission Awards, there are no entries for commoner land claims associated with Kīlauea Ahupua‘a.

While no commoner Land Commission Awards (LCAs) are listed in Kīlauea Ahupua‘a, eleven awards are clustered along the south side of Kīlauea Stream in adjacent Kāhili Ahupua‘a. Most of these commoner Land Commission Awards lie in a low, wide terrace next to the stream, evidently well watered and well suited for maintenance of taro *lo‘i*.

It is unknown why there were no commoner *kuleana* land holdings within Kīlauea Ahupua‘a at the time of the Māhele (1848) and the following Kuleana Act. There was, however, a pattern at the time of the division of lands in which the land overseers (*konohiki*) often tried to present their overlord *ali‘i* with undivided tracts of land, believing that to be in the best interests of their masters. Therefore, it could be that there was a systematic pattern to discourage commoner land claims in Kīlauea Ahupua‘a. It certainly seems odd that there was not a single claim in what should have been a well-populated *ahupua‘a*.

The land claims just south across Kīlauea Stream (universally referred to as “Kāhili Stream” in the land records of claims within Kāhili Ahupua‘a) are summarized below in Table 2. While these are all outside the project area (indeed outside of Kīlauea Ahupua‘a), they offer insight into such Hawaiian occupation as may have existed within Kīlauea Ahupua‘a and yet gone unrecorded in the Māhele-era land documents. Virtually all claims involve a house lot (understood as a permanent residence) and a few irrigated pond fields for taro cultivation (*lo‘i*). Several claims mention “*kula,*” which in this context probably refers both to pasturage and areas of dry land cultivation (with *wauke* specifically mentioned as a *kula* crop). Other specific cultigens mentioned are the bark-cloth plant *wauke, noni,* and orange trees.

Table 2. Commoner Land Commission Awards within Kāhili Ahupua‘a

LCA #	Awardee	Place name	Area	Land Use
9067	Keo	Kāhili, Ulehulehu; Kanaele given as place name of five *lo‘i* and *kula;* Uleulehu given as place name of two *lo‘i;* Reference to *loko* “Kanaio”	2.25 acres	*‘Āpana* 1, 2, and 3 were quite close together; claims seven *lo‘i*, two *māla* of *wauke* , and “a house lot in Kilauea”; Reference to at least two *loko* “Kanaio” and one owned by Luakini; also “Konohiki’s pond”
10013	Leimanu	Kāhili (Kāhililalo), Kaukahiwai, and Kaiaakahiunu named as place of house lot; *lo‘i* and *kula*; Kaukahinu (Kaukahinau) named as place of two *lo‘i*; Nanohala named as place of *kula*	1 acre	*‘Āpana* 1, 2, and 3 were quite close together; claims five *lo‘i*, *kula* for planting *wauke* and a house lot
10013B	Mokuhali‘i	Kāhili, five *lo‘i* in Ho‘opala (Hapala); *kula*, house lot, and orange tree in Kapunahoa	1 acre	*‘Āpana* 1 and 2 were quite close together; claims five *lo‘i*, *kula*, a house lot, and an orange tree
10015	Luakini	Kāhili [in one account all holdings also said to be “in one area in Kilauea”]	2 acres	Claims two *lo‘i*, *kula*, a house lot “in Kīlauea,” and two orange trees
10082	Mamao	Kāhili, Makaihiwa‘a (var. Makaihuwa‘a and Makaihuaaa) ‘Ili; claims two *lo‘i* in *‘ili* of Kapuka; reference to *pali* of Makaihuwa‘a	5.5 acres	Claims six *lo‘i* and a house lot
10083	Mamuakalono	Kāhili	33 rods	Claims one *lo‘i*, one *māla* of *wauke,* one *māla* of *noni*, and a house lot
10333	Naaimaneo	Kāhili, Kupe; holdings said to be in *‘ili* of Upa (var. Kupa); brook named “Kilauea”	0.75 acre	Claims a field of *kalo* embracing a number of small *lo‘i* and *kula*

3.1.6 Late 1800s

3.1.6.1 The History of Kīlauea Plantation

In January 1863, a former American whaler named Charles Titcomb purchased the entire *ahupua‘a* of Kīlauea amounting to approximately 3,016 acres from Kamehameha IV for $2,500 (Grant 2896) (Figure 14 and Figure 15). This land grant included the present project area. By this time, Charles Titcomb was already a veteran of several enterprises at Kōloa, Hanalei, and Kīlauea, Kaua‘i, including efforts to cultivate silkworms, coffee, tobacco, sugarcane, and cattle. He expanded his holdings to the west through further purchases within the next couple of years. The Kilauea Plantation, begun in 1863 by Mr. Titcomb, became a sugar estate in 1877 when Captain John Ross and E. P. Adams, in partnership with Titcomb, purchased much of the land and leased another substantial tract (Aikin 1988:19). Titcomb and his family continued to be involved in the plantation. He, his Hawaiian wife, and two of his eight children are buried in a family plot near his former home behind the Kīlauea Elementary School.

The Kilauea Plantation “was one of the smallest plantations in the Hawaiian Islands operating its own sugar mill” (Condé and Best 1973:159). In 1881, a railway was begun, and Princess Lydia Kamakaeha (Lili‘uokalani) drove in the first spikes for the railroad bed. The plantation infrastructure grew over the next twenty years. An article from the San Francisco Chronicle describes the system:

> Transportation system consists of 12 and a half miles of permanent track, five miles of portable track, 200 cane cars, six sugar cars and four locomotives. Kīlauea is situated three miles from the landing at Kahili, with which it is connected by the railway system. Sugar is delivered to the steamers by means of a cable device at the rate of from 600 to 800 bags an hour. Mr. J. R. Meyers was the plantation manager. [*San Francisco Chronicle*, July 18, 1910 in Condé and Best 1973:152]

The plantation employed Chinese and Portuguese workers. In the 1880s, Kīlauea Sugar Company began major modification of water resources in the uplands with dams, reservoirs, ditches, and flumes (Joesting 1984). This may have had a major damaging effect on *lo‘i kalo* downstream and possibly signaled the end of large-scale native agricultural practices in Kīlauea and vicinity.

The Kilauea Plantation Company started to be managed by C. Brewer and Company in 1910, and C. Brewer took over the controlling interest in 1948. The Kilauea Plantation Company continued to operate until 1971.

The Monsarrat map of “Kaua‘i Between the Kalihiwai and Moloaa Streams” (1892) shows the plantation infrastructure in place at that time (Figure 16). Overlays indicate that the “Government Road” lies at approximately the same elevation as the older “Hanalei Road” and the present Kūhiō Highway—well *mauka* of the project area. The railroad, begun in 1881, and the Ko‘olau Ditch are shown running from the mill at Kīlauea as far as the east side of East Waiakalua, terminating near the Government Road well *mauka* of the present project area.

ROYAL PATENT.

KAMEHAMEHA IV., By the grace of God, King of the Hawaiian Islands, by this His Royal Patent, makes known unto all men, that he has, for himself and his successors in office, this day granted and given, absolutely, in Fee Simple, unto Charles Titcomb his faithful and loyally disposed subject, for the consideration of Two thousand five hundred dollars paid into the Royal Exchequer, all that piece of Land situated at Kaolau and known as the Ahupuaa Kilauea in the Island of Kauai, and described as follows:

Commencing at a stake on the Cliff overlooking the sea, near the mouth of Kilauea River from which the Mt. Peak Kalioni bears S. 15½ W., and Mt. Peak, Neki bears S. 55° W running N. 79° W. 30. 20 Chains along the edge of the Cliff bounding the Sea to the high promontory or Cliff Called Nihokia, from thence North 42° W. 27.60 Ch. along the Sea to the Cliff Called Kaiaopala from thence S. 4° W 39.7 Ch. to the point of land or Cape Called Wawoni, from thence S. 43° W 10 Ch. along the Sea to a Cliff from thence S. 6° W 20 Ch. along the Sea to a pile of Rocks upon the [illegible] S. 66° W 25 Ch. more or less to the boundary

Figure 14. Portion of Royal Patent Granting “the Ahupua‘a Kilauea” to Charles Titcomb (from Aikin 1988:17)

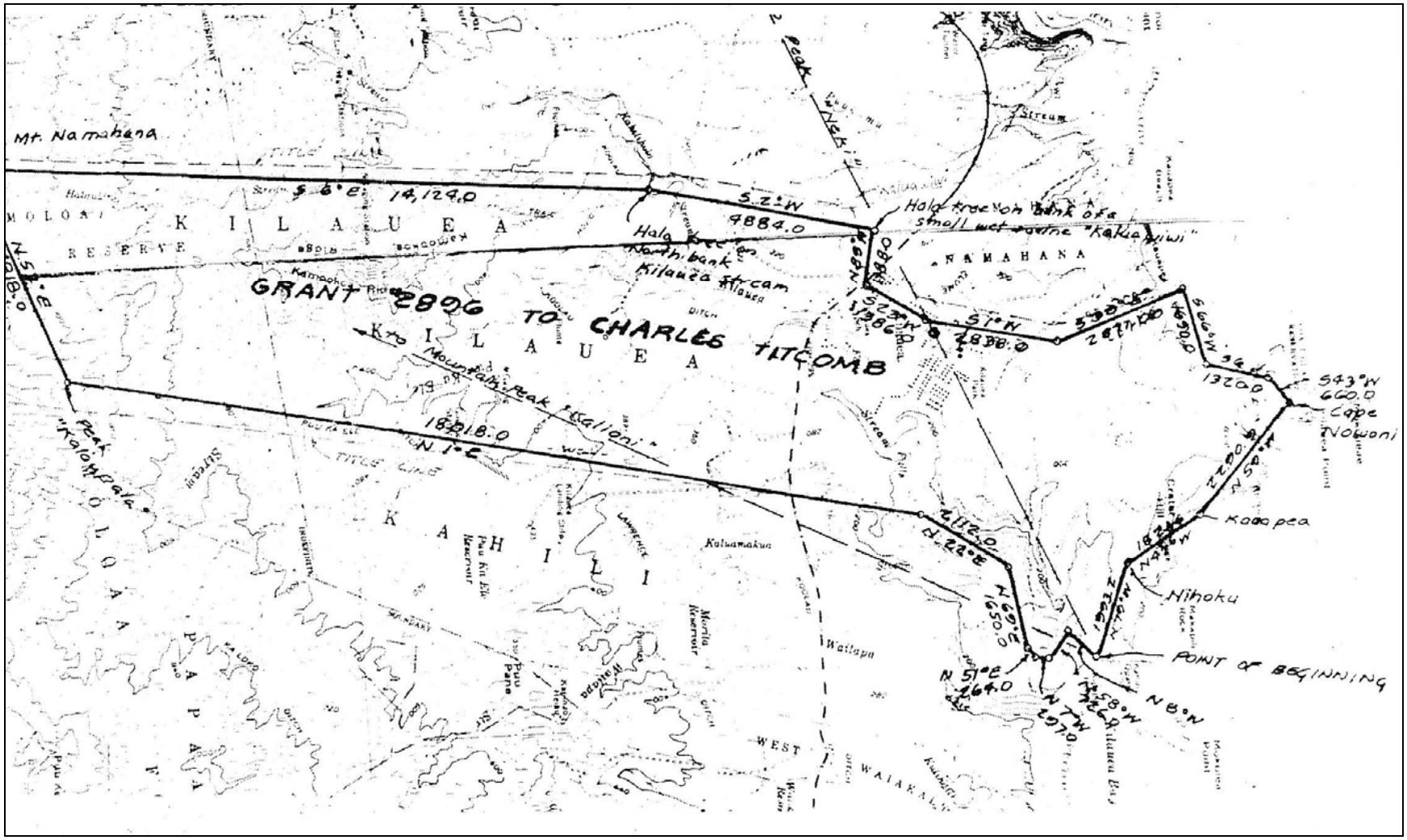


Figure 15. Map of Grant 2896 (Kīlauea Ahupua‘a) sold to Charles Titcomb (from Aikin 1988:18)

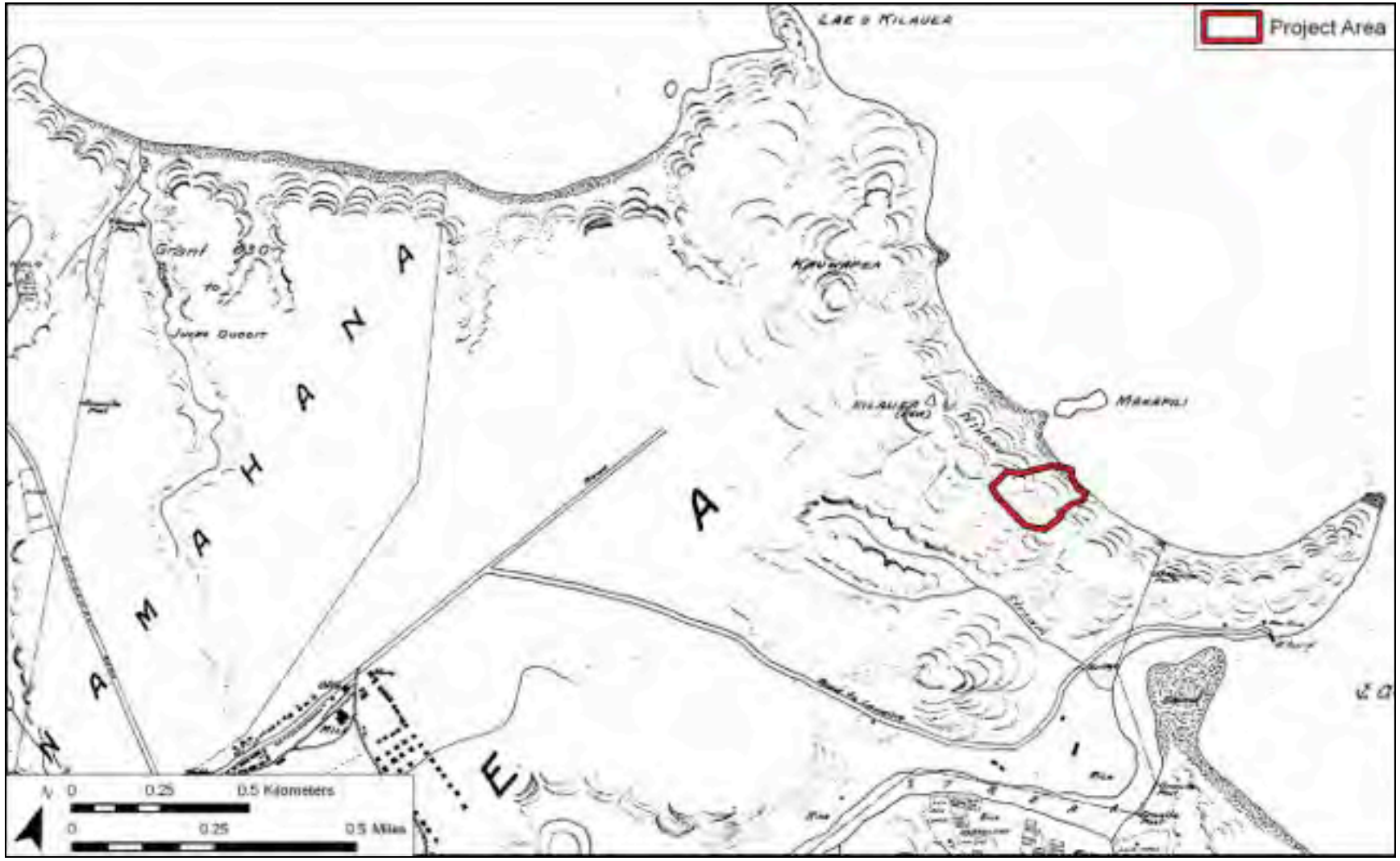


Figure 16. Portion of Monsarrat map of “Kaua‘i Between the Kalihiwai and Moloaa Streams” showing general development in the project area and vicinity circa 1892

Part of this Kilauea Plantation Company rail system passed by Kahili Quarry on the way to an off-loading station at Mokolea Point, where raw sugar was cabled down to transport ships (Site # 50-30-04-1811). Kahili Quarry was located on Kīlauea Bay at the mouth of Kīlauea Stream, about 500 m southeast of the project area. Rock from the quarry was hauled by rail car and later by truck through the plantation fields, where it was used to reinforce the field roads (Fredericksen and Fredericksen 1989:8). The road to the landing ("Quarry Road") ran approximately 400 m east of the present project area in 1892 (see Figure 16).

In 1938, trucks were employed to transport harvested cane, and by 1942, the rail system was abandoned entirely (Condé and Best 1974). Sugar continued as a crop until 1971, when Kīlauea Sugar Co. was terminated (Custodial Chronology of the Sandy Saemann Property, Kīlauea, Kaua‘i 1989).

A 1910 U.S. Geological Survey Map, Kīlauea Quadrangle (Figure 17) shows the plantation infrastructure and other development in the vicinity of the project area at that time. The road out to Mokolea Point ran along the south side of the project area.

A 1930 map (Figure 18) of the Kilauea Plantation (Condé and Best 1973:159) shows the plantation's sugar cane fields and associated infrastructure. The map indicates that sugar was not cultivated within the project area, (sugar fields are labeled by number). The map also shows the plantation rail line heading from Kīlauea Town to the landing at Mokolea Point east of the present project area.

3.1.6.2 Rice Production at Kīlauea Stream

Concurrent with the sugar plantation was the introduction of the first train. By the 1890s, much of the old *kalo*-growing areas of this portion of Kaua‘i were now producing rice, farmed by Chinese immigrants. There were 55 acres of land in rice production in the Kīlauea-Kāhili area in 1892 and eventually a rice mill on Kīlauea Stream (Char and Char 1979). While it is understood that this rice mill was begun by Chinese, it clearly went into Japanese management. A photograph of the interior of the Kīlauea Rice Mill (Figure 19) suggests that it was a good-sized enterprise (*Garden Island* 1978). The mill is known to have been on the stream terrace east of Kīlauea Stream. Rice and vegetable cultivation is also indicated along the banks of Kīlauea Stream circa 1925.

The 1963 U.S. Geological Survey map (Figure 20) does not indicate any structures within the project area other than an unimproved road extending down to the Kahili Quarry, southeast of the project area. The 1963 map also indicates Kīpapa Heiau (temple), located on the sandy shoreline of Kīlauea Bay, near the mouth of Kīlauea Stream 600 m southeast of the present project area.

