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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

January 21, 2015

Director Jessica Wooley
Office of Environmental Quality Control
Department of Health, State of Hawai'i
235 S. Beretania Street, Room 702
Honolulu, Hawai'i 96813

Dear Director:
With this letter, the Division of Forestry and Wildlife hereby transmits the draft environmental assessment and anticipated finding of no significant impact (DEA-AFONSI) for the Waiākea Timber Management Area Sustainable Commercial Harvest of Timber situated at (3) 1-8-012:001 (3) 2-4-008:001, (3) 2-4-008:006, (3) 2-4-008:010, and (3) 2-4-008:022, in the South Hilo and Puna Districts on the island of Hawaii for publication in the February 8, 2015 edition of the Environmental Notice.

Enclosed is a completed OEQC Publication Form, one copy of the DEA-AFONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted the summary of the action in a text file by electronic mail to your office.

If there are any questions, please contact Sheri Mann at (808) 587-4172.

Sincerely,

Lisa J. Hadway, Administrator
Division of Forestry and Wildlife

AGENCY ACTIONS
SECTION 343-5(B), HRS
PUBLICATION FORM (FEBRUARY 2013 REVISION)

Project Name: Waiākea Timber Management Area Sustainable Commercial Harvest of Timber
Island: Hawaii
District: South Hilo and Puna Districts
TMK: (3) 1-8-012:001 (3) 2-4-008:001, (3) 2-4-008:006, (3) 2-4-008:010, and (3) 2-4-008:022
Permits: BLNR approval
Proposing/Determination Agency: Department of Land and Natural Resources, Division of Forestry and Wildlife, 1151 Punchbowl St. Rm 325, Honolulu, HI 96813, Sheri S. Mann, (808) 587-4172
(*Address, Contact Person, Telephone*)
Accepting Authority:
(*for EIS submittals only*)
Consultant: Anden Consulting, 2812-B Kalihi Street Honolulu, HI 96819, Christen Mitchell, (808)222-7877
Status (check one only):

X DEA-AFNSI	Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin.
__FEA-FONSI	Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.
__FEA-EISPN	Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin.
__Act 172-12 EISPN	Submit the proposing agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqchawaii@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin.
__DEIS	The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin.
__FEIS	The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.
__ Section 11-200-23 Determination	The accepting authority simultaneously transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the proposing agency. No comment period ensues upon publication in the periodic bulletin.
__Section 11-200-27 Determination	The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.
__Withdrawal (explain)	

Summary (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page)**:**

The Division of Forestry and Wildlife (DOFAW) proposes to commercially harvest timber from the Waiākea Timber Management Area (WTMA) through a Request for Proposal process and subsequent issuance of a timber land license. The proposed action involves the use of State land, including those within the Conservation District. As such, the proposed action requires an environmental assessment pursuant to Hawai‘i Revised Statutes (HRS) Chapter 343. An environmental assessment was previously prepared in 1999 for similar activities, resulting in a finding of no significant impact. The intent of this environmental assessment is to update the analysis to reflect changes in the surrounding environment over the past fifteen years.

Project activities will include road maintenance, timber harvesting, site preparation, reforestation and other forest management practices for timber stand improvement. Strict adherence to the State's Best Management Practices for Maintaining Water Quality in Hawaii (BMPs) and to the management objective of sustainable, long-term forest plantation productivity will minimize impacts to the physical environment.

DRAFT

ENVIRONMENTAL ASSESSMENT

Waiākea Timber Management Area

Sustainable Commercial Harvest of Timber

JANUARY 2015

Prepared by:
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813

with assistance from
Anden Consulting
2812-B Kalihi Street
Honolulu, HI 96819

In accordance with
Chapter 343, Hawai‘i Revised Statutes

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APPENDICES

I. SUMMARY

Project Name	Sustainable Commercial Harvest of Timber
Project Location	Waiākea Timber Management Area Island of Hawai‘i South Hilo and Puna Districts Upper Waiākea, Waiākea and ‘Ōla‘a Forest Reserves
Land Use	Forest Reserve

TMKs	State land use	County zoning
(3) 1-8-012:001	Conservation	none
(3) 2-4-008:001	Conservation	none
(3) 2-4-008:006	Conservation	none
(3) 2-4-008:010	Conservation	A-3(a)
(3) 2-4-008:022	Conservation	none

Proposing Agency	Department of Land and Natural Resources Division of Forestry and Wildlife
Anticipated Determination	Finding of No Significant Impact

Summary of Action
The Division of Forestry and Wildlife (DOFAW) proposes to commercially harvest timber from the Waiākea Timber Management Area (WTMA) through a Request for Proposal process and subsequent issuance of a timber land license. The proposed action involves the use of State land, including those within the Conservation District. As such, the proposed action requires an environmental assessment pursuant to Hawai‘i Revised Statutes (HRS) Chapter 343. An environmental assessment was previously prepared in 1999 for similar activities, resulting in a finding of no significant impact. The intent of this environmental assessment is to update the analysis to reflect changes in the surrounding environment over the past fifteen years.

The project area is located in the Upper Waiākea, Waiākea and ‘Ōla‘a Forest Reserves. The WTMA was established to create a forest resource base that could provide a consistent wood and forest products supply to stimulate the forest product industry in Hawai‘i. Major planting efforts began in 1959; timber inventory data indicates that the WTMA in its current configuration contains approximately 16,000,000 cubic feet of gross merchantable timber, primarily composed of Queensland maple (*Flindersia brayleyana*), *Eucalyptus saligna* and *grandis*, Australian toon (*Toona ciliata*), and

tropical ash (*Fraxinus uhdei*).