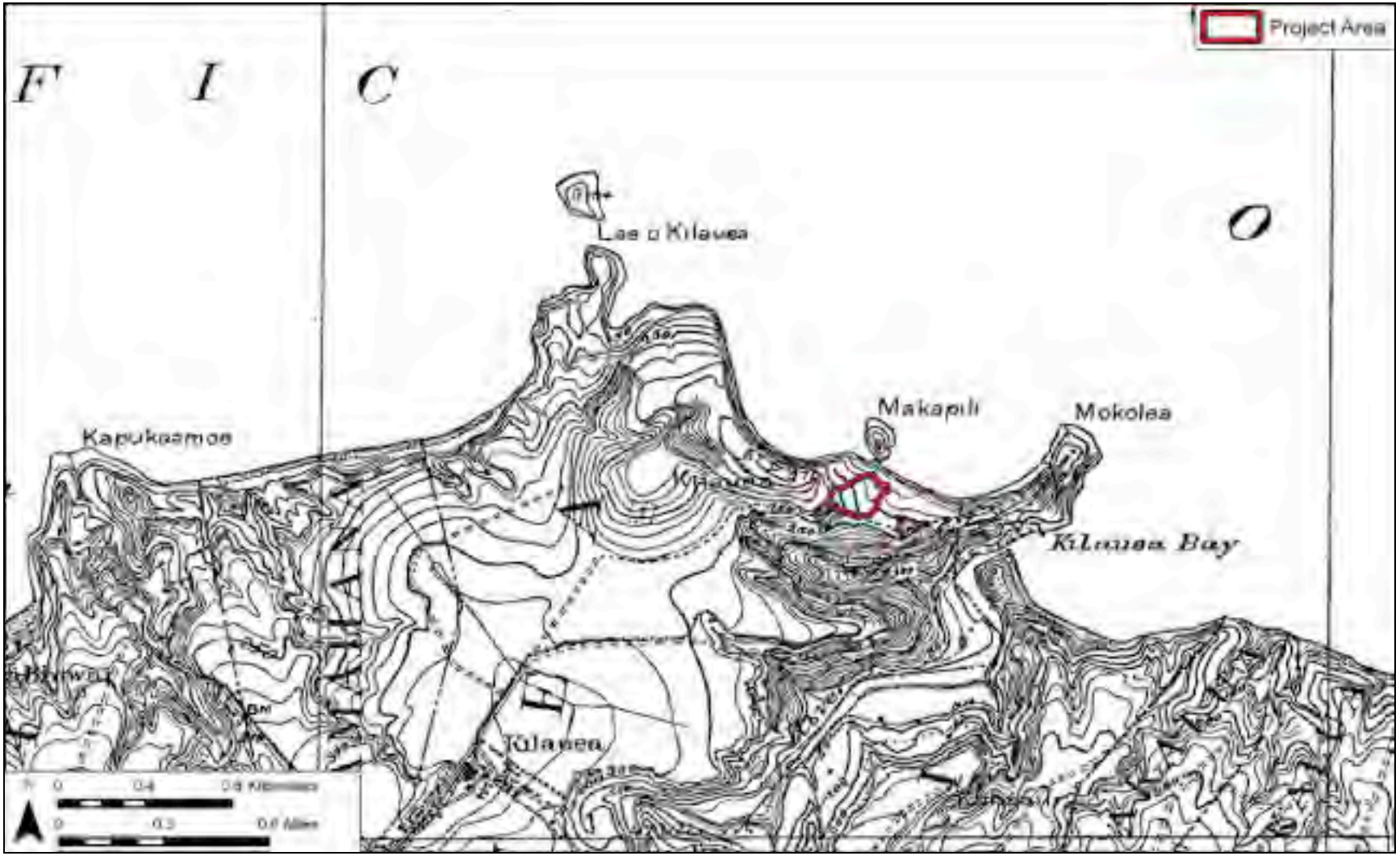


Figure 17. Portion of 1910 U.S. Geological Survey Topographic Map, Kīlauea Quadrangle, showing the location of the project area

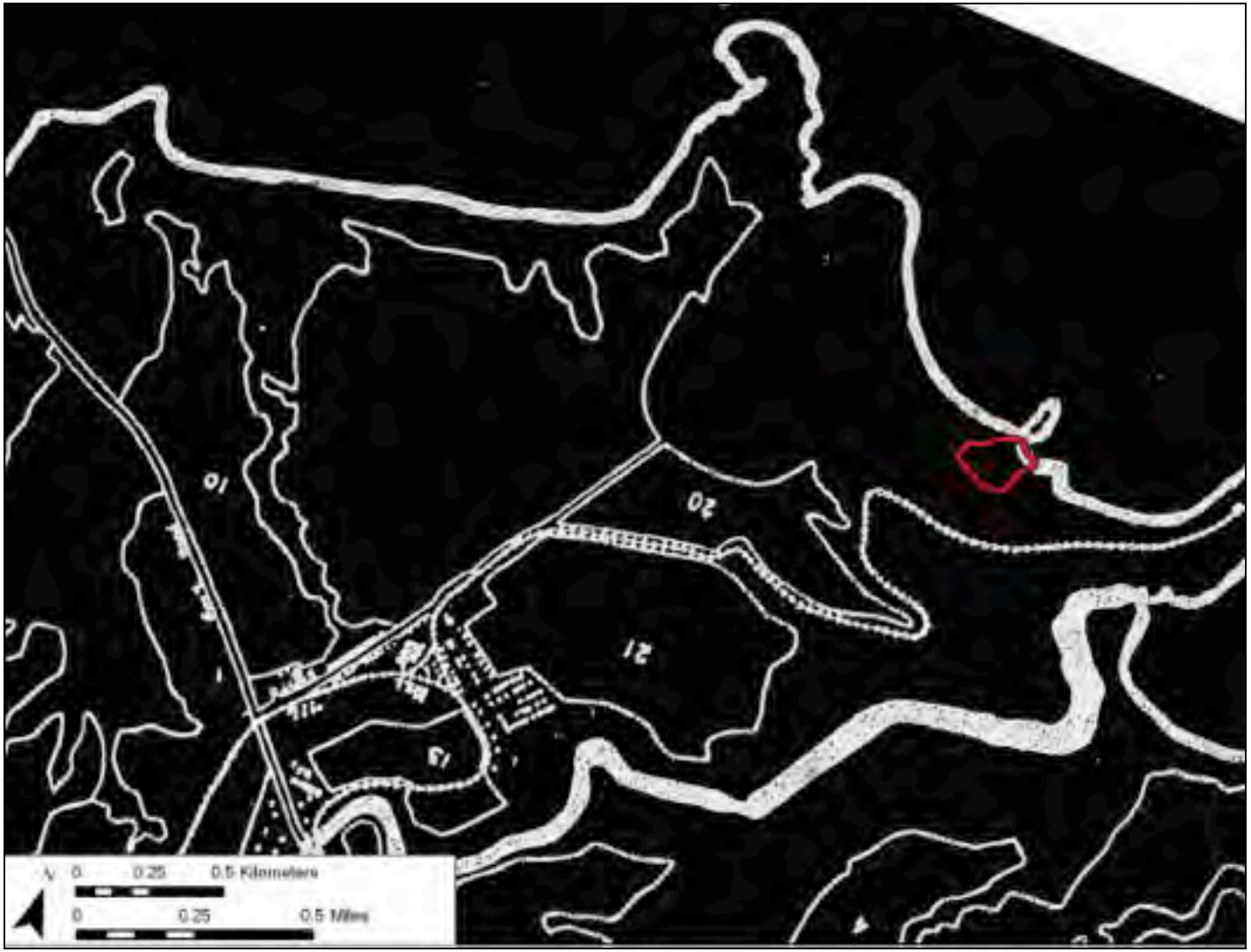
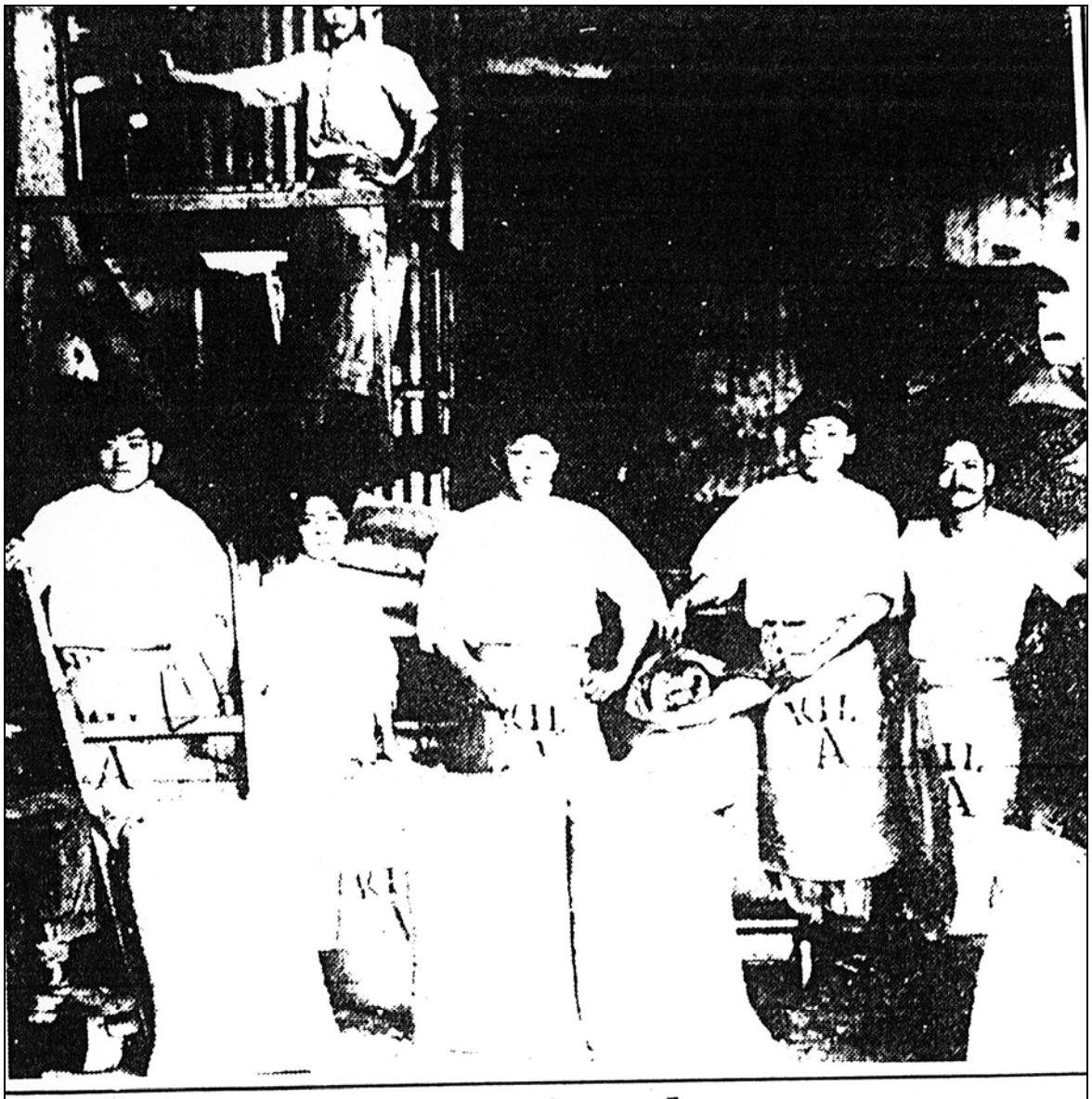


Figure 18. 1930 map of the Kīlauea Sugar Company; note railroad down to Mōkōlea Point but otherwise no infrastructure in or adjacent to project area (Condé and Best 1973:159)



Gone are the days . . .

THE ONCE BUSY KILAUEA RICE MILL . . . has now become a part of Kauai's history but a photo lent by the Kauai Museum brings back memories of the days when the fields from Hanalei to Wailua were planted with rice . . . and identifies the young workers as . . . (l to r) Imada, Kagawa, Okimoto, Okasaka, and Miyashiro.

Figure 19. Historical photo of the interior of the Kīlauea Rice Mill showing that it was a relatively large rice mill for Kaua‘i and also that it was run by Japanese (note aprons “KIL A” (*Garden Island* 1978)

Figure 20. 1963 U.S. Geological Survey Topographic Map, Anahola Quadrangle, showing the location of the project area; note Kīpapa Heiau and the Kahili Quarry northeast of the project area)

3.2 Previous Archaeological Research

Few archaeological studies of land within the boundaries of the subject property have been completed. Archaeological studies within and in the vicinity of the project area are summarized in Table 3; those that involved fieldwork are located in Figure 21. More detailed discussion of some of the more pertinent studies follows.

3.2.1 Thrum (1906) Heiau Study

Thomas Thrum compiled the first systematic listing of Kaua‘i Island archaeological sites in his study of “Heiaus and Heiau Sites Throughout the Hawai‘i Islands” (Thrum 1906:36-44). In the vicinity, he briefly described four *heiau*: Pailio at central Kīlauea, Kapinao and Kapuohaua‘e at Waiakalua, and Kipapa at Kāhili, as follows:

- Pailio—Central Kīlauea: a round heiau of about 100 ft diameter; class unknown; site covered in cane field
- Kapinao—Waiakalua-east: a large heiau of about 200 by 400 ft, high walled and stone paved; still in existence; of po‘okanaka class
- Kapuohaua‘e—Waiakalua-uka: a small, round heiau, paved, with high walls; of husbandry class; still standing
- Kipapa—Kāhili: a large heiau of some 300 by over 100 ft in size, paved, with walls five feet high; standing in cane field in partial ruin

3.2.2 Bennett (1931) Survey

During his 1928/1929 landmark survey of the island of Kaua‘i, Wendell Clark Bennett identified five sites (Sites 129 to 133) within the Ko‘olau District of Kaua‘i between Pila‘a to the east and Kalihiwai to the west including: Site 129, Kapinao Heiau, in Waiakalua Valley; Site 130, taro terraces, in East Waiakalua and West Waiakalua valleys; and Site 131, house sites, in East Waiakalua and West Waiakalua Valleys and on the ridge between. Also, in Kīlauea, Bennett described two *heiau* sites: Site 132, Kipapa Heiau and Site 133, Pailio Heiau. Bennett described Site 132, Kipapa Heiau, as follows:

> Site 132. Kipapa heiau, on the end of the first bluff east of Kilauea River in Kahili section. Described by Thrum as “A large heiau of some 300 by over 100 feet in size, paved, walls five feet high, standing in cane field in partial ruins.” Since that time the stones have been removed. [Bennett 1931:133]

U.S. Geological Survey maps indicate Kīpapa Heiau as located on the east side of the mouth of Kīlauea Stream, just 200 m or so northeast (outside) of the northeast edge of the present project area. Shideler et al. (2008:39) reports that a brief effort was expended in the course of that fieldwork to find any evidence of Kīpapa Heiau, but no trace was found.

Bennett described Site 133, Pailio Heiau as follows:

> Site 133. Pailio heiau, in the canefields shoreward of Kilauea. The site does not have a view of the river valley. Thrum says that it was, “A round heiau of about

Table 3. Archaeological Studies near the Present Kīlauea Project Area

Source	Nature of Study	Location of Study	Finds
Handy and Handy 1972	Native Planters of Hawaii	Archipelago-wide	Handy and Handy conclude that Kīlauea is a relatively small producer of taro because of the nature of its hinterland.
Kikuchi 1987	Archaeological Survey	Proposed Visitor Center, Kīlauea Point, National Wildlife Refuge Kalae O Kīlauea,	Surface remains of historic structures associated with Kīlauea Lighthouse and a sugar loading complex are described, but no traditional Hawaiian sites were found.
Fredericksen and Fredericksen 1989	Archaeological Inventory Survey	Crater Hill and Mokolea Point of Kīlauea Point National Wildlife Refuge, Kīlauea	Historic structural remains related to the transport and loading of sugar at Mokolea Point, a World War II-era radar installation on Crater Hill, and Kīlauea Lighthouse are identified.
Toenjes and Hammatt 1990	Archaeological Survey	Ninety-Four Acres in Kīlauea	No sites were identified.
McGerty et al. 1997	Archaeological Inventory Survey	Portion of a 26-Acre Parcel, Kāhili Ahupua‘a (TMK 5-2-21:7)	Site #s 50-30-04-974, -975, -976 and -977, including traditional Hawaiian sites down in the valley, are identified.
Cleghorn 2001	Archaeological Monitoring Report	Kīlauea Japanese Cemetery (TMK: 5-2-4:49)	There were no significant finds.
Shideler, Tulchin, and Hammatt 2007	Archaeological Field Inspection and Literature Review	An approximately 74-Acre Portion of the Kīlauea Falls Ranch Property, (TMK: [4] 5-2-012:035 por.)	Four specific areas of pre-Contact agricultural terraces were observed. A posited mill site (CSH 1) in the north side of the southwest project area was noted. An extensive complex of long well-built terraces supporting a series of what appear to have once been pond fields (CSH 2) was noted.

Source	Nature of Study	Location of Study	Finds
Shideler, Yucha, and Hammatt 2008	Archaeological Inventory Survey	An Approximately 74-Acre Portion of the Kīlauea Falls Ranch Property (TMK: [4] 5-2-012:035 por.) (roughly the same as Shideler, Tulchin, and Hammatt 2007)	Five historic properties were documented: SIHP # 50-10-04-579, an agricultural terrace; # -580, 53 agricultural terraces and two possible habitation areas (probably related to agriculture as field shelters); # -581, a stone retaining wall with cement and alignments and a rock-faced trail understood as a post-Contact permanent habitation; # -582, agricultural terraces; and # -583, agricultural terraces.
Sroat, Shideler, and Hammatt 2012	Archaeological Inventory Survey	A 75-Acre Kīlauea Agricultural Park Project, Kīlauea Ahupua‘a (TMK: [4] 5-2-004:099)	Four historic properties, comprised of five archaeological features, were documented within the project area: SIHP # 50-30-04-2123, a historic habitation terrace; # -2124, a historic, likely plantation-era concrete wall and concrete foundation structure; # -2125, a pre-Contact agricultural terrace; and # -2126, a historic drainage ditch.

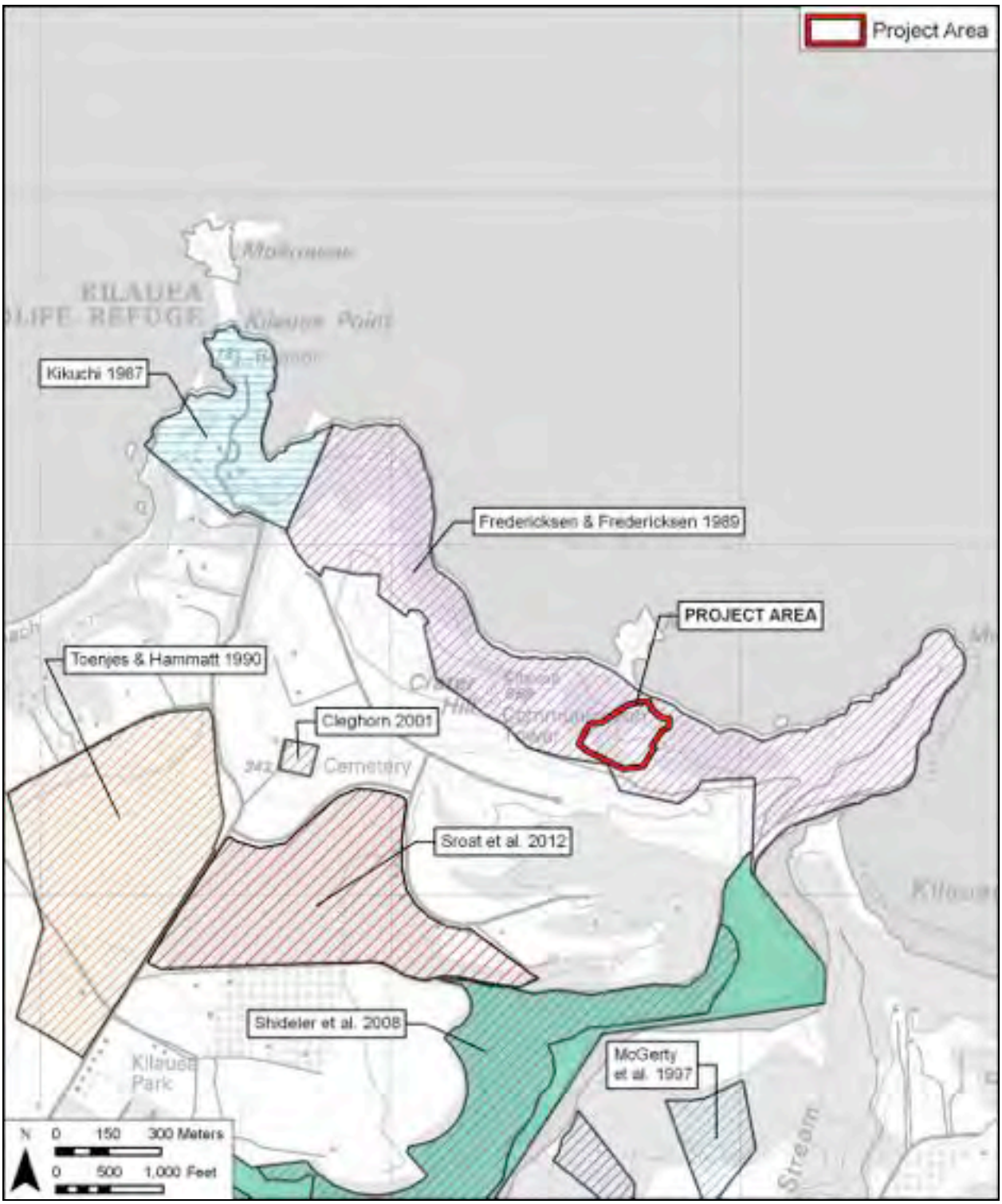


Figure 21. Map showing locations of previous archaeological studies involving fieldwork in the vicinity of the project area

> 100 feet diameter: class unknown. Site covered in cane field.” Nothing remains of the heiau to-day. [Bennett 1931:133]

The location is uncertain (Bennett didn’t find any trace), but the description suggests Pailio Heiau was not close to the present project area.

3.2.3 Handy and Handy (1972) Native Planter Observations

Handy and Handy (1972) carried out a summary study of traditional Hawaiian agriculture and the life, lore, and environment of native planters throughout the Hawaiian Islands and noted the following at Kīlauea and Kāhili:

> Kilauea is watered by a small river whose headwaters take the flow of streams above Kalihiwai as well as those coming down sloping kula lands above Kilauea. This is a peculiar terrain, with terraces along the north side of the river toward its seaward end belonging to Kilauea and those on the south side to the small ahupua‘a named Kahili. A mile upstream is a small terraced area, but beyond this there were no terraces, for the main stream flows in a narrow gulch, and so do other side streams which flow into the Kilauea River. Hawaiians evidently never developed lo‘i here because the neighboring kula land is too high above the streams for irrigation. This kula would have been excellent sweet-potato land. On the whole, Kilauea, despite a sizable river flowing through it, was a relatively small producer of taro because of the nature of its hinterland.
>
> Kahili is, as indicated above, part of the complex that includes Kalihiwai, Kalihikai and Kilauea. The three streams empty into the Kilauea River, which forms the boundary between Kilauea and Kalihi below the falls of the river. There are terraces on the south side of Kilauea River watered by two of Kahili’s streams. This is doubtless why this area was part of Kahili rather than of Kilauea. Only one stream had terraces back from the river. Here to the kula land was good for sweet-potato planting. [Handy and Handy 1972:421]

At least two archaeological surveys have been conducted in and adjacent to areas proposed as extensions to the Kīlauea Point National Wildlife Refuge.

3.2.4 Kikuchi (1987) Kīlauea Point National Wildlife Refuge Survey

In 1987, William K. Kikuchi surveyed the present grounds of the Kīlauea Point National Wildlife Refuge and areas of proposed extension. Considering the significance to native Hawaiians of seabird nesting colonies found within the refuge, Kikuchi extended the limits of his survey to search for associated cultural features or material. One area of his survey abuts the northeastern end of the present project area at the west bank of the mouth of Kīlauea Stream. Surface remains of historic structures associated with Kīlauea Lighthouse are described, and limited subsurface testing was performed, but Kikuchi found no evidence of remains related to native Hawaiian culture.

3.2.5 Fredericksen and Fredericksen (1989) Kīlauea Point National Wildlife Refuge Survey

Xamanek Researches (Fredericksen and Fredericksen 1989) surveyed extensions to the wildlife refuge, including Crater Hill and Mōkōlea Point (parcel 19 of approximately 38 acres). Land use and history of tenure is documented well, followed by detailed descriptions of historic structural remains related to the transport and loading of sugar at Mōkōlea Point, a World War II-era radar installation on Crater Hill, and Kīlauea Lighthouse. Although archaeological evidence of native Hawaiian exploitation of seabird colonies was one object of the survey, no such remains were observed. The findings of this study that included the present project area are discussed in greater detail below.

3.2.6 Toenjes and Hammatt (1990) Study of 94 Acres at Kīlauea

Two loci suggesting previous traditional Hawaiian activity were found and tested for subsurface deposits. Locus A was located in the southwest corner of the 94-acre parcel and was under papaya cultivation. Upon finding a water-rounded cobble and a small fragment of coral, an examination was made of the soil between every other row of trees in the grove. Indications of archaeological deposits were sparse and included two pieces of coral, one fragment of unidentified marine shell, and several possible basalt flakes dispersed through the grove. The area of the papaya grove and scatter covered approximately 3,800 m^2 (41,000 ft^2).

Locus B was located in the central portion of the 94-acre parcel in an extensive former sugar cane field, then lying fallow. Much of the ground surface was clearly visible, with scattered indications of recent mechanized disturbance. The only suggestion of previous cultural activity consisted of sparsely scattered coral across an area of about 7,500 square meters (80,700 square ft.) No bone or shell material was observed in association with Locus B or anywhere else in the project area. Several possible flakes of basalt and one basalt core or possible adze blank were observed dispersed across the surface of the field apart from the coral scatter.

Subsurface testing at Locus A and Locus B, as well as in the area from which a basalt core was collected was conducted. Excavation exposed no culturally modified lithics. The presence of coral and coral sand in cane fields was noted as common, having been historically imported for the purpose of “liming” the soil. Lacking other archaeological components of Hawaiian culture, e.g. bone and shell midden, lithic debris or modified coral, the significance of these scatters was regarded as minimal. Examination of all other fields of the property indicated no archaeological remains of informational significance were present.

3.2.7 McGerty et al. (1997) Study of 26 Acres at Kāhili

McGerty, Fortini, and Spear (1997) noted that much of the project area had been extensively bulldozed but identified four archaeological sites with 47 features including alignments, terraces, walls, enclosures, fire pits, a hearth, an *imu*, a possible buried facing and a post-hole. The sites included:

- Site # -974, which is comprised of 26 features (alignments, terraces, a wall, an enclosure, pit features, a hearth, and an *imu*) and was interpreted as a late pre-Contact/early post-Contact permanent habitation complex. Site # -974 was recommended for further data recovery.

- Site # -975, which is made up of nine features (enclosures, alignments, terraces, and a wall) and was thought to relate to the Site # -974 permanent habitation complex. Two features were thought to be possible burials. Site # -975 was recommended for both further data recovery work and preservation.
- Site # -976, which is comprised of seven features (enclosures, terraces, and a posthole) and was interpreted as a late pre-Contact/early post-Contact permanent habitation site. Site # -976 was recommended for preservation.
- Site # -977, which is made up of three features (an alignment and terraces) and was interpreted as being utilized for late pre-Contact/early post-Contact agriculture. Site # -977 was recommended for no further work.

Two radiocarbon dates were obtained and calculated as AD 1795–1955 and AD 1660–1955.

3.2.8 Shideler et al. (2007) and (2008), and Hammatt and Shideler (2010) Studies for Kīlauea Falls Ranch

CSH carried out two studies for Kīlauea Falls Ranch on the west side of Kīlauea Stream (also known as Kahili Stream). A total of 62 features were identified within a total of five sites in a proposed agro-forestry area. Four of these five sites (SIHP # 50-30-04-579, -580, -582 and -583) are primarily or exclusively agricultural terraces. The only exception at these four sites is SIHP # 50-30-04-580, Features L and MM, which are interpreted as temporary habitation features related to the agricultural terraces. One site (SIHP # 50-30-04-581) was understood as primarily post-Contact and either a permanent habitation or work area.

The inventory survey (Shideler et al. 2008:69) concluded that the approximately 1,500–1,800 mm (60-70 in) of annual rainfall within that project area made cultivation possible without irrigation. While it was concluded that there may well have been pre-Contact ponded field (*lo‘i*) taro cultivation along the Kīlauea Stream flood plain, it was suggested that the vagaries of hurricane, tsunami, and flood may have made such planting down by the stream precarious. It was suggested that cultivation up on the steep slope may have been more secure.

The evidence from the Māhele records indicates that there was little or no pre-Contact permanent habitation within the Kīlauea Falls Ranch project area per se, although there was a community on the southeast side of the stream mouth from the 1840s well into the twentieth century. An interviewee, Ms. Sara H. Keahonui Jones, born in 1919, who had lived in the *makai* area of Kāhili Ahupua‘a most of her life, remembered the following: “The homes were all on stilts and once the water rose all the way up under the house” (Hammatt and Shideler 2010:17) The propensity of the Kāhili/Kīlauea Stream to flood may have encouraged development on the steep slope.

Particularly relevant in the Kīlauea Falls Ranch study was SIHP # 50-30-04-580, which consisted of a dense cluster of 55 archaeological features including 53 soil-retaining terraces and two possible habitation areas. These features were in a relatively compact area just south of the east end of the present study area (Figure 22).

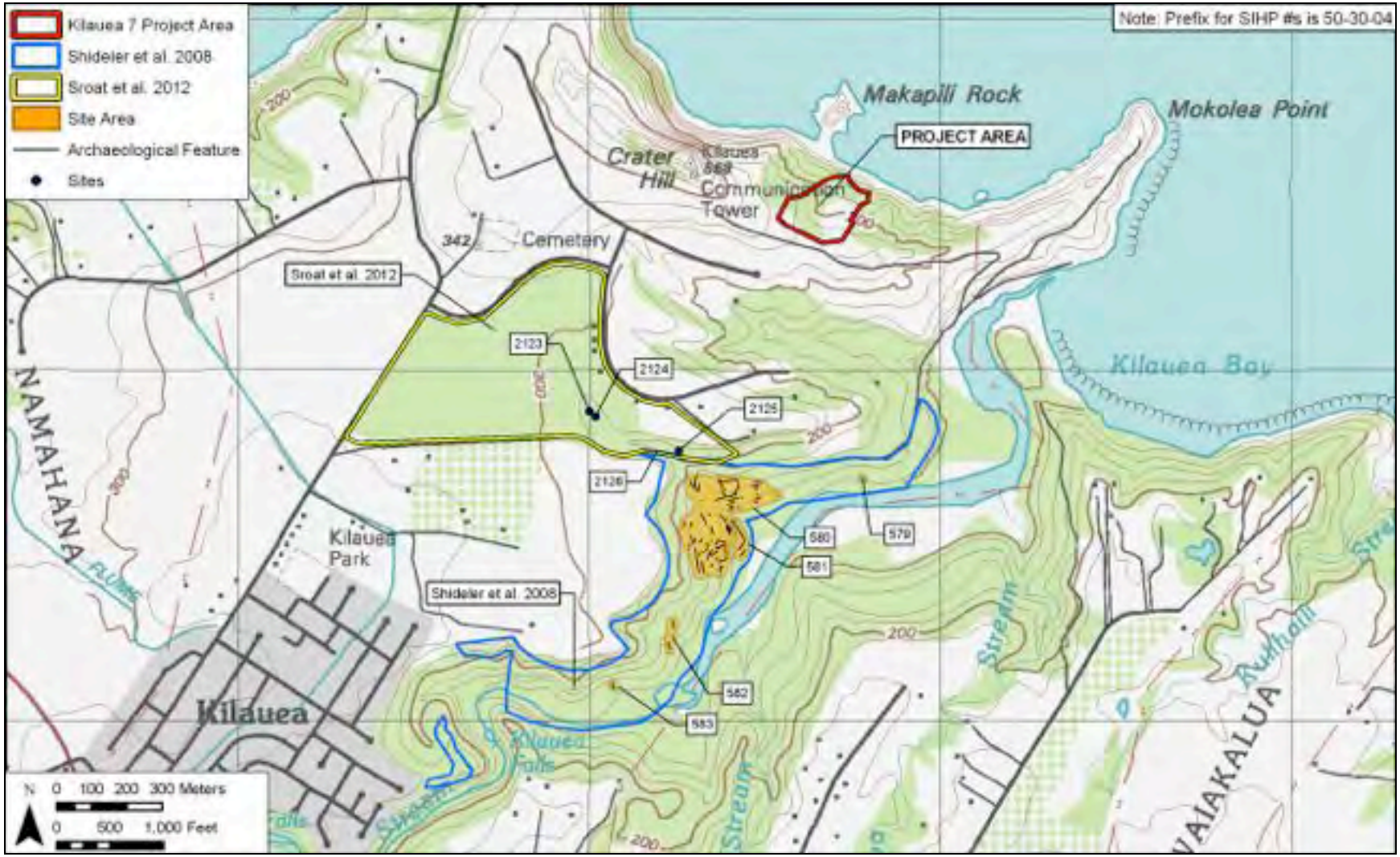


Figure 22. U.S. Geological Survey 7.5 Minute Series Topographic Map, Anahola Quadrangle (1996), showing the location of historic properties identified in the Kīlauea Falls Ranch (Shideler et al. 2008) study in relation to the present study area

3.2.9 Sroat et al. (2012) Study for the 75-Acre Kīlauea Agricultural Park Project

CSH completed an archaeological inventory survey for the Kīlauea Agricultural Park Project, located at the juncture of Kīlauea Lighthouse Road and Quarry Road. A total of four historic properties were identified within the project area. SIHP # 50-30-04-2123 consisted of a stacked cobble and boulder terrace (one to four courses) comprised of stone construction on two corners connected by a linear ledge of soil. It appears to have functioned as a historic habitation terrace. SIHP # -2124 likely is a plantation-era structure that consists of two concrete wall structures, including one linear form and one U-shaped form with concrete flooring. SIHP # -2125 is a stacked cobble and boulder agricultural terrace (one to four courses), and SIHP # -2126 is a remnant drainage ditch.

All four historic properties were located within the tributary gulch of the Kīlauea Stream Valley in the southeastern portion of the project area. No sites were identified within the level tablelands previously utilized for sugarcane cultivation.

3.3 Findings of Xamanek Researches, Kīlauea Point National Wildlife Refuge Survey

In 1988, Xamanek undertook an archaeological and historical survey of two TMK parcels: TMK 5-2-004:009, the Crater Hill 96-acre parcel and TMK 5-2-005:019, the 38-acre Mokōlea Point parcel.

The ruins of a sugar-loading complex (SIHP # 50-30-4-1861) on Mokōlea point are described:

> Mokolea point provided immediate, visible features of historic and archaeological interest in the form of the ruins of the sugar-loading complex. Foundation stones remain in situ, outlining the perimeters of the complex, and oxidized iron and steel remnants of the cable-loading equipment are apparent throughout the site area. One of the foundation structures was made of brick some of which were imprinted with the letters “CALAEN.” The track bed for the narrow gauge railroad engine and hauling cars is visible. It was strewn with what appears to be anthracite coal. Numerous pieces of pulley wheels, sling cable, levers, bolts and nuts, a boiler box, a wire-loading carriage, intermixed with recent human litter are scattered over the site area. While considerably oxidized, the boiler box and a wire-loading carriage are preservable and restorable. The cliff-side concrete base for one of the support stanchions guiding the cable to off-shore-lying vessels is also still present and in good condition. According to Ranger Moriarty, at least one of the mooring anchors is still in place on the bottom of Kīlauea Bay. . . . These off-shore moorings usually consisted of 4 anchors placed in a pattern forming a rectangle. . . . Mokolea Point with its sugar-loading complex ruins presents an historically and archaeologically unique site in the State of Hawaii on U.S. Government protected land. [Fredericksen and Fredericksen 1989:16-17]

A “World War II secret radar installation” (SIHP # 50-30-4-1810) is also described:

> This site represents an impressive complex to the observer. Two ventilation shafts terminate near the summit of Crater Hill ridge. The present building which houses radio equipment is built on the original foundation used during World War II. Some 50 or more feet below the vent structures lies the entrance to a tunnel which was part of the radar complex. The tunnel is approximately 130 feet in length, running back into the hillside at about 55 degrees magnetic. The chamber below the vent is about 15 to 20 feet wide and 45 feet long, and the "chimney" under the vent is about 30 to 35 feet high. A considerable quantity of material in the form of cast-off items appears to have been thrown down the vent, and has collected on the chamber floor below. . . . The tunnel was used as a storage area for explosives by Kilauea Plantation after the war. The entry tunnel measures about 8 feet wide and 8 feet high. It had originally been shored up with wooden beams, and the wall surface had been plastered. Originally, the entryway had been secured by a metal door which presently lies to one side of the tunnel. At some time in the past, a fire was built in the entry way which burned out many of the wooden beams near the entrance. . . .
>
> About 20 feet to the west of the tunnel entrance lie the remains of the former radar complex generator enclosure. The chamber measures about 8 by 12 feet, with the remnants of two mounting platforms for generators still identifiable. At the rear of the enclosure (the north wall) there are two ventilation shafts, or perhaps, more appropriately, exhaust shafts. Both are rectangular in shape and measure ca. 2 feet square. Presently, both of them are filled with detritus and seem to be totally sealed-off from their outlet near the summit of the ridge. Whether or not this is the second tunnel spoken of by Mr. Sarkis is unclear. [Fredericksen and Fredericksen 1989: 19]

The 1988 Xamanek study identified "no Hawaiian artifacts from either the historic or prehistoric periods . . . nor were there any indications of features or structures from these eras" (Fredericksen and Fredericksen 1989:19).

Section 4 Results of Fieldwork

A systematic pedestrian survey of the project area was completed on April 9, 2013. Due to the steep terrain and dense vegetation, portions of the project area were not accessible. Despite these constraints, CSH archaeologists were able to inspect the majority of the 6.67-acre project area for surface cultural resources. The results of the inspection indicate that the project area is densely covered with exotic grasses, ironwood (*Cassuarina equisetifolia*), Christmasberry (*Schinus terebinthifolius*), *koa haole* (*Leucaena leucocephala*), and *hala* (*Pandanus* sp.). The coastal boundaries of the project area appear to be more heavily populated with *naupaka* (*Scaevola sericea*) and *akoko* (*Chamaesyce celastroides*) plants. No surface cultural resources were observed during the systematic survey.

Section 5 Summary and Recommendations

At the request of Pacific Rim Conservation, Cultural Surveys Hawai‘i, Inc. (CSH) conducted an archaeological assessment for the Kīlauea Point National Wildlife Refuge Fencing Project, Kīlauea Ahupua‘a, Hanalei District, Island of Kaua‘i, TMK: (4) 5-2-004: 103 por. The Kīlauea Point National Wildlife Refuge is located at the northernmost tip of the Island of Kaua‘i between Kīlauea Point and Mokolea Point. The fencing project area is just south of Makapili Rock, approximately 1.5 km northeast of Kīlauea Town and 200 m east of Crater Hill. The project area consists of a 6.67 acre parcel of sloping land between 140 and 250 ft AMSL, abutting precipitous sea cliffs on the northeastern end. Vegetation consists of exotic grasses, ironwood (*Cassuarina equisetifolia*), Christmasberry (*Schinus terebinthifolius*), *naupaka* (*Scaevola sericea*), *koa haole* (*Leucaena leucocephala*), *akoko* (*Chamaesyce celastroides*), and *hala* (*Pandanus* sp.).

Proposed development within the project area consists of the installation of a fence to protect the habitat of ground nesting birds within the National Wildlife Refuge. For the fence construction, ground disturbing activities will include removing all vegetation within a 4 m-wide path along the fence line and smoothing that area with minor grading. To secure the fence, 30 cm-wide post holes will be augured in 1m deep every 3 to 4 m. After fence construction, the refuge staff will remove the non-native vegetation within the fenced area (the majority is non-native), which should involve minimal ground disturbance.

The pedestrian survey of the project area confirmed that there are no surface archaeological cultural resources within the project area.

Based on traditional and historic accounts, the project area is located within a portion of Kīlauea Ahupua‘a that is not well documented. In the Māhele of 1848, Kīlauea Ahupua‘a was retained as Government Lands and there were no entries for commoner land claims. Eleven of the LCA awards in adjacent Kāhili, however, provide a picture of what settlement near the project area might have been like at the time. These 11 LCA awards in Kāhili are clustered along the south side of Kīlauea Stream, lying in a low, wide terrace next to the stream, which is evidently well watered and well suited for maintenance of taro *lo‘i*. Virtually all claims involve a house lot, a few include *lo‘i*, and several claims mention "*kula*" (pasture) with *wauke* (paper mulberry), *noni* (Indian mulberry), and orange trees being cultivated.

Lands adjacent to the project area were cultivated with sugar cane in historic times by the Kīlauea Sugar Company. The sugar company modified water resources in the uplands with dams, reservoirs, ditches, and flumes (Joesting 1984), which may have damaged and ended large-scale native agricultural practices in Kīlauea and its vicinity. The Kīlauea Sugar Company ended its operations in 1971. According to background research and historic maps, the project area might have been utilized as pastureland during the twentieth century. It is possible that any remnant cultural resources were either removed or destroyed by the Kīlauea Sugar Company and/or livestock.