Project activities will include road maintenance, timber harvesting, site preparation, reforestation and other forest management practices for timber stand improvement. Strict adherence to the State's *Best Management Practices for Maintaining Water Quality in Hawaii* (BMPs) and to the management objective of sustainable, long-term forest plantation productivity will minimize impacts to the physical environment.

The benefits of guiding public timber and forest product assets into local processing facilities include immediate economic gain to the local economy, creation of high quality jobs for the local community, and establishment of a more productive forest product industry in the State of Hawai'i. It also provides a more consistent source of revenue to DOFAW to improve forest management throughout Hawai'i island. Primary anticipated impacts of project activities include the potential spread of invasive species, temporary disruption of existing recreational activities within the WTMA, and impacts on local traffic.

II. PROJECT PURPOSE AND NEED

The Waiākea Timber Management Area was established for commercial forest products harvesting – to provide a consistent wood supply to support the development of a forest products industry. In 1956, the Waiākea Arboretum was created to test adaptability and growth potential of 84 introduced timber species, clearing of the WTMA by bulldozer occurred between 1959 and 1968, and major planting efforts began in 1959. These efforts continued into the mid-1970s, planting an estimated 2.3 million trees. Another 330 acres formerly leased to the Puna Sugar Company was planted in the early 1980s.

In 1997, a forest timber survey was conducted to determine timber species volume and to obtain data on tree species size and density. The timber survey data revealed a gross volume of over 17 million cubic feet of merchantable timber resources for trees with diameters greater than four inches in diameter at breast height. Based on the timber survey, the WTMA has an estimated economic stumpage value of several million dollars; actual revenue depends on the markets currently available for the timber resources. The value-added economic gain to the local economy is estimated to be greater than the actual stumpage value, by providing primary and secondary employment, by providing a local source of wood for wood products, and by contributing to energy security as a biofuel source.

DOFAW has received previous requests from the private sector for access to the timber within the WTMA, from those interested in wood chips, veneer, plywood, lumber, biofuel, and other higher value wood products, such as molding, paneling, flooring, furniture, and turning stock (e.g., for bowls). From 1985 to 1988, the State and the Puna Sugar Company entered into a timber harvest agreement for approximately 1,500 acres of Eucalyptus. The harvested trees were converted to wood chips and used to produce power at a local electrical generator plant, and the harvested area was replanted with Eucalyptus. From 2001 to 2011, most of the WTMA (approximately 68%) was under a timber land license agreement with Tradewinds Forest Products. Tradewinds intended to harvest approximately 500 acres per year to provide raw materials for a mill that was never constructed. Due to a myriad of start-up problems, very little timber was harvested from WTMA. As of July 2014, approximately 1,000

acres of WTMA remain under a timber land license. To date, little to no harvesting of planted hardwoods has occurred with the exception of small-scale timber salvage operations, where commercial value did not exceed $1,000. The timber resources of WTMA continue to mature.

Sustainable commercial harvest of the WTMA is proposed to effectively utilize existing aging timber resources and enhance the long-term health of the forest in this area. The proposed commercial harvest of WTMA implements the original purpose of the WTMA as it incorporates sustainable forestry techniques to provide a consistent wood supply. A sustainable commercial harvest operation in the WTMA will provide a model for developing and utilizing timber management areas on other islands and support the growth of a sustainable forest products industry in Hawai‘i. The island of Hawai‘i is arguably the best location in the State to stimulate a local forest products industry because of the good site conditions (soil, precipitation, etc.), higher unemployment rates, thousands of acres of forest and potential forest land, and a modest existing commercial forest resource base that can support a range of value-added forest processing options.

Historically, the economics of forestry operations in Hawai‘i have been variable. Some planted species have not succeeded, most timber plantations have not been effectively managed to maximize timber value, local processing opportunities have been limited, and the remote location and relatively small (compared to mainland forests) timber resource base increases costs of harvest. However, DOFAW believes that guiding public timber assets into capable local processing operations/facilities can support jobs for the local community and supplement local energy needs. DOFAW further believes that WTMA can be economically profitable, while accommodating recreational uses and supporting a healthy forest. All revenues received by the State will be deposited into the Forest Stewardship special fund to be used for future forest management, pursuant to HRS §195F-4.

As required by Hawai‘i Revised Statutes §183-16.5, the Board of Land and Natural Resources (Board) must approve a Forest Management Plan before a single tree can be harvested on state-owned land. In 1999, both a management plan and an environmental assessment were completed by DOFAW for the purpose of commercial harvest and reforestation of the WTMA, and a timber license was issued in 2001. As DOFAW prepares to conduct an RFP to issue a new timber land license or licenses, the previous management plan has been revised (and is attached as Appendix B) and this Draft Environmental Assessment (DEA) has been prepared to reflect changes that have occurred in the environment and communities in this area.

III. SCOPING AND PUBLIC PARTICIPATION

A formal scoping letter was sent to a variety of Federal, State, and Hawai‘i county agencies, community groups, non-profits, and interested individuals in March 2012 by postal mail and by email. The list of consulted parties is included as Appendix A. Oral comments were received from three individuals; written comments were received from Hawai‘i Volcanoes National Park, DLNR-State Historic Preservation Division, DLNR-Office of Conservation and Coastal Lands, the State Department of Hawaiian Home Lands, the State Department of Health, the State Department of Transportation, the County of Hawai‘i Planning Department, County of Hawai‘i Department of Research and

Development, County of Hawai‘i Fire Department, Mauna Kea Recreational Users Group, Big Island Mountain Bike Association, and an individual. Copies of the letters are included as Appendix H. Overall, initial public response to the project has been generally positive.