No cultural resources were observed within the survey area. Therefore, CSH recommends no further archaeological work for the proposed project. Based on background research and the current study, it is unlikely that surface cultural resources associated with pre- and post-Contact land use are present within the project area. In the unlikely event that previously unidentified

cultural resources are encountered by project construction, the project proponents should immediately stop work in the vicinity and contact DLNR/SHPD.

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Appendix D: Custom Soil Resource Report for Island of Kauai, Hawaii, Kauai National Wildlife Refuge Complex

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Island of Kauai, Hawaii

Kauai National Wildlife Refuge Complex

June 17, 2013

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

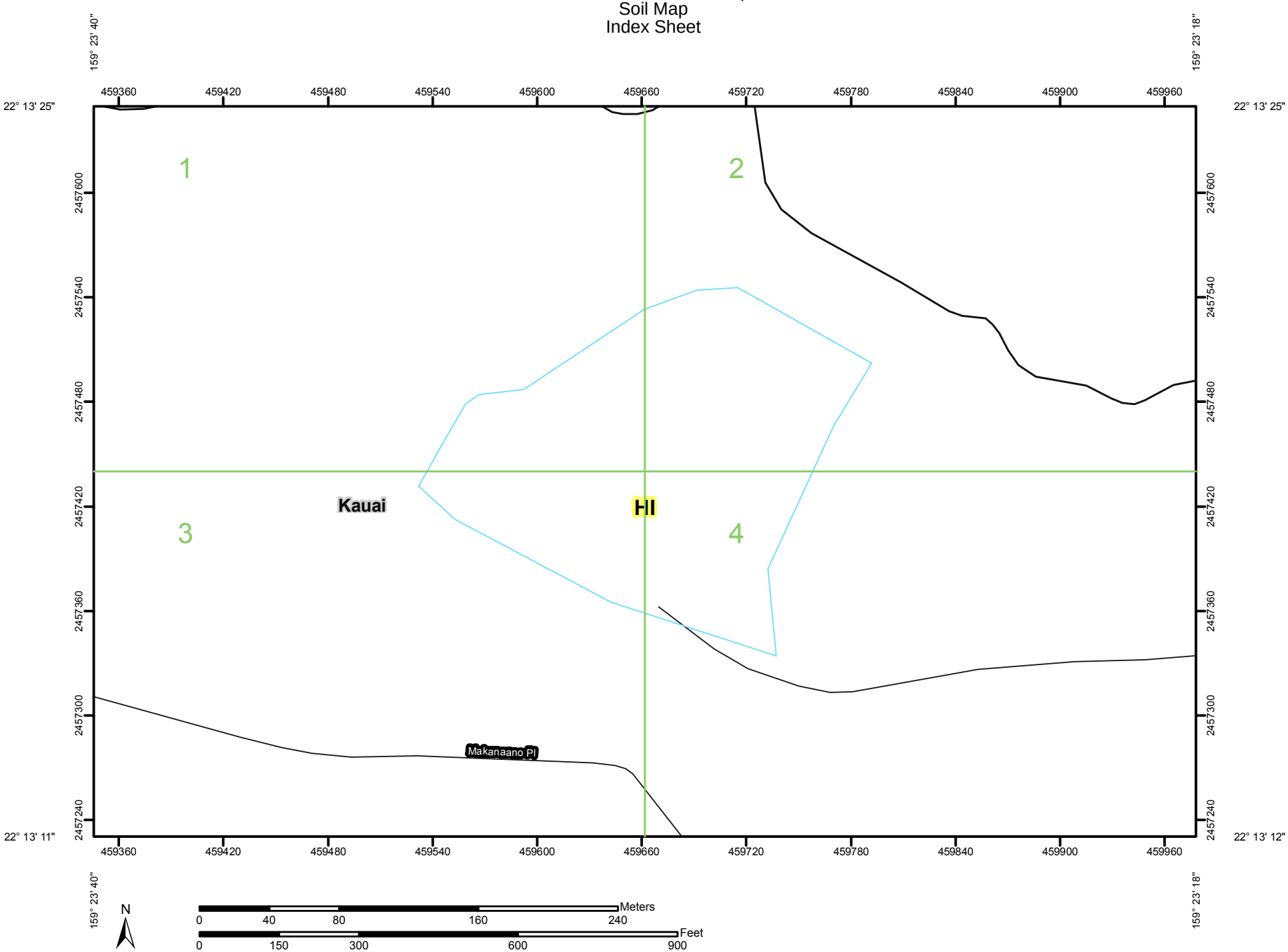
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

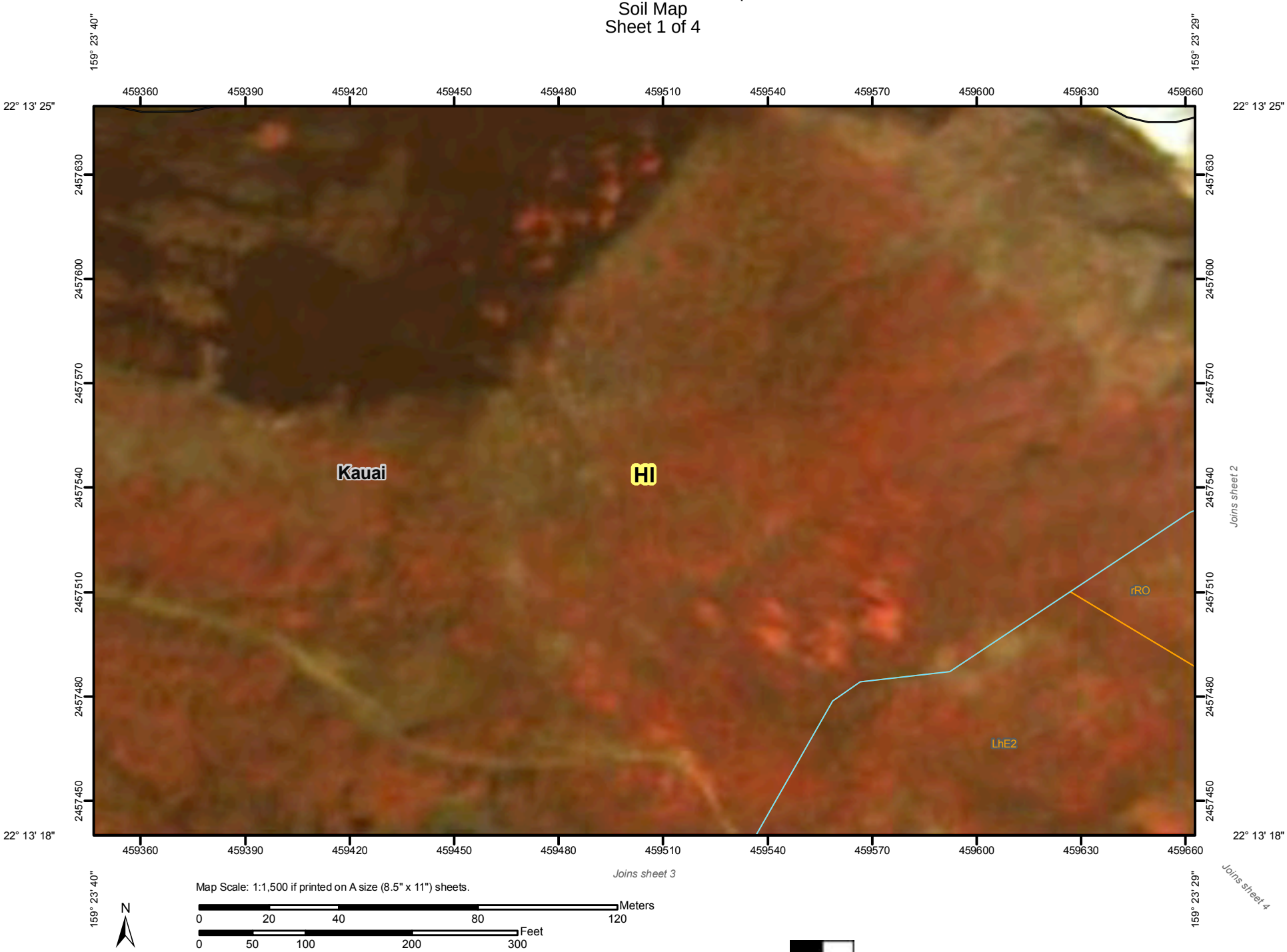
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map
Index Sheet



Custom Soil Resource Report
Soil Map
Sheet 1 of 4



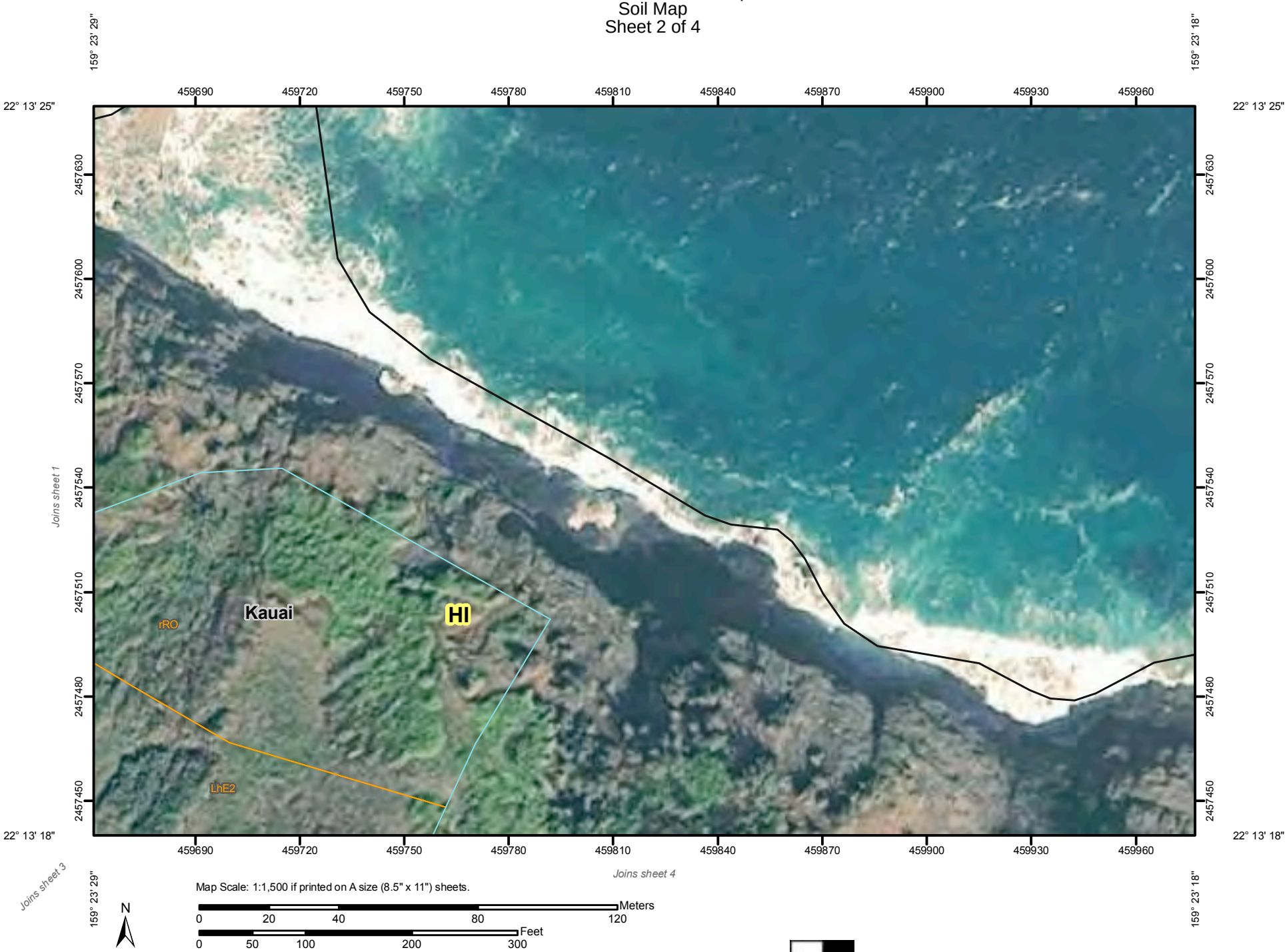
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Soil Map
Sheet 2 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Soil Map
Sheet 3 of 4

Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Custom Soil Resource Report
Soil Map
Sheet 4 of 4

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:1,500 if printed on A size (8.5" × 11") sheets.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Kauai, Hawaii
Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Island of Kauai, Hawaii (HI960)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
LhD	Lihue silty clay, 15 to 25 percent slopes	0.4	5.7%
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	5.1	65.6%
rRO	Rock outcrop	2.2	28.6%
Totals for Area of Interest		**7.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If

intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Island of Kauai, Hawaii

LhD—Lihue silty clay, 15 to 25 percent slopes

Map Unit Setting

Landscape: Uplands
Elevation: 0 to 800 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 72 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition

Lihue and similar soils: 100 percent

Description of Lihue

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous dust

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Moderate (about 8.4 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e
Hydrologic Soil Group: B

Typical profile

0 to 12 inches: Silty clay
12 to 60 inches: Silty clay

LhE2—Lihue silty clay, 25 to 40 percent slopes, eroded

Map Unit Setting

Landscape: Uplands
Elevation: 0 to 800 feet
Mean annual precipitation: 40 to 60 inches

Mean annual air temperature: 72 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Lihue and similar soils: 100 percent

Description of Lihue

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basic igneous dust

Properties and qualities
Slope: 25 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Moderate (about 8.4 inches)

Interpretive groups
Farmland classification: Not prime farmland
Land capability (nonirrigated): 6e
Hydrologic Soil Group: B

Typical profile
0 to 6 inches: Silty clay
6 to 60 inches: Silty clay

rRO—Rock outcrop

Map Unit Setting
Landscape: Lava fields
Elevation: 0 to 10,000 feet
Mean annual precipitation: 10 to 175 inches
Mean annual air temperature: 45 to 75 degrees F
Frost-free period: 365 days

Map Unit Composition
Rock outcrop: 100 percent

Description of Rock Outcrop

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, tread, rise

Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Properties and qualities

Slope: 5 to 99 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Available water capacity: Very low (about 0.0 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 8s
Hydrologic Soil Group: D

Typical profile

0 to 60 inches: Bedrock

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Land Management

Land management interpretations are tools designed to guide the user in evaluating existing conditions in planning and predicting the soil response to various land management practices, for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture, and rangeland. Example interpretations include suitability for a variety of irrigation practices, log landings, haul roads and major skid trails, equipment operability, site preparation, suitability for hand and mechanical planting, potential erosion hazard associated with various practices, and ratings for fencing and waterline installation.

Erosion Hazard (Off-Road, Off-Trail)

The ratings in this interpretation indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. The ratings are based on slope and soil erosion factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

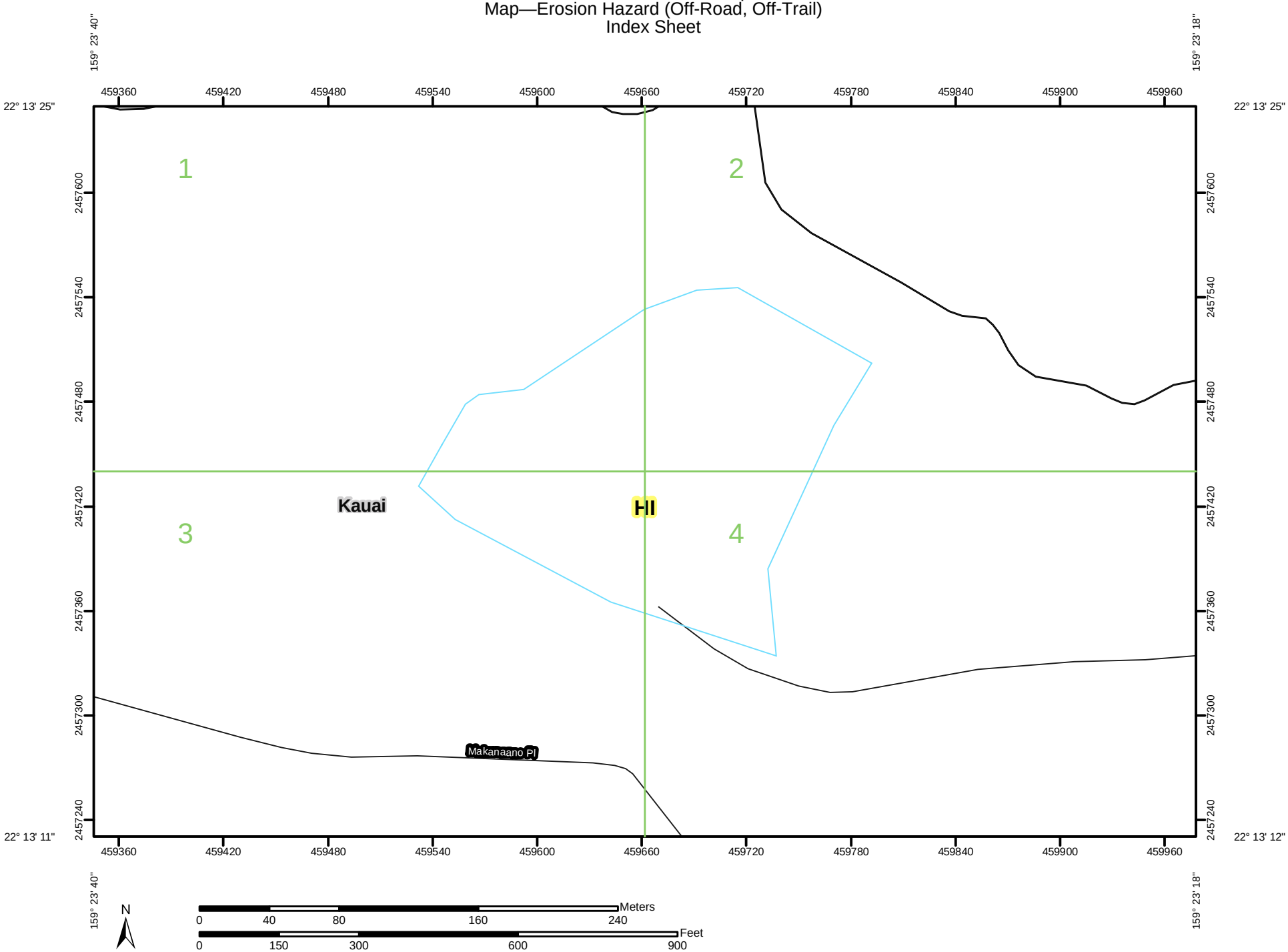
The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