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

- recommendation for an archaeological inventory survey within the lower elevations of the project area;
- potential impacts on State highways of transporting oversized and/or overweight materials;
- potential impact on traffic;
- impact of timber management on native species;
- concern regarding access to timber for local woodworkers;
- potential impact to existing recreational uses in WTMA;
- the potential for introduction or spread of invasive plant species;
- potential impacts on bats; and
- the need for reforestation after harvest.

Issues raised in the 1999 Forest Management Plan providing for commercial harvest included:

- possibility of watershed degradation;
- past military dumping of chemical agent canisters;
- replanting the site with nitrogen fixing plants or bamboo and rattan;
- availability of job opportunities for local people; and
- availability of area for hunting, recreation, and non-wood forest product gathering.

IV. PROJECT DESCRIPTION

A. Overview

DOFAW proposes to sustainably harvest timber from WTMA through the issuance of a Request for Proposals resulting in a timber land license agreement or agreements. As outlined in the WTMA Draft Forest Management Plan, commercial harvest within the WTMA will be guided by the following 8 principles:

1. The State should utilize its land and timber within the WTMA to maximize local processing where feasible, create jobs, and encourage development of *integrated processing facilities* that provide suitable outlets for the range of species and grades of wood that currently exist. The availability of plantation forest resources within the WTMA could allow for development of a variety of wood processing plants (e.g., lumber and veneer), and biomass power or biofuels facilities. This will provide *immediate employment opportunities*. It will also encourage other investors and landowners to become involved in plantation forestry at the onset, stimulating additional employment opportunities. DOFAW should also look at current market and future demand projections, to help decide what will be the most valuable and in-demand timber to replant.

2. Effective soil erosion control practices, including harvesting methods and replanting, safe use of herbicides, and visual buffers along major transportation corridors will be required for all commercial forest operations within the WTMA as outlined in the State's Best Management Practices.

3. The State will evaluate all non-native species proposed for planting for potential invasiveness utilizing the Hawai‘i Weed Risk Assessment and other relevant information.

4. The need to *involve the public* in project planning and development is important to account for the appropriate use of the resources, especially when it affects the local communities. Careful integration of timber management with *hunting, recreational, and gathering activities* will aid in developing community support for growing and processing timber resources.

5. A portion of the timber within WTMA should be reserved to *supply local entrepreneurs and small businesses*, thus increasing community recognition regarding the economic opportunities offered by sustainable forest management. This reservation percentage will be based on the amount of local demand. The *higher value timber* within the WTMA can provide wood needed to take advantage of new forest marketing programs to stimulate the creation of *niche market for locally grown woods*. Portions of the WTMA should also be used for the development of non-timber forest products.

6. The public forest estate in Hawai‘i has a *low level of public investment* (e.g., one forester per 150,000 acres of public forest reserve on the island of Hawai‘i); in order to manage the WTMA sustainably, a portion of the timber proceeds should be reinvested back into the forest.

7. Timber management and research activities in the WTMA can provide a valuable educational role in extension and training, contributing practical information to both government and private sectors, while helping create a professional forestry work force.

8. There will be no timber harvesting, forest clearing, or other commercial timber operations within designated native forest sections of the WTMA.

Sustainable timber harvest in WTMA will involve the following activities:

1) repair and maintenance of existing forest road infrastructure,
2) harvesting of timber,
3) replanting of harvested areas,
4) management of planted areas, and
5) transport of harvested timber and other forest products from WTMA.

Implementation of a timber license agreement will also require DOFAW staff time for monitoring compliance with DOFAW's conditions by the licensee.

DOFAW will require all bids received for harvesting within WTMA to include at minimum:

- identification of areas and species to be harvested,
- anticipated markets for harvested timber,
- detailed information about harvest methods,
- site preparation methods for replanting,
- replanting plans (including species selection variations),
- timber stand improvement methods,
- transportation plan,
- timeline for proposed activities,
- sanitation and invasive species protocols, equipment staging locations, equipment cleaning, and other related activities, and
- any planned mitigation measures.

In addition, DOFAW will require that all harvest activities comply with the measures listed in the State's *Best Management Practices for Maintaining Water Quality in Hawaii* (BMPs) (attached as Appendix C). Developed in 1996, these practices can be used to minimize the impact of forestry practices on water quality and cover the following topics: roads, timber harvesting, chemical management, streamside management, fencing, wildlife damage control, fireline construction, prescribed burn, and reforestation. Finally, DOFAW will require that all harvest activities comply with the mitigation measures outlined in the Final EA.

Within the WTMA, approximately 779 acres of native forest (defined as areas containing 50 percent or more native forest cover) remain. Commercial timber harvest will not occur in these areas. The primary goal in these areas will be forest protection and they will remain accessible for traditional gathering of forest resources, research, hunting, and recreation.

B. Repair and maintenance of existing forest road infrastructure

Approximately 130 miles of unimproved access roads grid the WTMA into 245 40-acre blocks. These roads can be utilized for timber harvest purposes, and with this network of roads in place, no new permanent roads need to be constructed. Improvements to the existing road, such as clearing, grading, or reconstruction of water bars, dips, culverts and cross drainages, may be required to accommodate harvesting activities and to repair or restore the existing roads after harvesting activities are complete. Temporary skid trails, used to move logs from the forest to the landing area, and landings, where logs are loaded into trucks for transportation, will be permitted, with locations determined in advance after collaboration with DOFAW. Temporary trails and landings will be allowed to revegetate naturally or artificially revegetated after harvesting activities are complete. All roads, skid trails, and landing sites utilized within the WTMA must be mapped and approved by DOFAW prior to any harvest activities.

Because forest roads have the potential to create more erosion than any other forestry activity, all improvements and maintenance of the existing access roads and all work related to temporary skid trails will conform to the BMPs reprinted in Appendix C. Maintenance of active and inactive roads will

be sufficient to maintain a stable surface and keep the drainage system operating. The following practices are to be incorporated:

1) maintenance will include cleaning dips and crossdrains, repairing ditches, marking culverts inlets to aid in location, and clearing debris from culverts;
2) keep culverts, flumes and ditches functional before and during the rainy season to diminish the danger of clogging and the possibility of washouts;
3) conduct road surface maintenance as necessary to minimize erosion of the surface and subgrade;
4) during operations, keep the road surface crowned or outsloped and keep the downhill side of the road free from berms except those intentionally constructed for protection of fill;
5) avoid using roads during wet periods if such use would likely damage the road drainage features; and
6) water bars will be inspected after major rain storms and damage should be promptly corrected.

In addition, the following practices are to be incorporated during establishment and use of skid trails and landings:

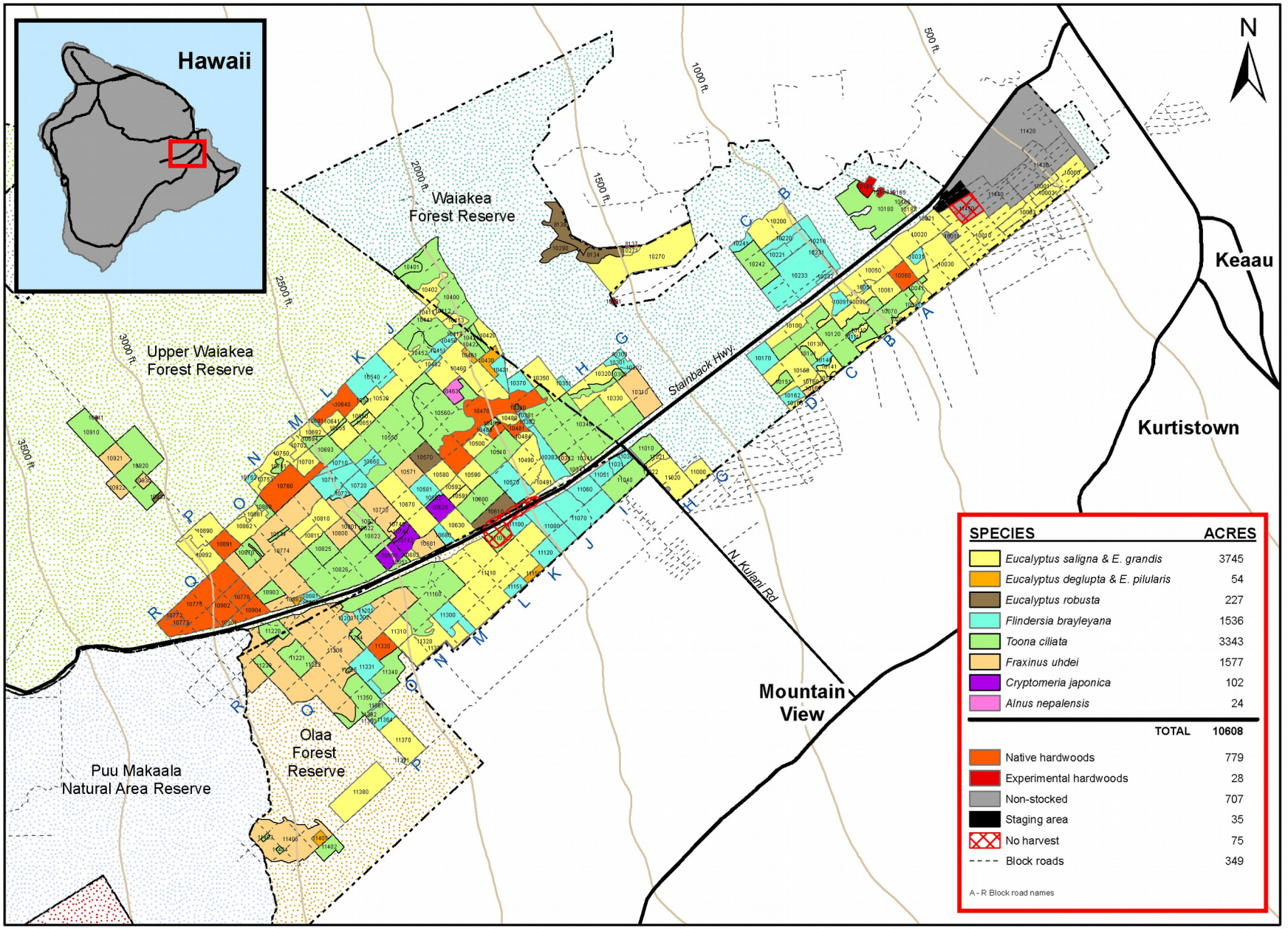
1) location of temporary access roads will be planned before operations begin;
2) road construction will be kept to a minimum;
3) landings will be located to minimize the adverse impact of skidding on the natural drainage pattern;
4) logging roads and landings will be located on firm ground;
5) landings will be kept as small an area as possible;
6) when operations are completed, provisions will be made to divert water run-off from the landings and roads.