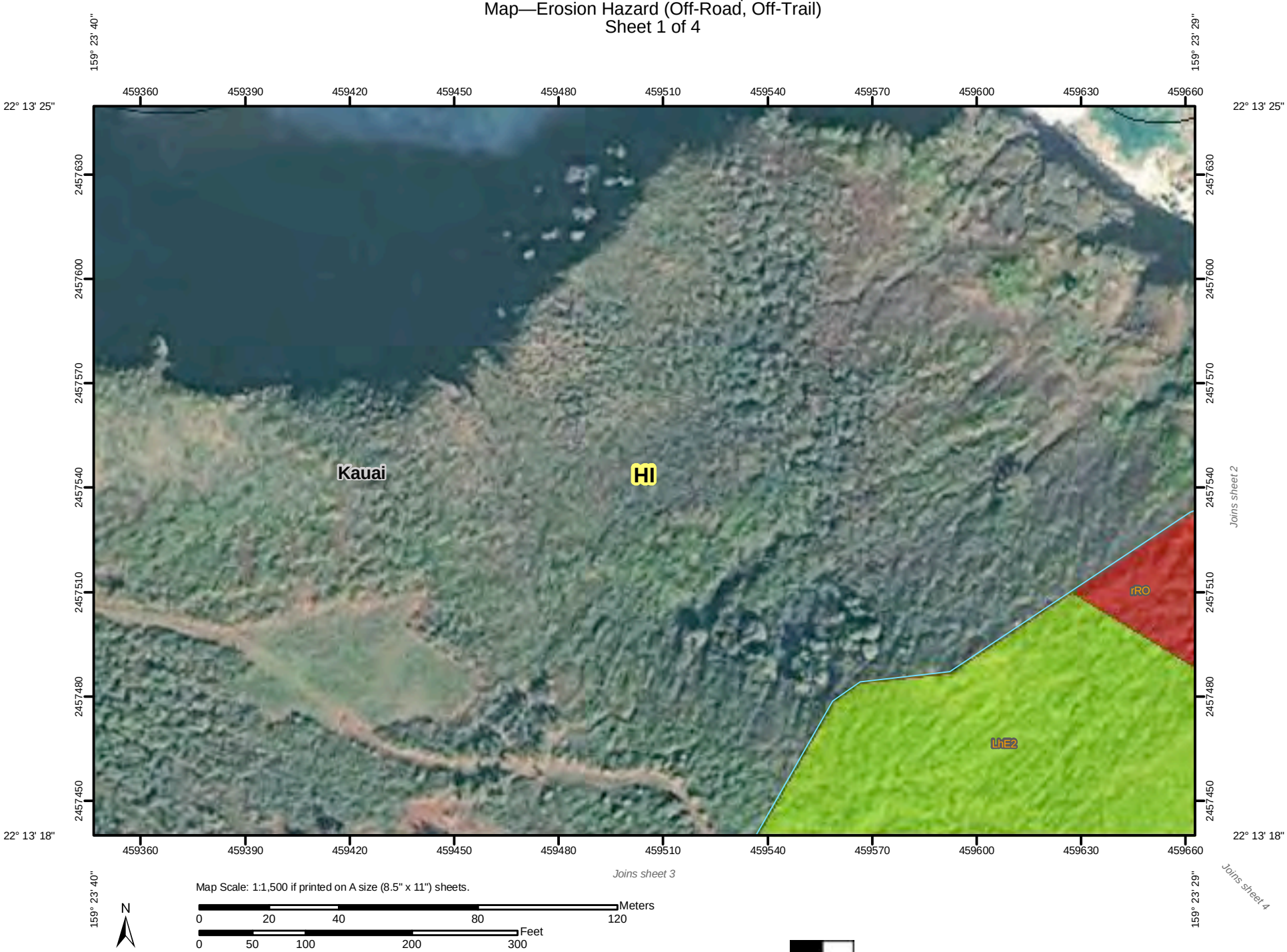
The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail)
Index Sheet



Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail)
Sheet 1 of 4



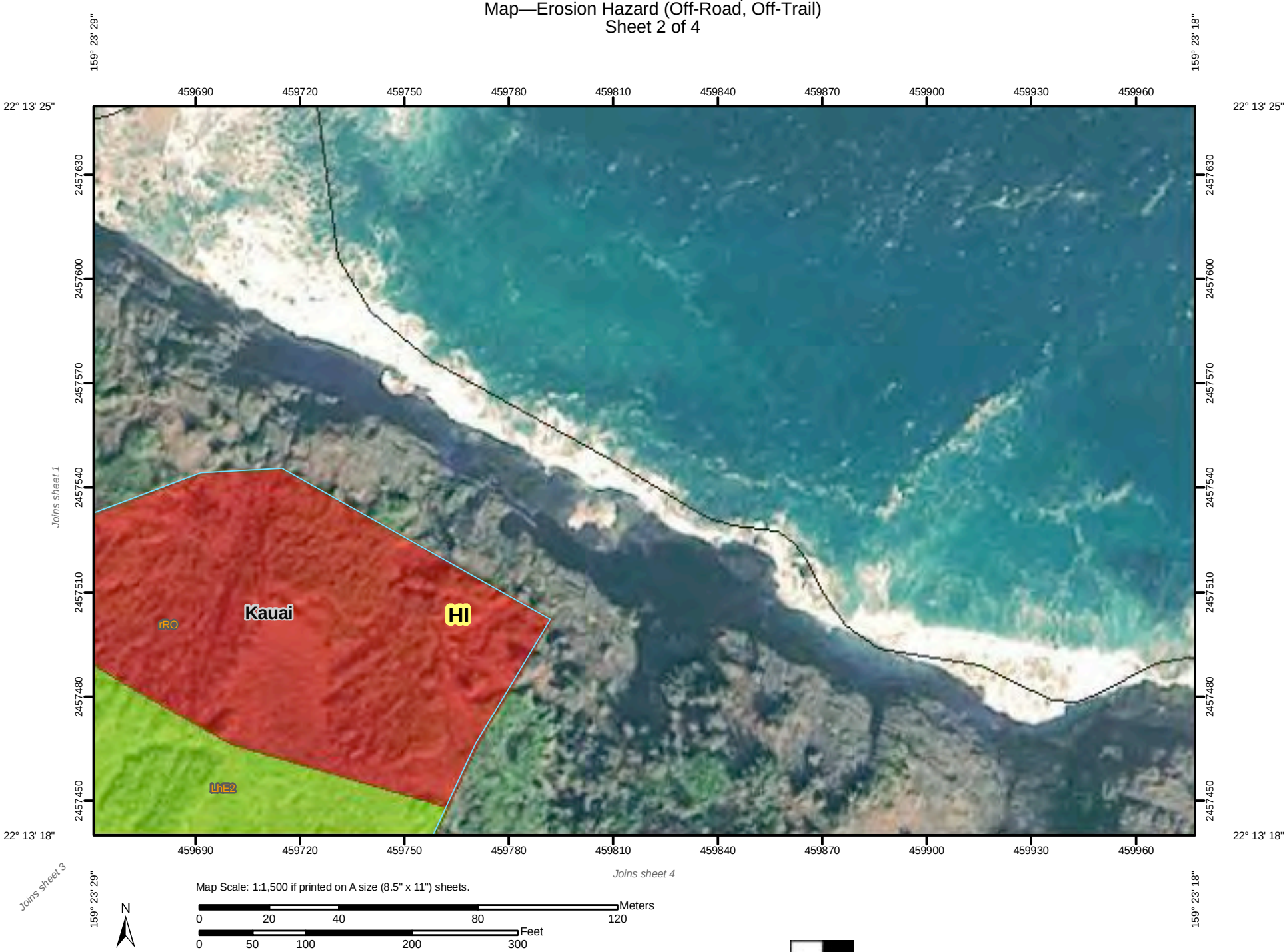
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail)
Sheet 2 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail)
Sheet 3 of 4

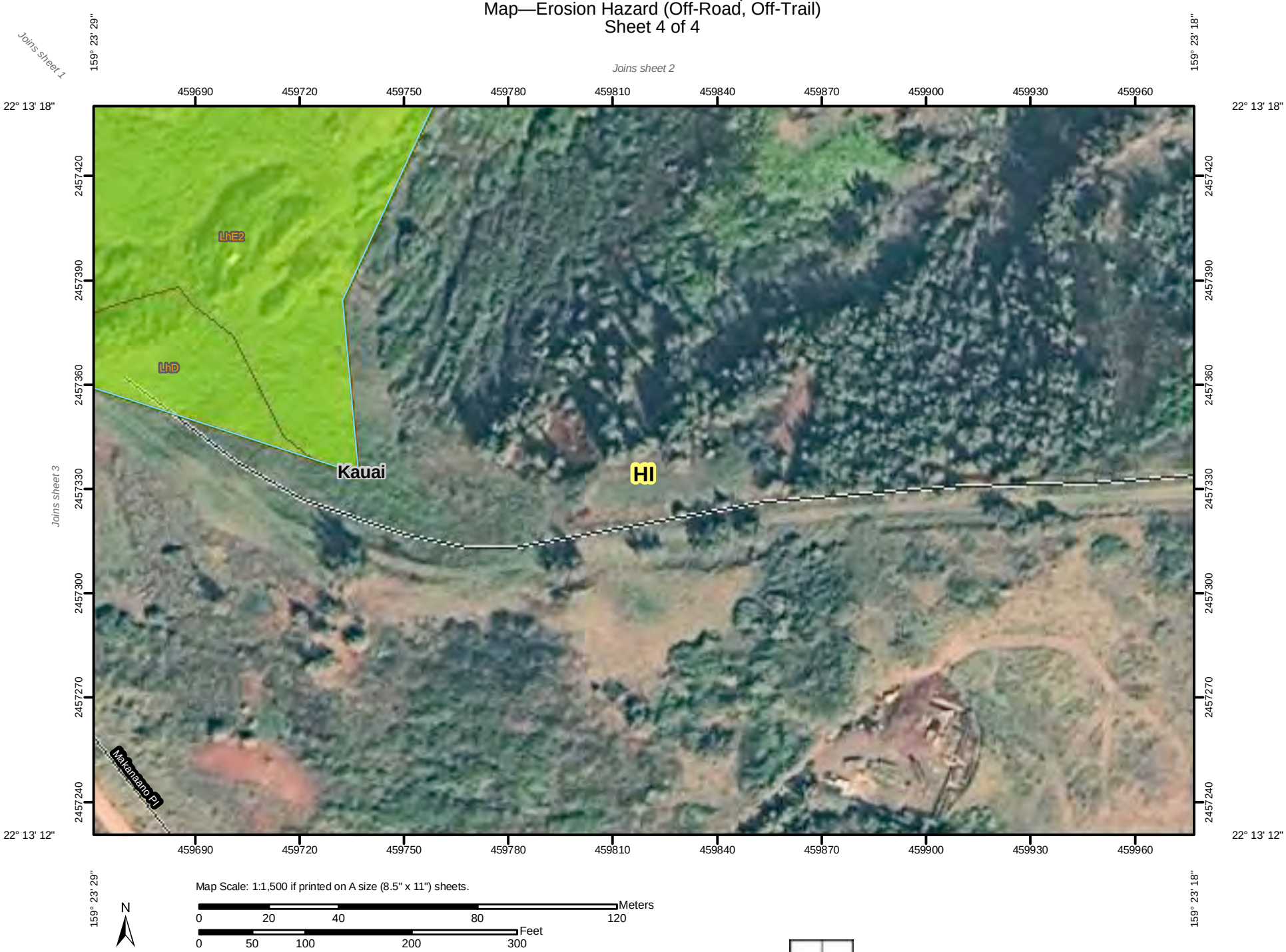
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail)
Sheet 4 of 4



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

Very severe

Severe

Moderate

Slight

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:1,500 if printed on A size (8.5" × 11") sheets.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Kauai, Hawaii
Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Erosion Hazard (Off-Road, Off-Trail)

Erosion Hazard (Off-Road, Off-Trail)— Summary by Map Unit — Island of Kauai, Hawaii (HI960)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
LhD	Lihue silty clay, 15 to 25 percent slopes	Moderate	Lihue (100%)	Slope/erodibility (0.50)	0.4	5.7%
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	Moderate	Lihue (100%)	Slope/erodibility (0.50)	5.1	65.6%
rRO	Rock outcrop	Very severe	Rock outcrop (100%)	Slope/erodibility (0.95)	2.2	28.6%
				Slope/erodibility (0.95)		
Totals for Area of Interest					**7.8**	**100.0%**

Erosion Hazard (Off-Road, Off-Trail)— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Moderate	5.5	71.4%
Very severe	2.2	28.6%
Totals for Area of Interest	**7.8**	**100.0%**

Rating Options—Erosion Hazard (Off-Road, Off-Trail)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Potential for Seedling Mortality

The ratings in this interpretation indicate the likelihood of death of naturally or artificially propagated tree seedlings, as influenced by soil characteristics, physiographic features, and climatic conditions. Considered in the ratings are flooding, ponding, depth to a water table, content of lime, reaction, available water capacity, soil moisture regime, soil temperature regime, aspect, and slope.

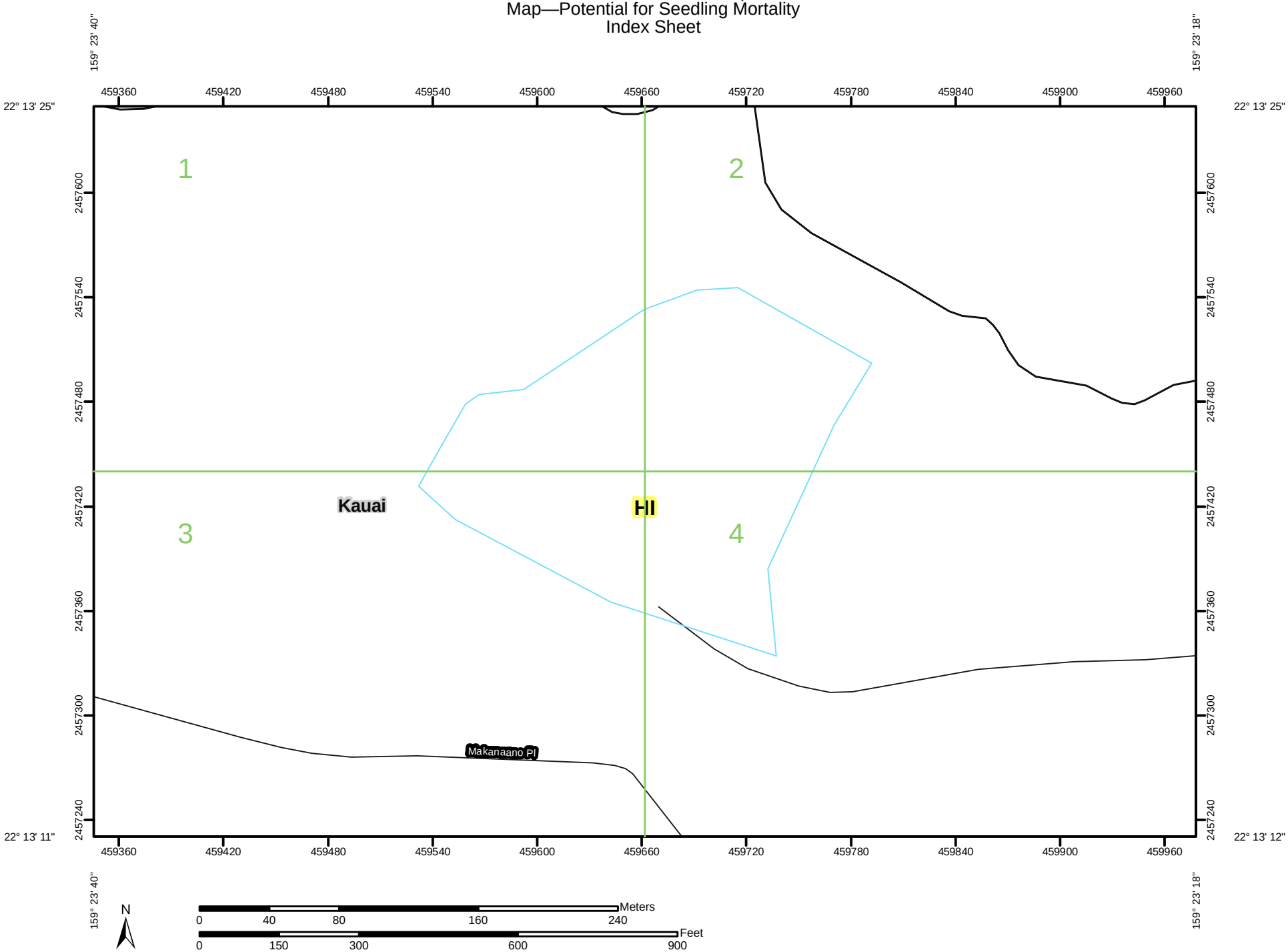
The ratings are both verbal and numerical. The soils are described as having a "low," "moderate," or "high" potential for seedling mortality. "Low" indicates that seedling mortality is unlikely. Good performance can be expected, and little or no maintenance is needed. "Moderate" indicates that seedling mortality can occur because one or more soil properties are less than desirable. Fair performance can be expected, and some maintenance is needed. "High" indicates that seedling mortality can occur because of one or more soil properties and that overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration.

Numerical ratings indicate gradations between the point at which the potential for seedling mortality is highest (1.00) and the point at which the potential is lowest (0.00).

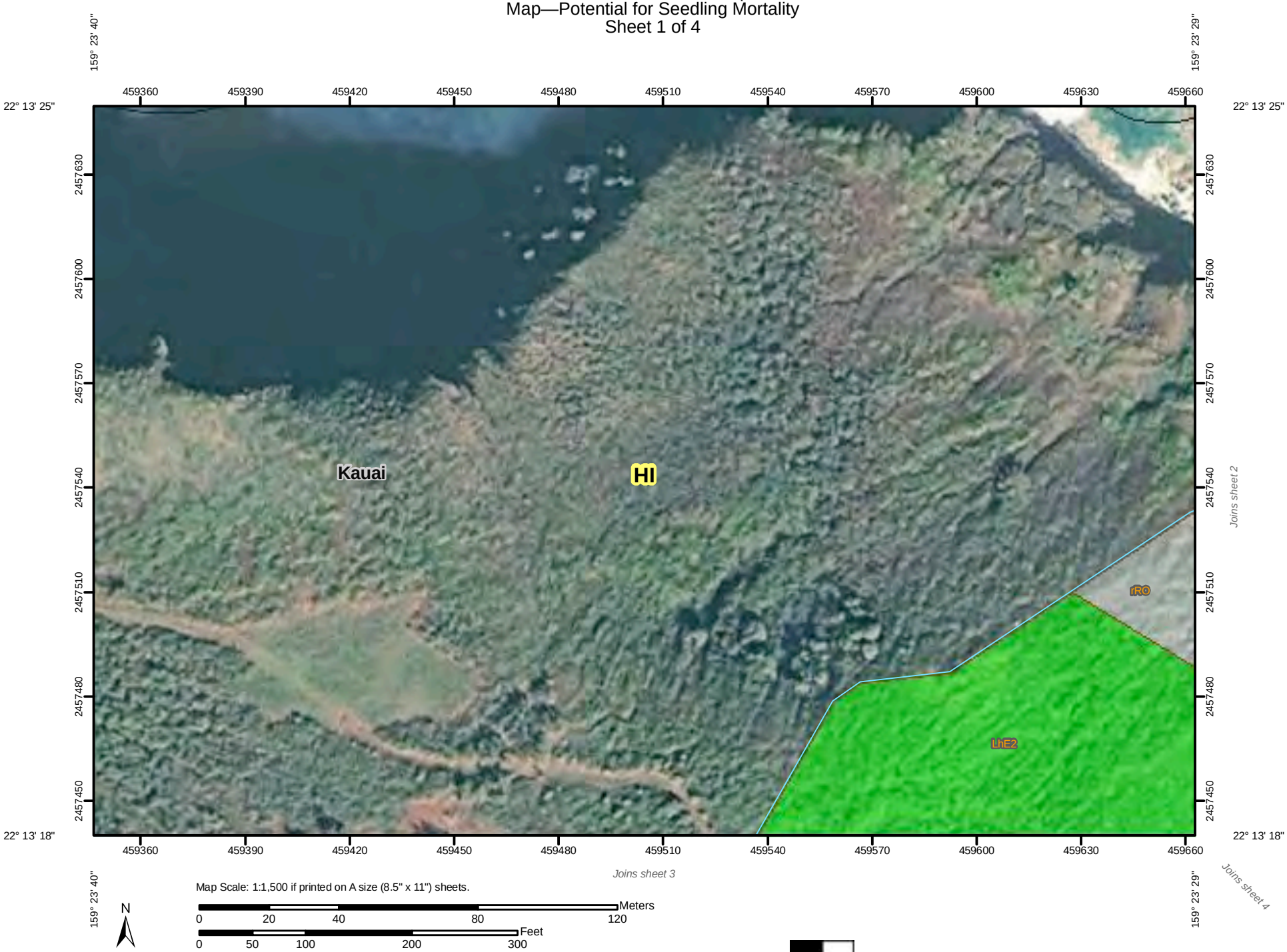
The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Potential for Seedling Mortality
Index Sheet