C. Harvest of timber

Timber inventory data from 1997 indicated that the WTMA in its current configuration contains over 17 million cubic feet of timber on a gross merchantable basis. This timber is not uniform; as noted earlier, DOFAW planted different species throughout the WTMA in 40-acre blocks. There are approximately 4,026 acres of *Eucalyptus* species, 3,343 acres of Australian toon, 1,577 acres of tropical ash, and 1,536 acres of Queensland maple (see Figure 1). The remaining acreage is generally composed of other introduced timber species (including Sugi pine (*Cryptomeria japonica*) and Nepal alder (*Alnus nepalensis*)), native forest (approximately 779 acres), or is considered non-stocked (generally former sugar land that has not yet been planted with timber species).

The timber species have different potential uses and vary in their potential economic value, due to differences in physiology and their suitability for site conditions.

Figure 1. Waiakea Timber Management Map
Primary Tree Species - Based on 1997 Timber Inventory



State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
October 2013

0 0.5 1 2 3 4 Miles

HAWAII STATEWIDE GIS PROGRAM

Table IV-1: Timber Species of WTMA

Tree species (common name)	**Scientific name**	**Likely Use; Other uses**	**Acreage in WTMA**	**Estimated volume (ft3)**	**Estimated board foot (BF)**
Sydney bluegum and grand eucalyptus	*Eucalyptus saligna & E. grandis*	Biofuel; paper production, saw timber, veneer	3,745	8,176,042	37,132,760
Swamp mahogany	*E. robusta*	Wood products; biofuel	227	1,007,433	4,816,112
Rainbow eucalyptus and Blackbutt eucalyptus	*E. deglupta & E. pilularis*	Biofuel; saw timber	54	88,711	401,217
Australian toon	*Toona ciliata*	Wood products; biofuel	3,343	2,588,887	9,504,944
Tropical ash	*Fraxinus uhdei*	Biofuel	1,577	863,971	3,324,086
Queensland maple	*Flindersia brayleyana*	Wood products; biofuel	1,536	2,539,213	10,287,031

Most commercial species of *Eucalyptus* are well suited to the growing conditions found in the WTMA. Rapid growth rates, high yields, and straight form of these trees make some of them desirable for a wide variety of processing opportunities including lumber, veneer, plywood, and biofuel. Rapid growth though, can cause processing issues for some species, such as *E. saligna*, but use of newer hybrids may reduce this issue. *Eucalyptus robusta* is currently considered more valuable than *E. grandis, E. saligna, E. deglupta,* or *E. pilularis* due to its site adaptability, high wood quality, and local and regional markets for this wood. Although *Eucalyptus* species have the potential, in general, to spread into adjacent areas under certain conditions, the planted species of *Eucalyptus* have not done so in the 45-plus years since the establishment of the WTMA plantations. Most *Eucalyptus* stands are mature and ready for harvest.

Queensland maple has also proven to be well adapted to the growing conditions in the WTMA. This species produces a high quality, light colored wood with potential use for finish grade lumber, veneer, plywood, and for value added operations such as flooring, paneling, molding, furniture, and cabinet making. As with the *Eucalyptus*, a range of stand ages and tree sizes are present, allowing

for both immediate harvest opportunities and new plantings. At present, the size and value of the commercial market for Queensland maple is unknown.

Large areas of WTMA were also planted with Australian toon and tropical ash. Australian toon grew well only on the best quality sites, but poorly elsewhere, and tropical ash was poorly adapted to local site conditions. After 45-plus years' growth, most of these species' stands only contain scattered pole sized trees and some areas have regenerated into native forest. The commercial value of the Australian toon and tropical ash is unknown, and these timber species are most likely to be utilized for biomass or biofuel purposes. Other timber species in the WTMA include Sugi pine (102 acres), Nepal alder (24 acres), and other introduced timber species covering small areas.

Timber harvest begins with the preliminary actions required before any cutting takes place. Preliminary actions include identification of harvest areas, on-site surveys for endangered species and archaeological features, development of a harvest plan that identifies access routes, skid trails, and landing areas, expected timing of actions, and site-specific best management practices to be incorporated, and mobilization of heavy equipment to the site.

Actual harvest involves several steps: 1) felling, or cutting, the trees; 2) bucking the cut tree, which involves removing the branches and if necessary, cutting the tree into logs; 3) extracting the logs from the felling site in the forest to a landing area, using ground-based mechanical systems; and 4) loading the cut logs onto trucks for transportation off-site for processing.

Best management practices to be incorporated during harvesting include

1) careful felling of trees to minimize damage to the tree, adjacent timber, and native forest adjacent to but outside the WTMA;
2) avoiding use of existing road ditches as skid trails;
3) use of water bars for skid trails on steep slopes;
4) servicing equipment involving fuel, lubricants, or coolants in places where the materials cannot enter streams; and collecting used oil and other liquids for proper disposal (not poured on the ground); and
5) mulching or seeding erosion-prone areas upon completion of logging.

DOFAW will not prescribe a specific management regime for harvesting timber with the WTMA (e.g., regeneration harvest vs. selective harvest of specific trees). Due to the age of the trees, efficiency considerations related to mobilizing equipment and labor, and replanting considerations, DOFAW recognizes that cutting entire stands will be necessary. At the same time, DOFAW acknowledges the public perception and visual impacts related to regeneration harvest of large areas. Therefore, to address these concerns, harvesting restrictions for the WTMA include:

- Regeneration harvest, where previously planted trees and other vegetation are cleared, is limited to 40-acre blocks,
- Adjacent 40-acre blocks may not be harvested simultaneously,
- Harvested blocks must be replanted within six months, and new growth must reach 15 to 20 feet

tall, before adjacent blocks may be harvested,
- Up to 600 acres of regeneration harvest may be done annually,
- Thinning and selective tree removal may occur in other units (in addition to the 600 acres), and
- DOFAW may identify specific tree(s) to be left standing for visual buffers, wildlife habitat, or other reasons.

Restricting harvest of entire stands to 600 acres a year provides a secondary benefit of facilitating a sustained supply of timber from the WTMA over time. The proposed annual harvest of 600 acres or less is approximately 6% of the total area shown in Table IV-1, page 12.

In addition, timber felling will not be allowed between June 1 and September 15 due to potential impacts to the Hawaiian hoary bat, or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*). However, this restriction may be lifted upon additional surveys and the development and implementation of additional mitigation actions, if DOFAW Wildlife staff and the US Fish and Wildlife Service (USFWS) concur that the proposed mitigation actions will adequately protect the bat from take during ongoing harvesting activities. Other project activities, including loading and transporting timber, road maintenance, site preparation, and replanting may still occur within the WTMA during the "no-harvest" period.

D. Treatment of site post-harvest and replanting of harvested areas

Timber harvesting creates woody debris, called slash, composed of treetops and branches left behind after the cut logs are removed. Slash may be used in areas of soft-ground to create a pad for vehicles and to skid logs to mitigate erosion and reduce soil disturbance. Given the historic high precipitation in the area, most of the slash is expected to decompose and compost in place, which will enhance soil productivity by introducing more organic material into geologically young soil parent material. It may also be chipped or masticated with equipment, and incorporated into site planting preparation as mulch to reduce competition from grasses and introduced woody shrubs. In general, if too much slash is left behind, it may increase fire hazards at the harvest site. However, due to the wet conditions within WTMA, decomposition is expected to be accelerated and in most cases, what slash is left will be required to be scattered and under 36 inches in height, and also may be crushed further with a dozer. This material may be available to local markets should there be interest.

The harvest plan prepared before any harvesting activities will outline the specific methods to address slash for each 40-acre block. In general, the following options are recommended, listed in preferential order:

1) lop all logging debris such that it lies within 36 inches of the ground surface and away from stumps;
2) scatter and crush logging debris with a bulldozer;
3) where necessary, pile logging debris in designated windrows or piles.

After harvest, regrowth from stumps and roots (coppicing) and from seed fall may interfere with replanting activities. Herbicides may be utilized, following all applicable state and federal regulations

and label restrictions, to reduce competition. *Use of fire for site preparation for replanting will not be permitted.* Mechanical crushing, mastication, or manual clearance of vegetation may be used where necessary to provide sufficient access to ground surface to permit tree planting.

The harvest plan prepared before any harvesting activities will outline replanting specifications for each 40-acre block, including planned species, density, planting method, seedling protection, source of seed or seedling stock, and minimum survival expectations, as specifications will vary depending on the micro-conditions (elevation, rainfall, etc.) at the individual site. In general, planting of seedlings will occur within six months of the harvest to minimize establishment of invasive weed species in the area.

In general, species selection will depend largely on what species was harvested, growth potential for a given site, specific qualities of a species (e.g., growth rate, disease resistance, wood characteristics, ease of removal, tolerance to volcanic emissions), seedling availability, available or future markets for the specific species, and goals for that unit. Site productivity for tree growth in the WTMA can be broadly linked to lava flow type and age. Older flows are more productive sites than younger; ʻaʻā sites are more productive then pāhoehoe. In addition, depressions in the landscape and drainage areas seem to provide the highest growth potential, due to higher accumulation of geologically recent ash deposits and perhaps soil scraped from higher ground when the area was leveled in the 1960s and 1970s. A wide range of species will be considered for replanting, including *Eucalyptus* species and native timber species such as koa (*Acacia koa*), with the understanding that all species are being planted specifically for future harvest. Tropical ash and Australian toon will not be replanted due to poor performance. All non-native species proposed for planting will be evaluated for potential invasiveness using the Hawaiʻi Weed Risk Assessment and other relevant information and will be subject to approval by DOFAW. Native species will be selected for wildlife habitat value, watershed health, and value as a future wood source for local woodworkers.

Best management practices to be incorporated during site preparation and replanting include:

1) avoiding excessive soil compaction during harvest and mechanical site preparation,
2) utilizing the minimum preparation necessary to control competing vegetation and establish a desirable timber stand,
3) ensuring that windrows, disking, bedding, and planting with furrow type mechanical planters follow contours, and
4) planting trees on contour.

E. Management of planted areas

After seedlings are planted, timber stand management is necessary to enhance and ensure planting success. Timber stand management includes manual application of commercial fertilizers, to encourage seedling survival and growth, weed control to reduce competition, side branch pruning of young tree stands, and thinning of young stands to improve stand health and vigor as the trees age. In addition, insect and disease monitoring may be conducted for known problems to tree seedlings, such as *Phytophthora cinnamomi* (root rot disease) and for insect damage such as by the black twig borer

(*Xylosandrus compactus*).