Custom Soil Resource Report
Map—Potential for Seedling Mortality
Sheet 1 of 4



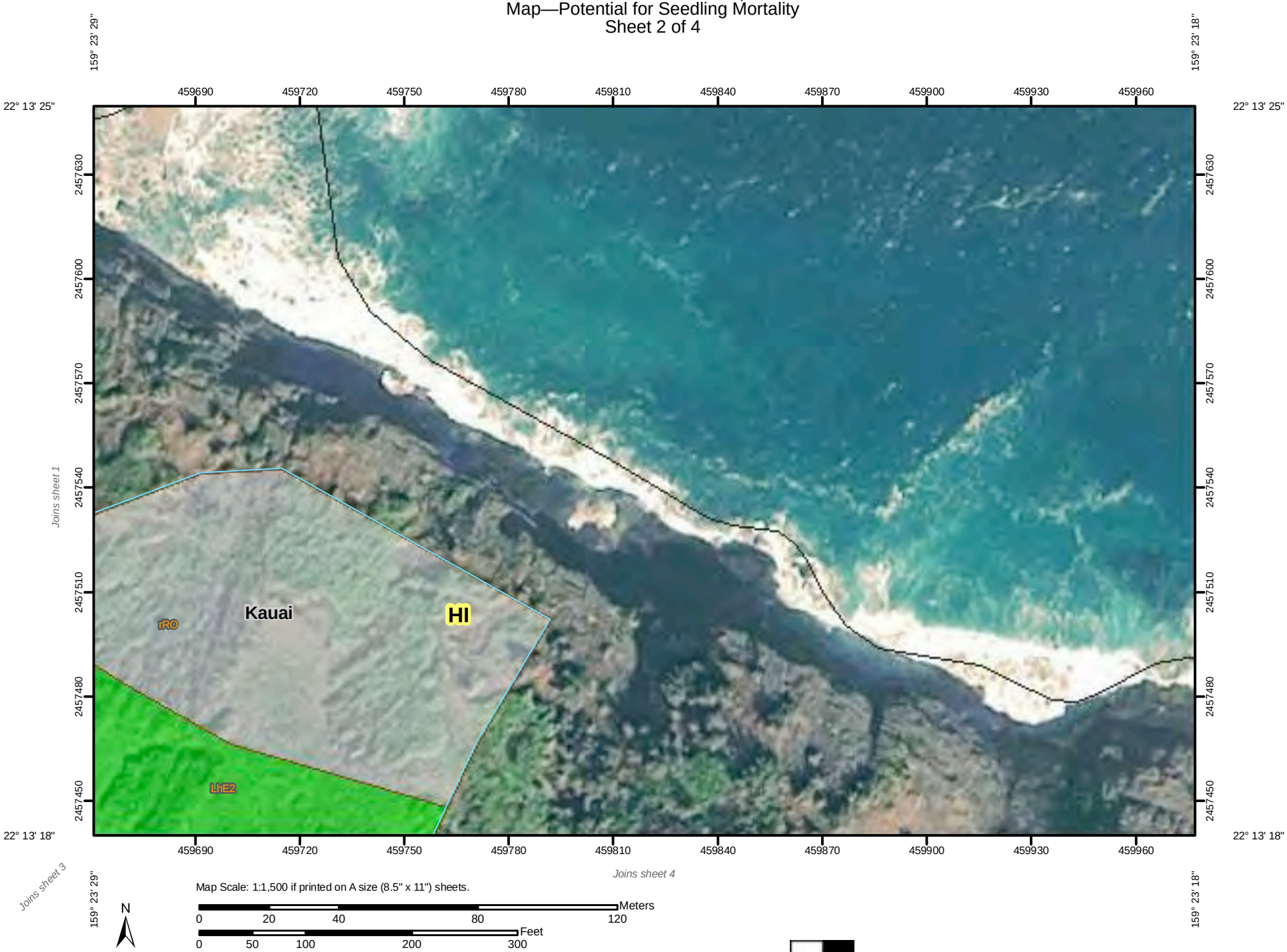
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Potential for Seedling Mortality
Sheet 2 of 4



Custom Soil Resource Report
Map—Potential for Seedling Mortality
Sheet 3 of 4

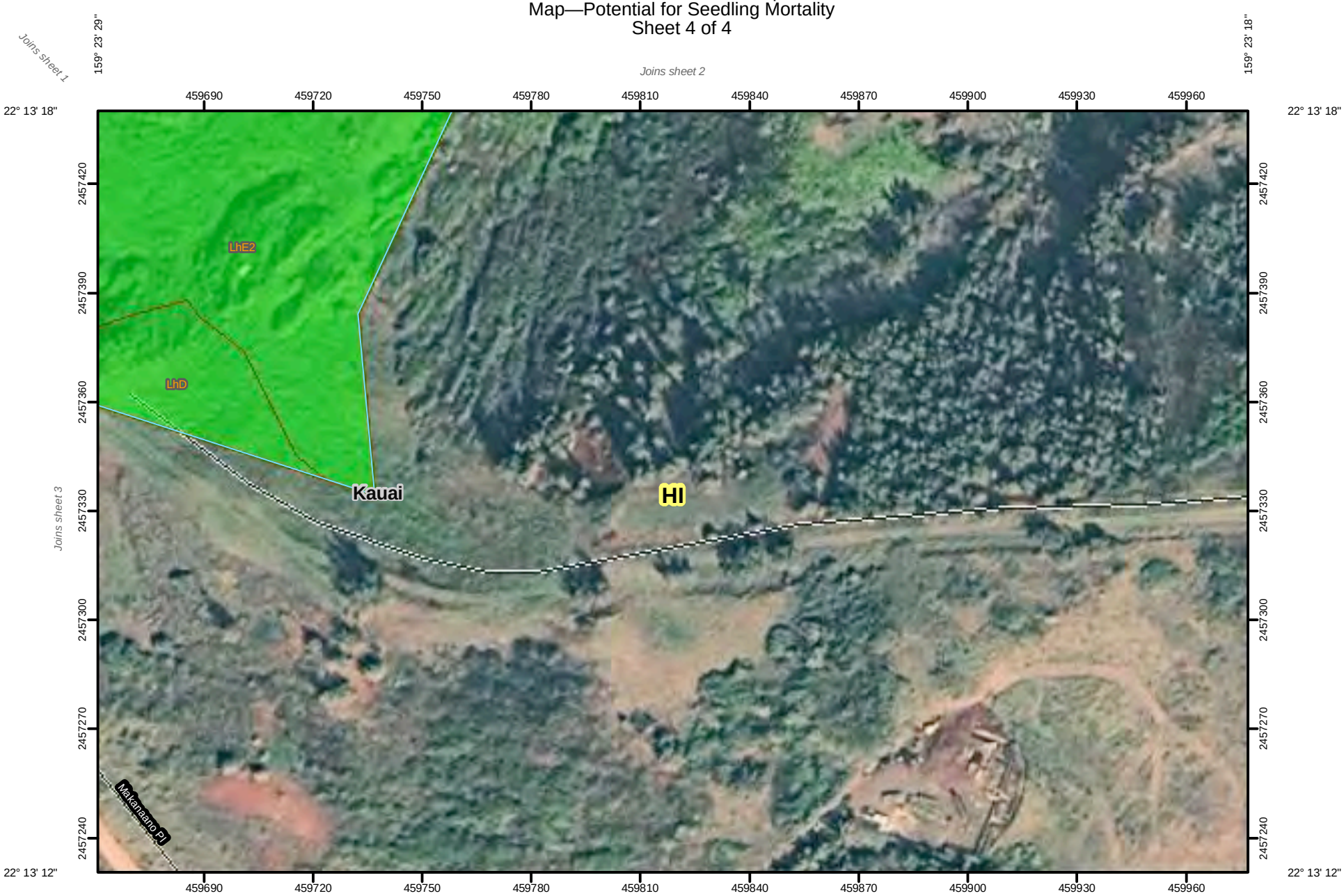
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Potential for Seedling Mortality
Sheet 4 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

High

Moderate

Low

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:1,500 if printed on A size (8.5" × 11") sheets.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Kauai, Hawaii
Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Potential for Seedling Mortality

Potential for Seedling Mortality— Summary by Map Unit — Island of Kauai, Hawaii (HI960)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
LhD	Lihue silty clay, 15 to 25 percent slopes	Low	Lihue (100%)		0.4	5.7%
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	Low	Lihue (100%)		5.1	65.6%
rRO	Rock outcrop	Not rated	Rock outcrop (100%)		2.2	28.6%
Totals for Area of Interest					**7.8**	**100.0%**

Potential for Seedling Mortality— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Low	5.5	71.4%
Null or Not Rated	2.2	28.6%
Totals for Area of Interest	**7.8**	**100.0%**

Rating Options—Potential for Seedling Mortality

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

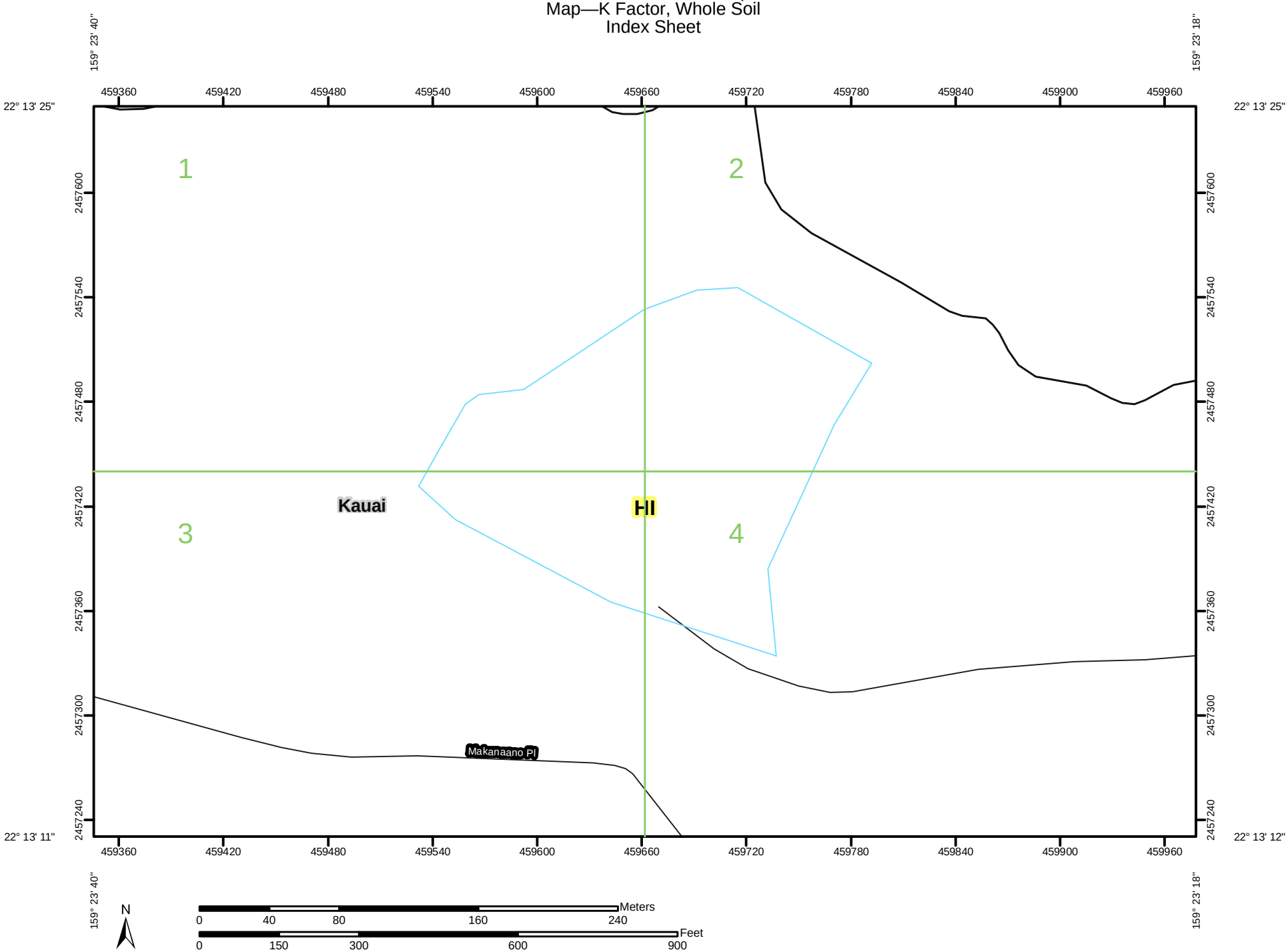
Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

K Factor, Whole Soil

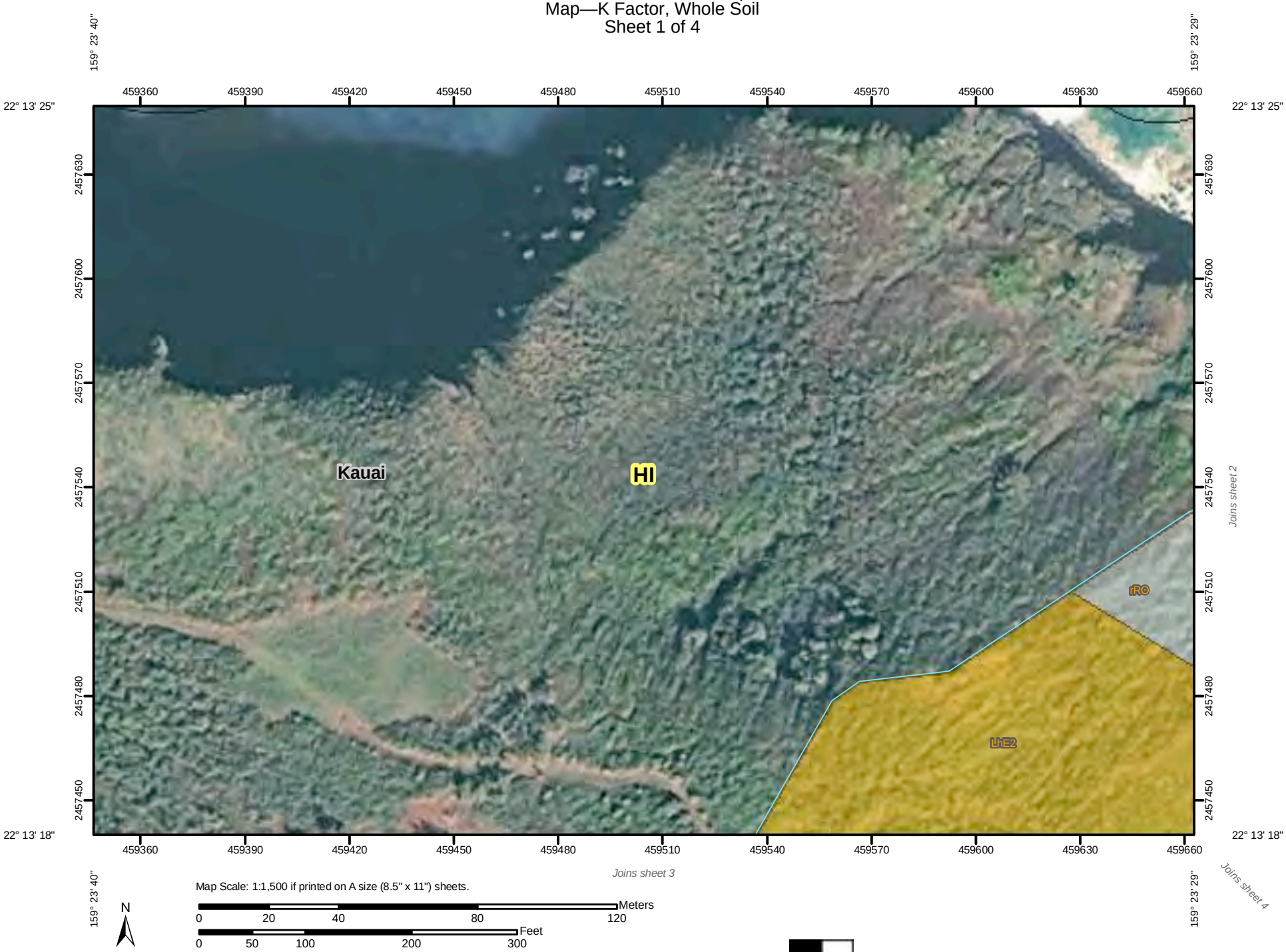
Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Custom Soil Resource Report
Map—K Factor, Whole Soil
Index Sheet



Custom Soil Resource Report
Map—K Factor, Whole Soil
Sheet 1 of 4



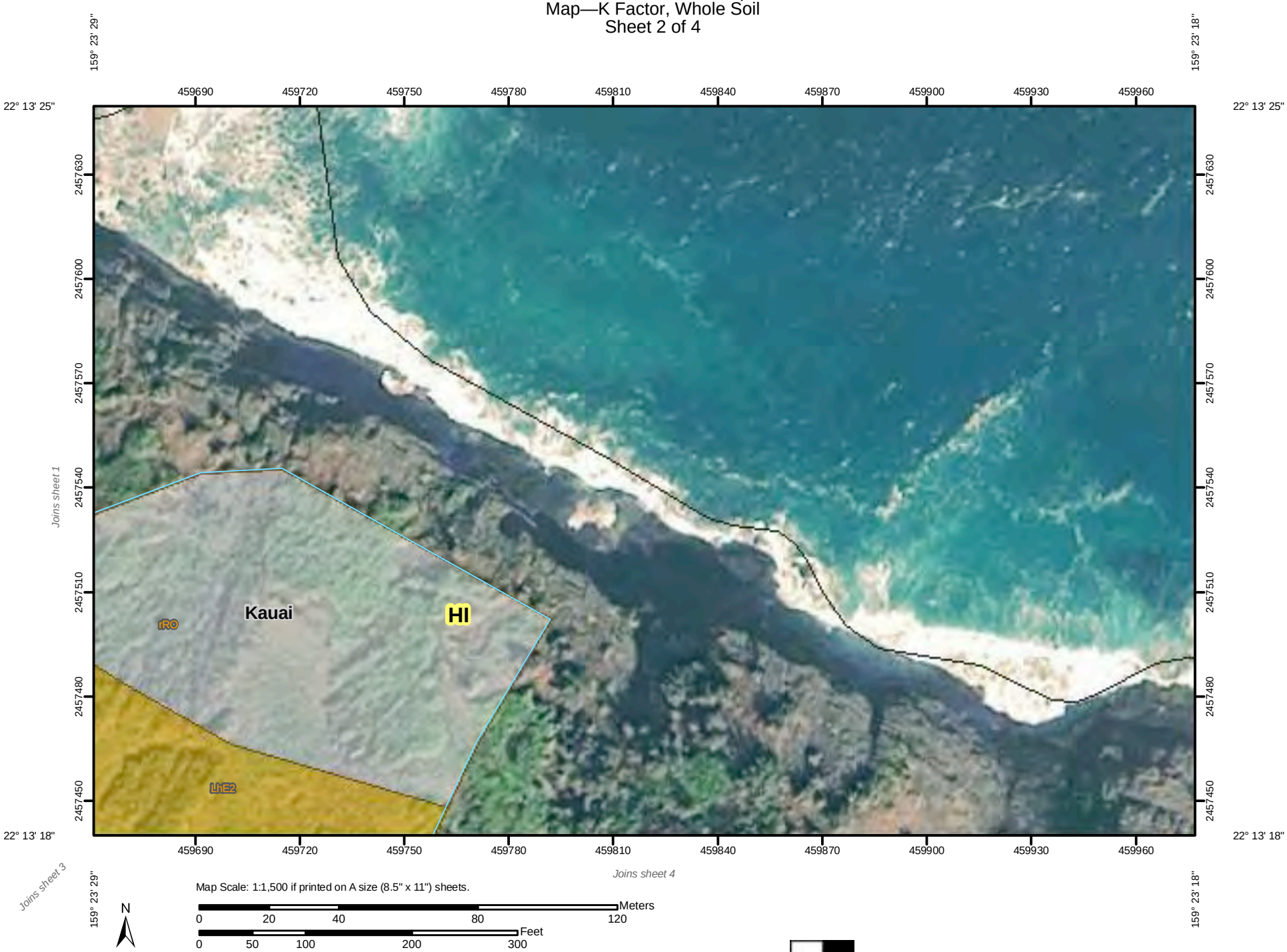
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Custom Soil Resource Report
Map—K Factor, Whole Soil
Sheet 2 of 4