Best management practices to be incorporated during timber stand management include:

1) choosing pesticides or herbicides suitable for use on the target species and registered for the intended use by the EPA,
2) following all label directions,
3) considering site factors, application conditions and techniques, and products available, in addition to cost and effectiveness when selecting pesticide or herbicide options, and
4) incorporation of protocols for transportation, storage, use, and disposal of chemicals, to minimize opportunities for spills or contamination.

F. Transport of timber from WTMA

Timber will be yarded to landings using a variety of ground-based, mechanical means, including skidding, use of log loaders or excavators to forward logs, or possibly forwarders. Trucks would then be loaded at the log landing or within units where access and conditions permit, and would leave the WTMA, likely via Stainback Highway or North Kūlani Road, to Highway 11 and then proceed to their destination. Truck traffic volume will depend largely on harvesting activity and what timber species is being harvested. Specific truck routes will depend upon the market for the harvested timber, the size of the truck and load, and relevant state and county transportation regulations. On average, DOFAW estimates that a maximum of twenty-eight trucks per day, regularly spaced throughout the day, would leave the WTMA. This is equivalent to about one truck every 15 minutes during a normal work day.

The above estimate is based on current truck traffic associated with an existing forestry operation on the Hamakua Coast and input from other professional loggers. The Hamakua Coast operation harvests approximately 3 acres a day of high-volume Eucalyptus stands, and rarely has over 25 trucks depart in a day. If WTMA contains lower volume stands or harvesting occurs at a lower capacity, truck traffic would be expected to be reduced.

The graveling of landing areas and the pullouts onto Stainback Road will be required as necessary to minimize the amount of mud tracked onto the paved road, and the roadway condition will be monitored and swept as necessary to minimize any roadway hazards created by mud or gravelly conditions.

G. Timing

Timber harvest is expected to occur in a patchwork fashion rather than from one side of the WTMA to the other because of the conditions placed on harvest (e.g., regeneration harvest limited to 40-acre non-adjacent blocks), the patchwork nature of WTMA (different species in 40-acre blocks), logistical issues involving access and movement of equipment, and increased growth rates of potential replanted species (e.g., some Eucalyptus species are ready for harvest within five to seven years of planting). If fully implemented, the commercial harvest of the entire WTMA would be spread over the next fifteen years. The timing of harvest of specific 40-acre blocks, and of specific timber species, will be dependent on market interest.

The State anticipates releasing its RFP, selecting a contractor or contractors, and awarding a license or licenses within one year of acceptance of the Final EA for this project. Harvesting activities could begin as early as two months after award of the license, depending on the time of year and the ability of the selected contractor to complete required pre-harvest planning and obtaining any additional permits or permissions. Licenses are anticipated to have terms of 10 years, with an option to extend for another 10-year period if performance is satisfactory, with clear milestones, so that the State can terminate a license for inaction or violations of the license terms in a timely manner. DOFAW's goal is to provide sufficient long-term assurances for potential contractors to obtain loans and make the necessary investments required to start-up a commercial harvest operation in Hawai‘i, yet at the same time, prevent bidders from tying up valuable wood resources for anti-competitive purposes. The key purpose at first will be to get mature trees harvested and replant seedlings to establish the next generation of forest, while creating local jobs and possibly providing raw materials for renewable energy production.

V. ALTERNATIVES CONSIDERED

A. Actions Considered but Eliminated

This DEA evaluates the proposed action and a no-action alternative. Several other management alternatives have been considered and were eliminated from further consideration for the following reasons:

Commercial harvest of existing native forest. Due to the value of native forest for watershed and habitat purposes, commercial harvest of existing native forest stands was not seriously considered, despite the commercial value of native species for specialized woodworking.

Non-commercial removal of non-native timber. Widespread removal of *Eucalyptus*, Queensland maple, tropical ash, and Australian toon on a non-commercial basis is not feasible due to extremely high cost and difficulty. Moreover, implementation of this alternative would result in the waste of valuable timber resources that could contribute to energy production or be utilized for a variety of wood products such as saw timber or veneer and would increase hazardous fuel loading and create open spaces likely to be colonized by invasive plant species.

One-time harvest of entire WTMA. Regeneration harvest of all the timber trees within WTMA over a short period of time would result in immediate financial gain, increase the potential for short-term employment, and streamline replanting efforts. Large trees could be used as timber; smaller trees for chips or pulp. This alternative was eliminated due to the significant disruption to public use and enjoyment of WTMA, increased potential for soil erosion and water quality degradation, loss of wildlife and game habitat, visual impacts of approximately 10,000 cleared acres, impact on roads and traffic of moving that volume of timber over a short period, and inability of this method to support the development and growth of a forest products industry due to its failure to provide a consistent stream of timber resources.

B. No Action Alternative

The No-Action Alternative would entail a continuation of the current management activities, without any commercial harvesting. Current management of the WTMA includes basic maintenance of roads for recreational access and use, oversight of the ATV park, rubbish removal, sign maintenance, and removing hazard trees in areas of high use. More intensive forest management would not be anticipated to occur because funding for forest management is limited and dependent on government appropriations, and DOFAW has limited staff and equipment on-hand.

The positive impacts include no disruption to the public use of the WTMA, no disruption to existing traffic patterns, and a higher aesthetic quality of the environment for those who oppose any commercial timber operations. The negative impacts of this alternative are increasing natural mortality due to increased susceptibility to insects and disease, continued expansion of invasive plant species, loss of economic return to the community and the state, loss of a potential revenue stream that would support forest health management, and reduced likelihood of establishing a sustainable forest products industry due to limited availability of raw material.