Custom Soil Resource Report
Map—K Factor, Whole Soil
Sheet 3 of 4

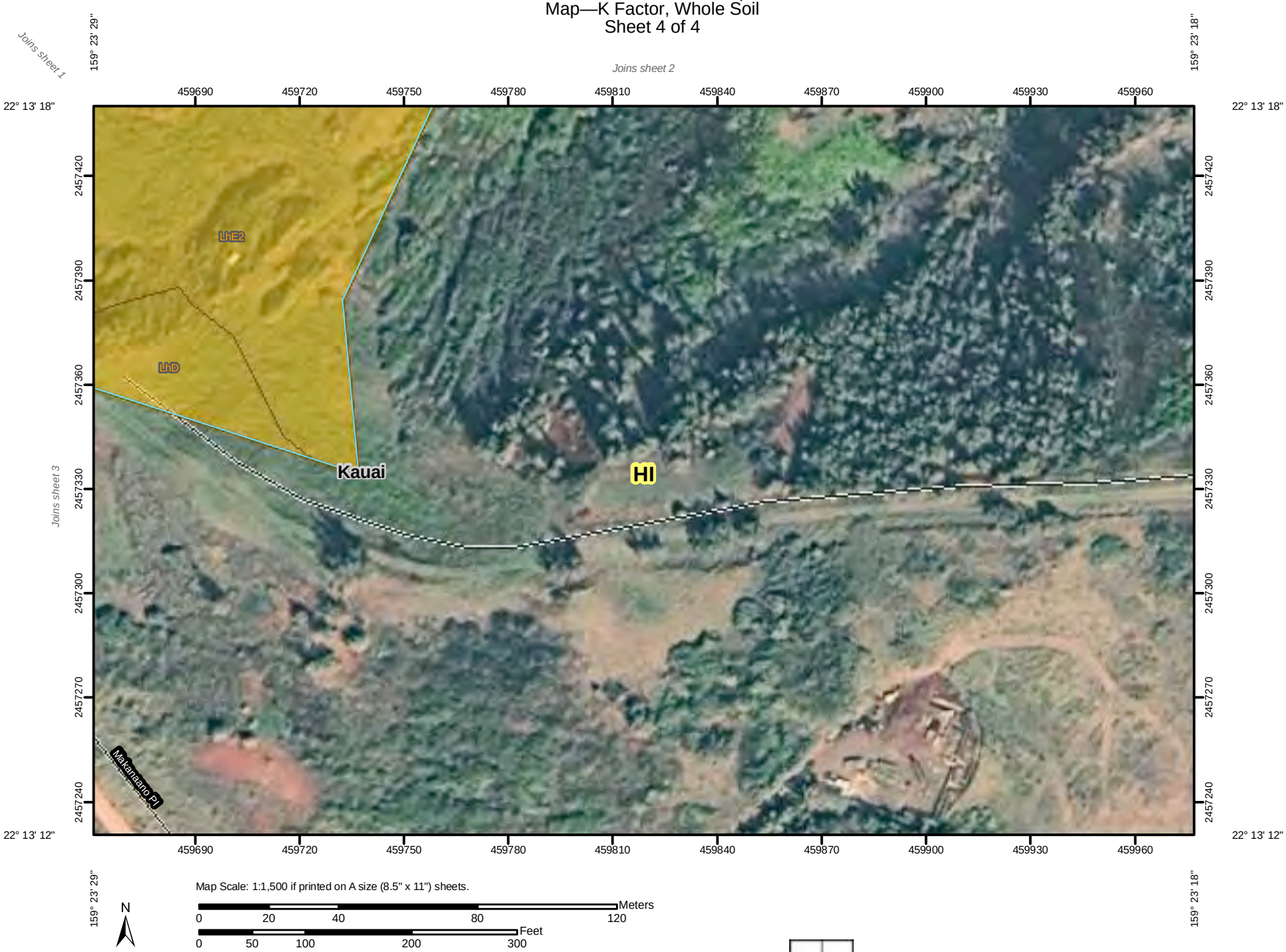
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—K Factor, Whole Soil
Sheet 4 of 4



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

.02

.05

.10

.15

.17

.20

.24

.28

.32

.37

.43

.49

.55

.64

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:1,500 if printed on A size (8.5" × 11") sheets.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Kauai, Hawaii
Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—K Factor, Whole Soil

K Factor, Whole Soil— Summary by Map Unit — Island of Kauai, Hawaii (HI960)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
LhD	Lihue silty clay, 15 to 25 percent slopes	.15	0.4	5.7%
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	.15	5.1	65.6%
rRO	Rock outcrop		2.2	28.6%
Totals for Area of Interest			**7.8**	**100.0%**

Rating Options—K Factor, Whole Soil

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

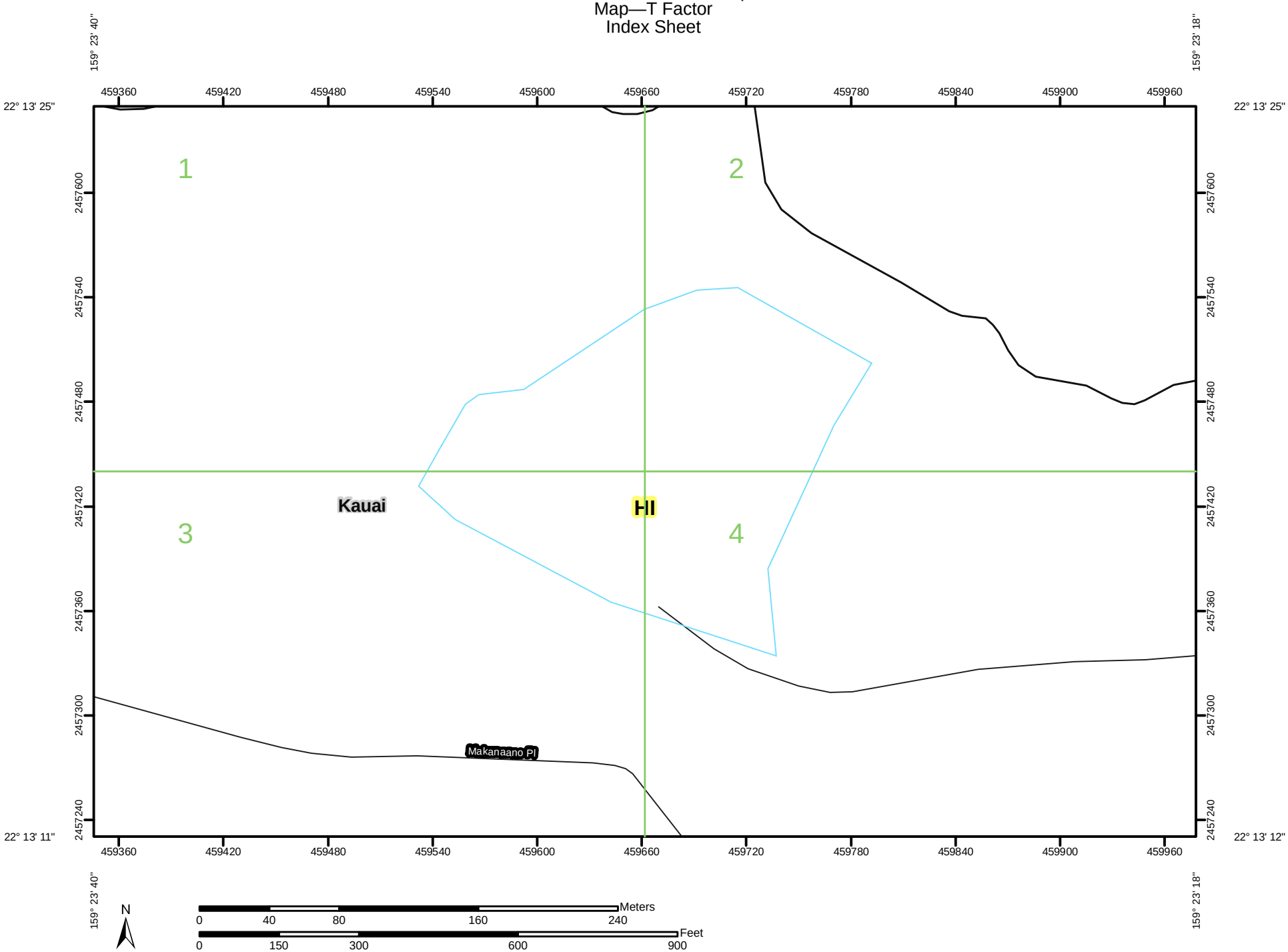
Tie-break Rule: Higher

Layer Options: Surface Layer

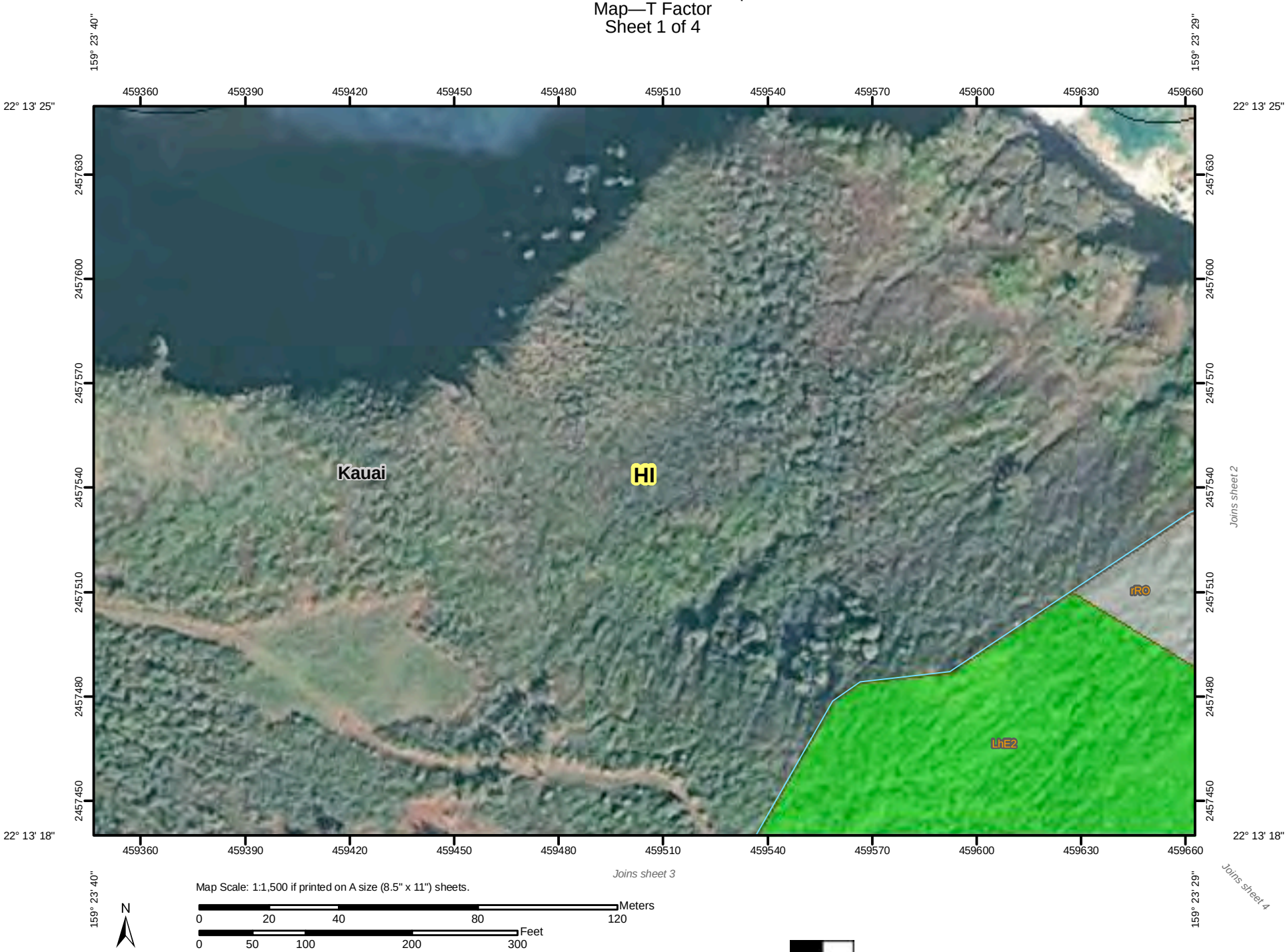
T Factor

The T factor is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Custom Soil Resource Report
Map—T Factor
Index Sheet



Custom Soil Resource Report
Map—T Factor
Sheet 1 of 4



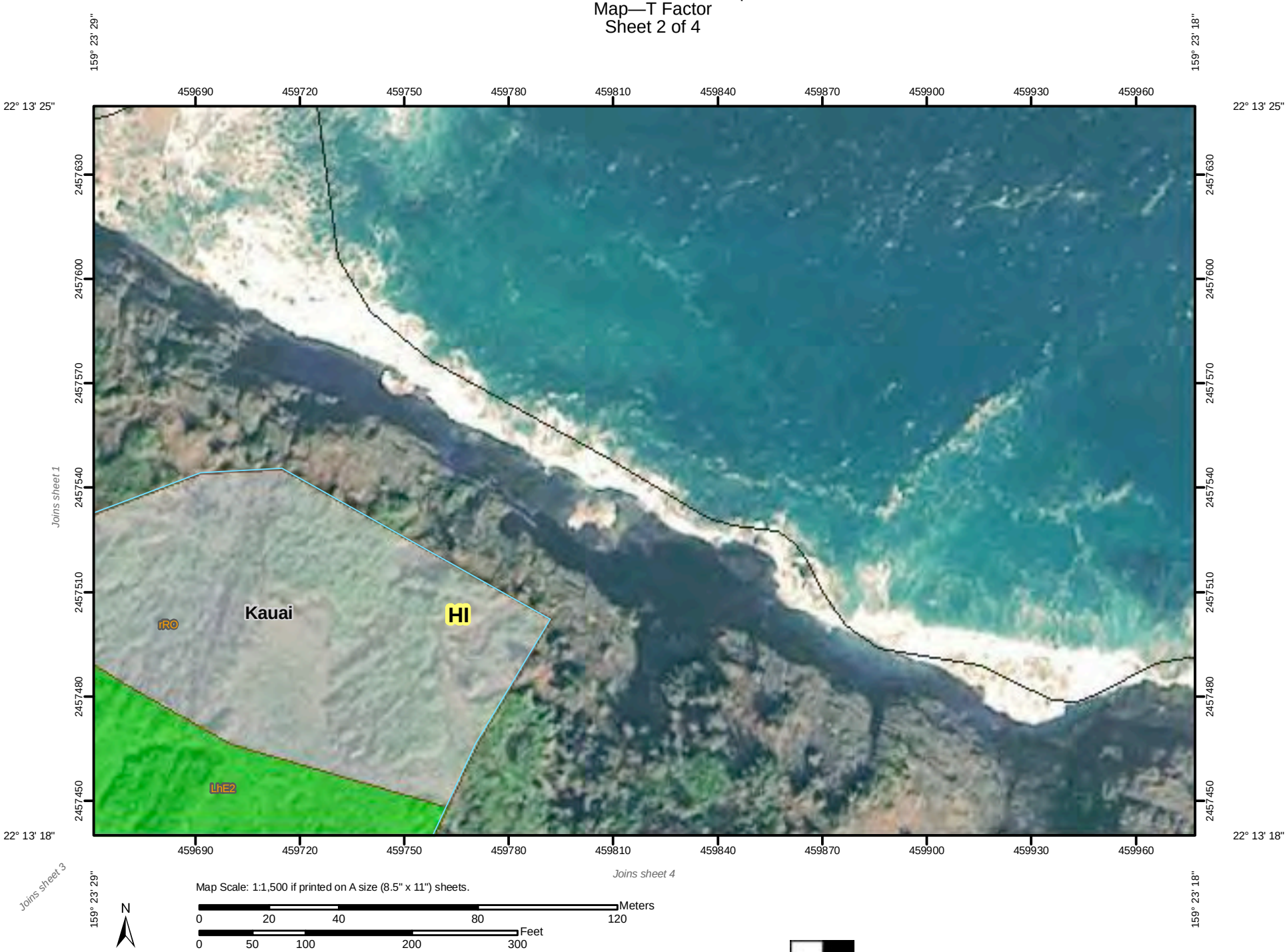
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—T Factor
Sheet 2 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—T Factor
Sheet 3 of 4

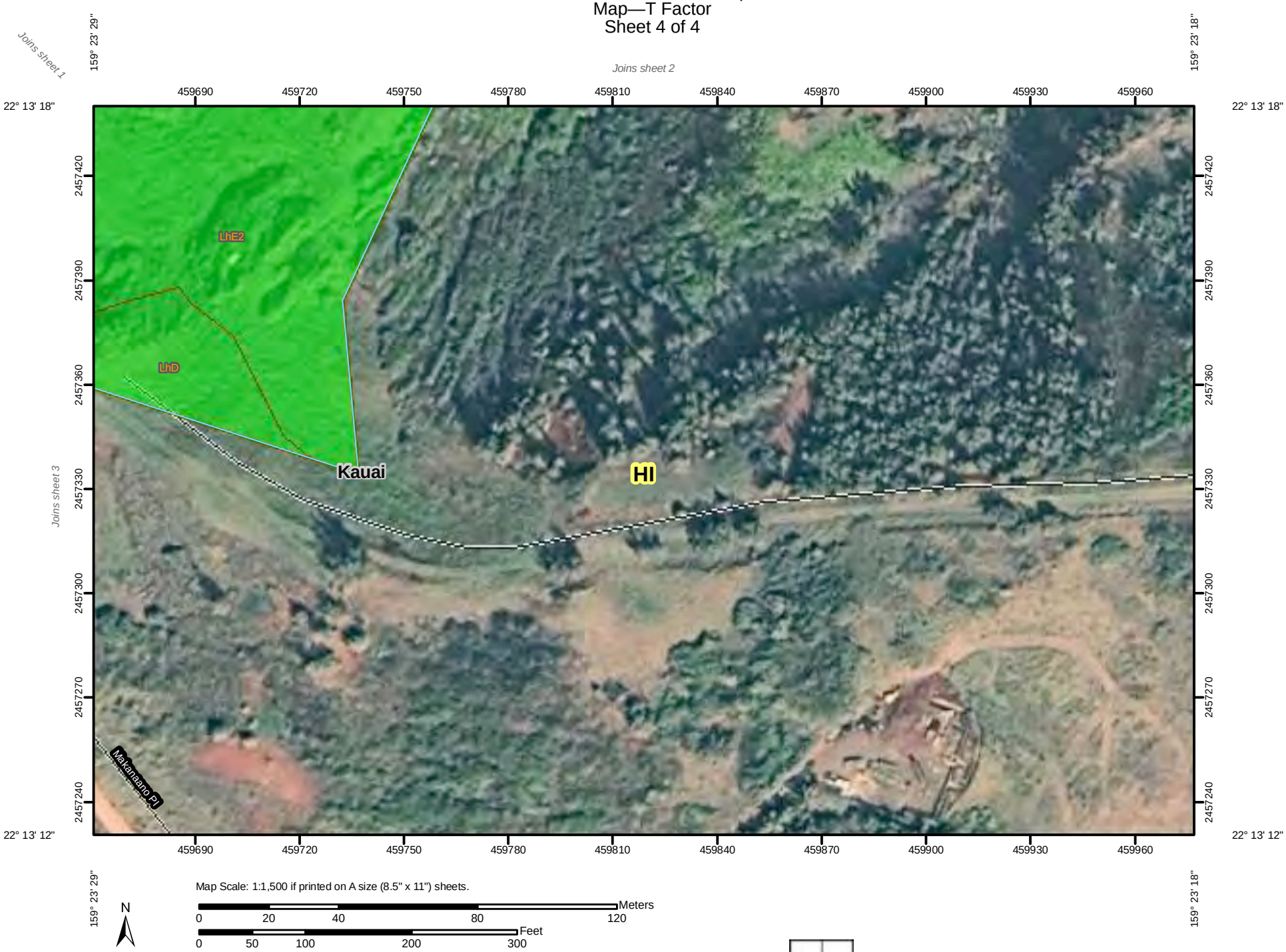
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—T Factor
Sheet 4 of 4



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

1

2

3

4

5

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:1,500 if printed on A size (8.5" × 11") sheets.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

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Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Kauai, Hawaii
Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—T Factor

T Factor— Summary by Map Unit — Island of Kauai, Hawaii (HI960)				
Map unit symbol	**Map unit name**	**Rating (tons per acre per year)**	**Acres in AOI**	**Percent of AOI**
LhD	Lihue silty clay, 15 to 25 percent slopes	5	0.4	5.7%
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	5	5.1	65.6%
rRO	Rock outcrop		2.2	28.6%
Totals for Area of Interest			**7.8**	**100.0%**

Rating Options—T Factor

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

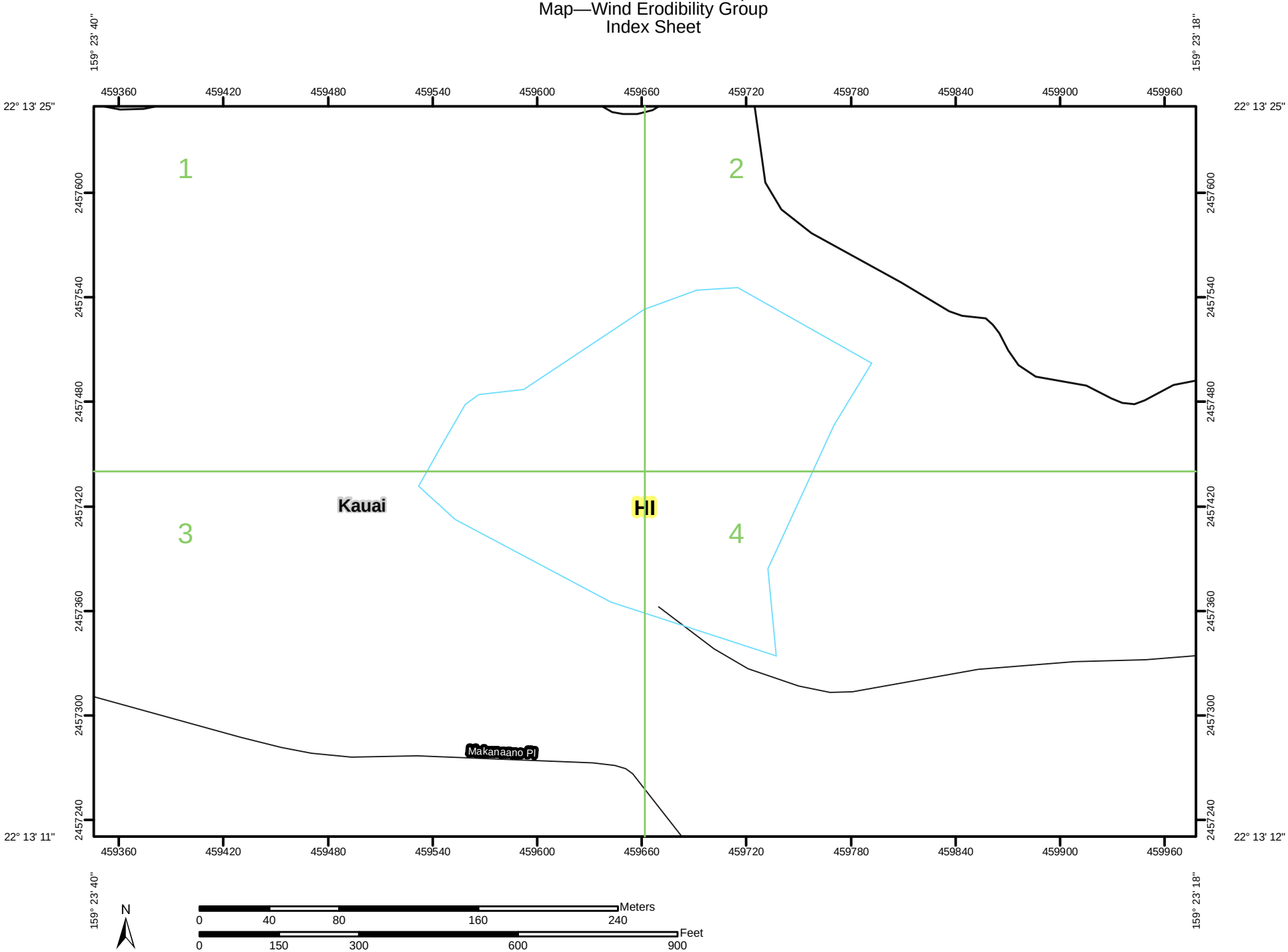
Tie-break Rule: Lower

Interpret Nulls as Zero: No

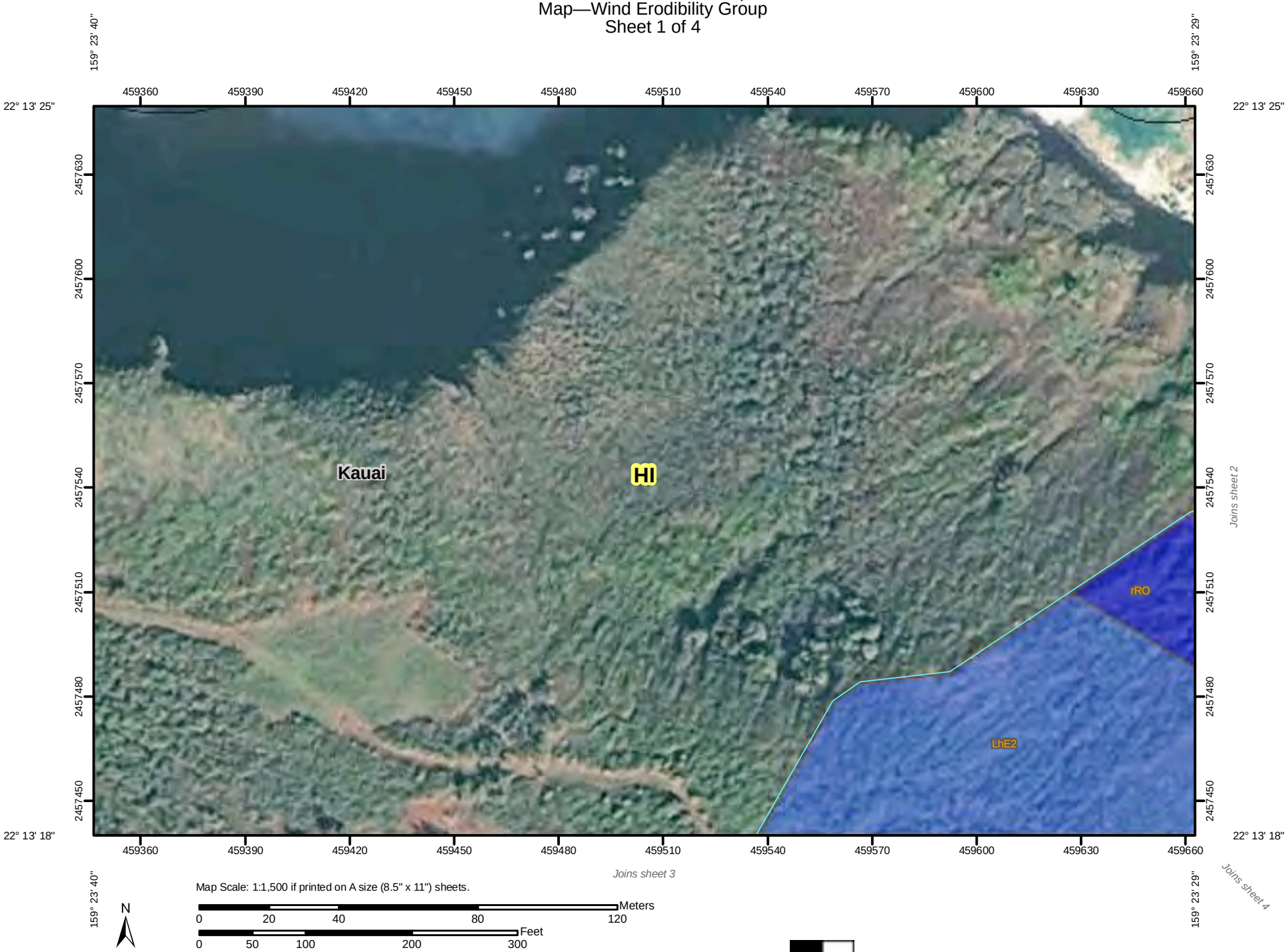
Wind Erodibility Group

A wind erodibility group (WEG) consists of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Custom Soil Resource Report
Map—Wind Erodibility Group
Index Sheet



Custom Soil Resource Report
Map—Wind Erodibility Group
Sheet 1 of 4



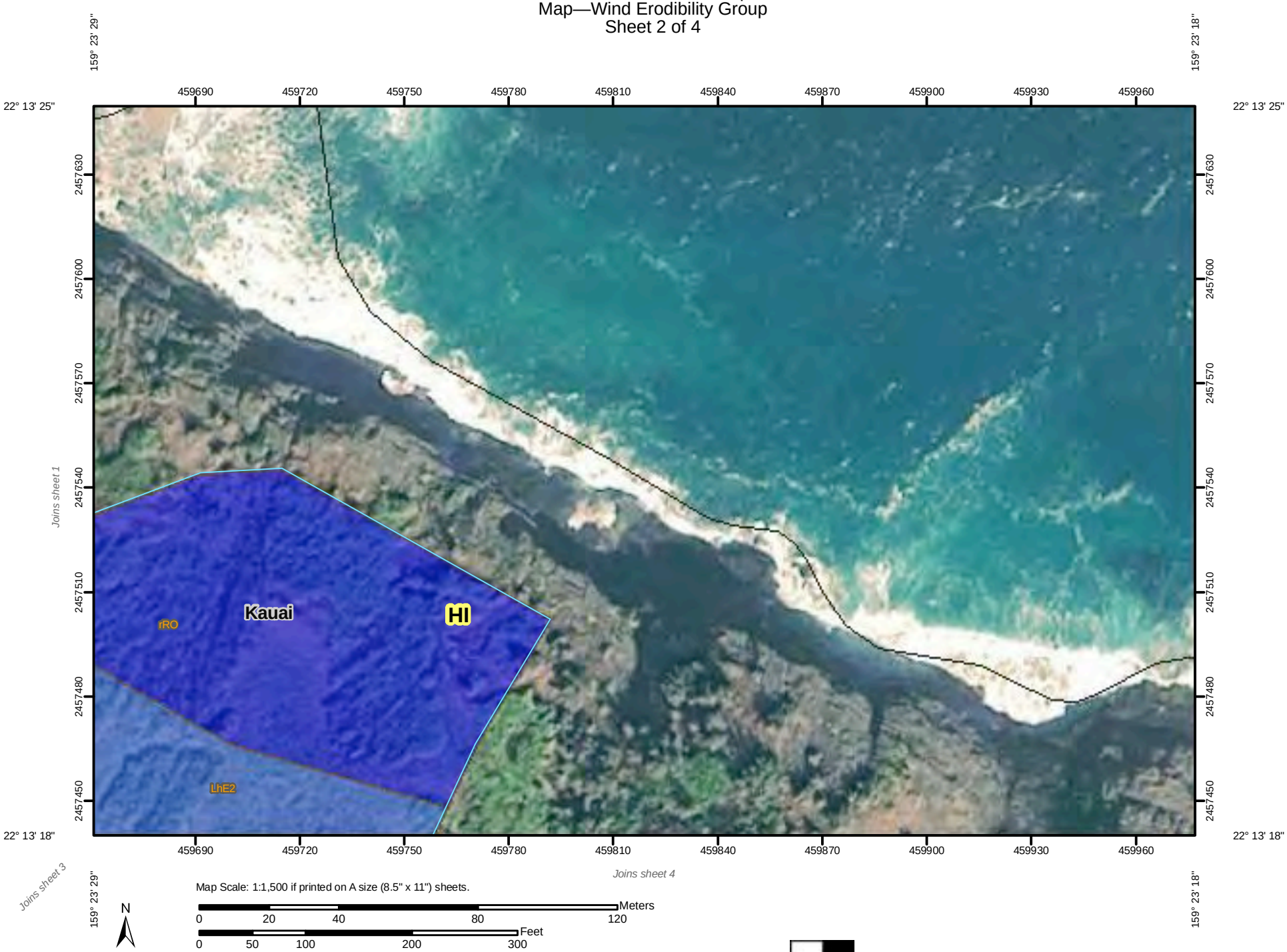
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Wind Erodibility Group
Sheet 2 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Wind Erodibility Group
Sheet 3 of 4

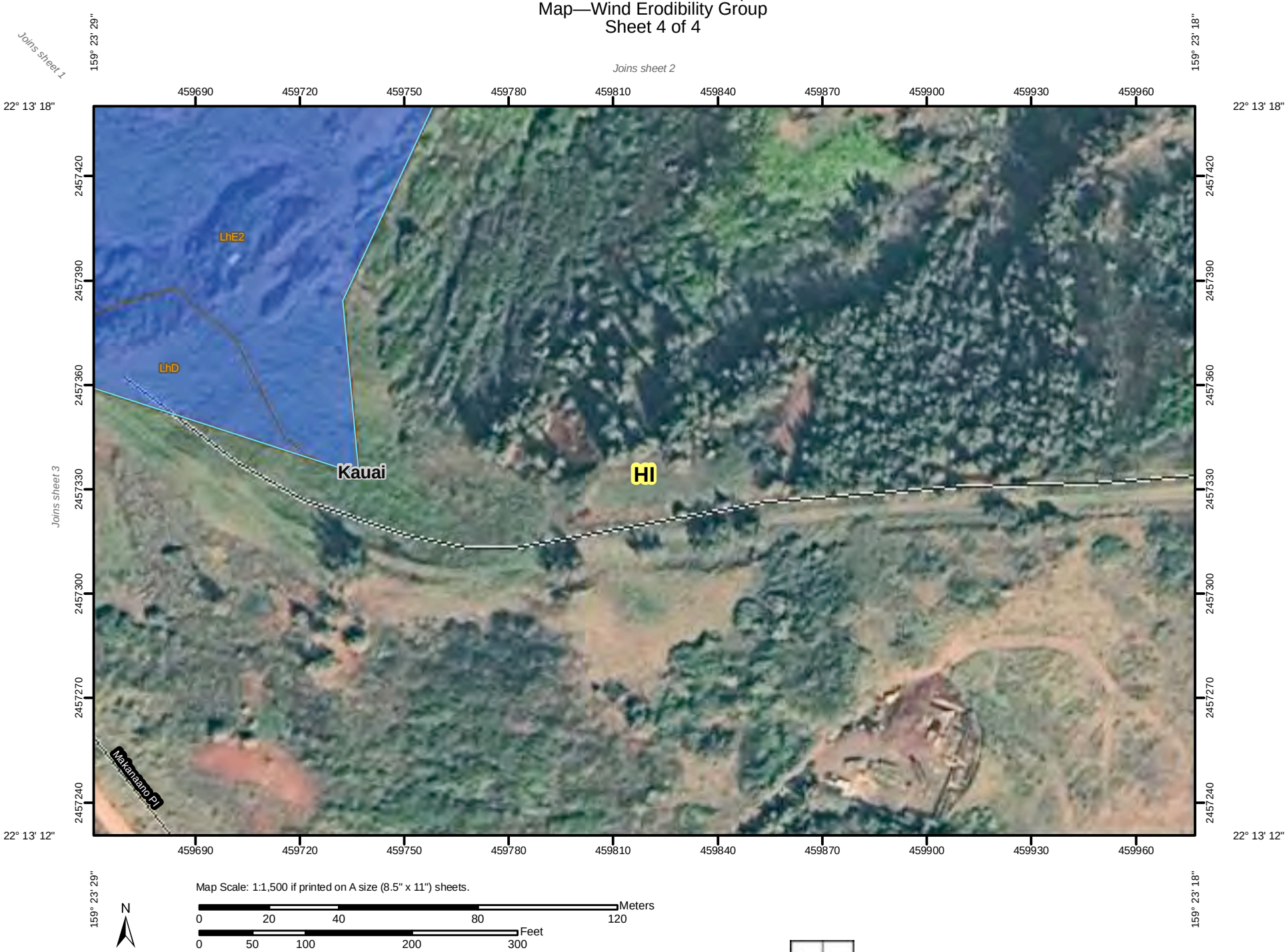
Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Custom Soil Resource Report
Map—Wind Erodibility Group
Sheet 4 of 4



Map Scale: 1:1,500 if printed on A size (8.5" x 11") sheets.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

1

2

3

4

4L

5

6

7

8

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

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Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 4N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

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Survey Area Data: Version 7, Sep 27, 2012

Date(s) aerial images were photographed: Data not available.

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Table—Wind Erodibility Group

Wind Erodibility Group— Summary by Map Unit — Island of Kauai, Hawaii (HI960)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
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LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded	7	5.1	65.6%
rRO	Rock outcrop	8	2.2	28.6%
Totals for Area of Interest			**7.8**	**100.0%**

Rating Options—Wind Erodibility Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

References

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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://soils.usda.gov/

Appendix E: Comments Received during Public/Agency Review Period and Service Responses

The USFWS received comments from 6 entities regarding the Draft Environmental Assessment (EA) for the NERP at Kīlauea Point NWR during the 45-day comment period (Table E-1). All written comments were reviewed and organized so that an objective analysis, summary, and presentation of the comments could be made.

Table E-1. Source of Draft EA Public Comments

Affiliation/Entities	Number of Commenters (September 16, 2013 through October 31, 2013)
Agencies	3
General Public	3
Total	**6**

Major comments received during the public comment period and how they were addressed in the Final EA are reflected below (Table E-2). However, comments concerning technical/minor edits are not reflected, but were incorporated where relevant into the Final EA. Authors of comments are included in parentheses.

Table E-2. Summary of Comments and Service Responses

Comment	Response
The project must be consistent with specified state water quality criteria and state water quality standards (Hawai‘i DOH).	Clarifying text noting existing condition at site involves erosion and noticeable runoff during major rain events (due to soils, cliffs, and natural erosion processes) was added to Section 3.1.3 in Chapter 3; clarifying text noting project designed to be consistent with state water quality standards was added to Section 4.3.2 in Chapter 4.
NPDES permit may be required (Hawai‘i DOH).	Clarifying text listing required permits was added to Section 1.6 in Chapter 1. NPDES not anticipated due to small scale of project (less than one acre disturbed) and project not anticipated to substantially alter the quality or quantity of any discharge.
Work involving waters of the US may require a permit from the US Army Corps of Engineers (Hawai‘i DOH).	Clarifying text listing required permits was added to Section 1.6 in Chapter 1. Army Corps permit not anticipated because project does not involve work in, over or under US waters.

Comment	Response
Impact on public access to areas adjacent to the project location that are visited by the public (Kīlauea Point, Kīlauea Lighthouse, cultural resources in general vicinity) from construction of the fence should be more thoroughly addressed (Hawai‘i OP).	Clarifying text regarding the location of the project site away from public transit routes and planned timing of construction to minimize impact to public visitation was added to Section 4.6 of Chapter 4.
The Final EA should include a list of any permits or approvals this project may require (Hawai‘i OP).	Clarifying text listing required permits was added to Section 1.6 in Chapter 1.
Recommend review of *Hawaii Watershed Guidance* for management measures to minimize coastal nonpoint pollution impacts (Hawai‘i OP).	*Hawai‘i Watershed Guidance* was added to the References in Chapter 5; clarifying text incorporating management measures was added to Section 2.3 of Chapter 2.
The DEA contains no reference to the Kaua'i Seabird Habitat Conservation Plan (KSHCP), currently in preparation (Planning Solutions).	Clarifying text listing KSHCP was added to Section 1.3 of Chapter 1.
KIUC and the KSHCP have had difficulty finding locations to do colony management and predator control work to benefit seabirds. There may be opportunities for Kaua'i Island Utilities Cooperative and KSHCP to coordinate their HCP efforts as part of the NERP (Planning Solutions).	Clarifying text noting that a portion of the NERP funding comes from fines associated with the settlement of criminal cases related to the past take of endangered seabirds, while KSHCP efforts focus on mitigating the effects of current and future take of endangered seabirds, was added to Section 1.3 of Chapter 1.
Recommend that specified invasive species protocols (steam clean vehicles, trailers, and equipment) be placed in the contract for construction and recommending the fence corridor and access be sprayed with herbicide (FWS National Invasive Species Program).	Clarifying text regarding invasive species protocols was added to Chapter 2.