C. Proposed Action

The proposed action is to sustainably harvest the Waiākea Timber Management Area and reforest the harvested areas with appropriate timber species for future harvests and markets. The project area was established for commercial timber production, while accommodating other forest uses such as recreation, research, and wildlife habitat. Timber growth in much of the project area is minimal and harvest would present the opportunity to replant with more valuable and faster growing species.

Positive impacts of this alternative include enhancement of the productivity and health of Hawaii's forests, creation of local jobs and increased economic value through local processing, continued public use of the area, and improvement of the local and state economy. Potential negative impacts include the potential spread of invasive species within and outside the WTMA, temporary disruption to recreational users, increased truck traffic on rural roads during harvest, and temporary decline of visual quality in harvested areas.

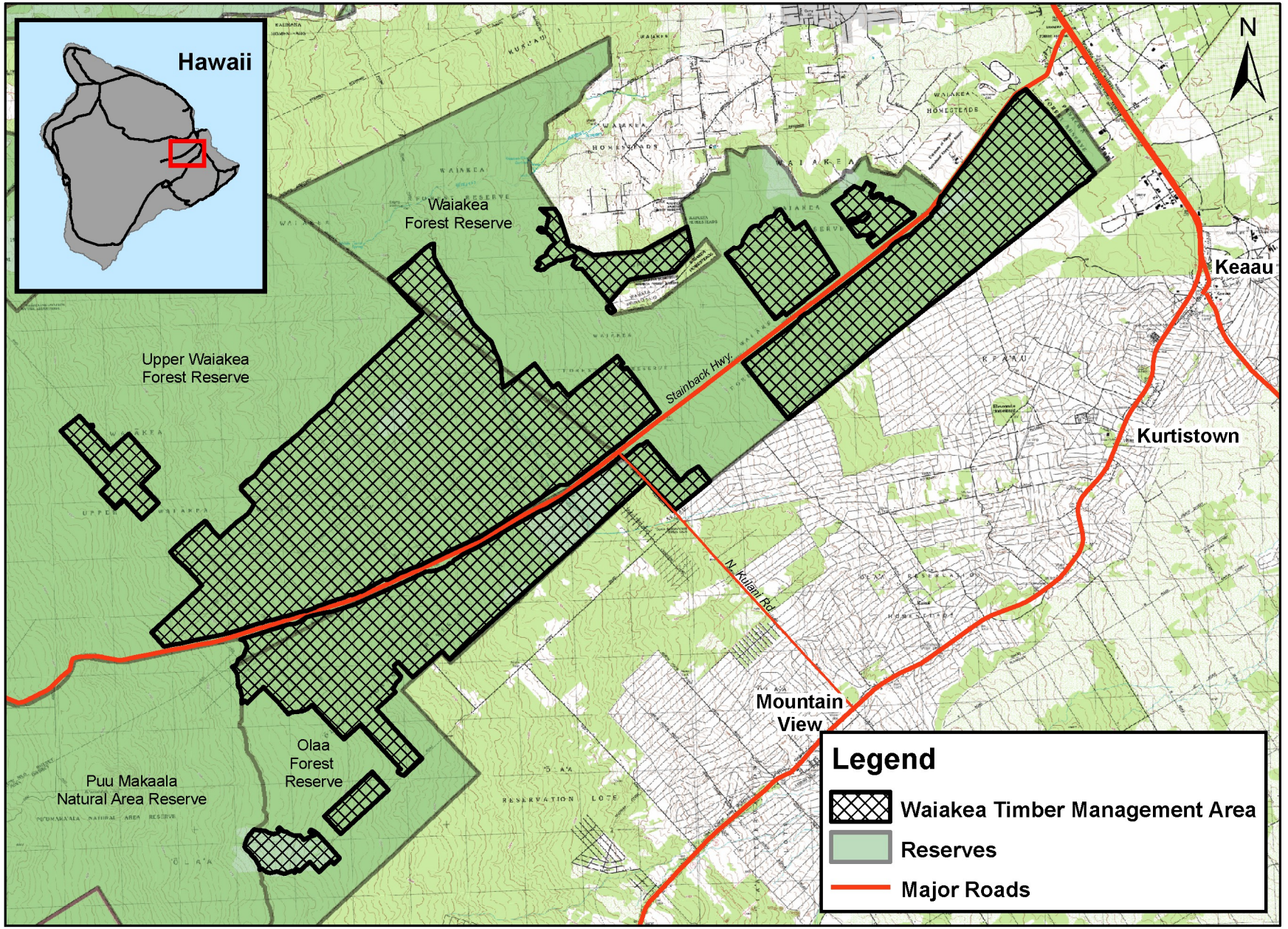
VI. SUMMARY DESCRIPTION OF AFFECTED ENVIRONMENT

A. Physical Environment

Location

The WTMA is located on the slopes of Mauna Loa volcano, approximately five miles southwest of Hilo town along the Stainback Highway, within the South Hilo and Puna Districts (Figures 2, 3) The 12,506 acre WTMA is comprised of 5 discrete parcels within the Waiākea (WFR), Upper Waiākea (UWFR), and ʻŌlaʻa Forest Reserves (OFR) where timber species were deliberately planted.

Figure 2. Current extent of Waiakea Timber Management Area



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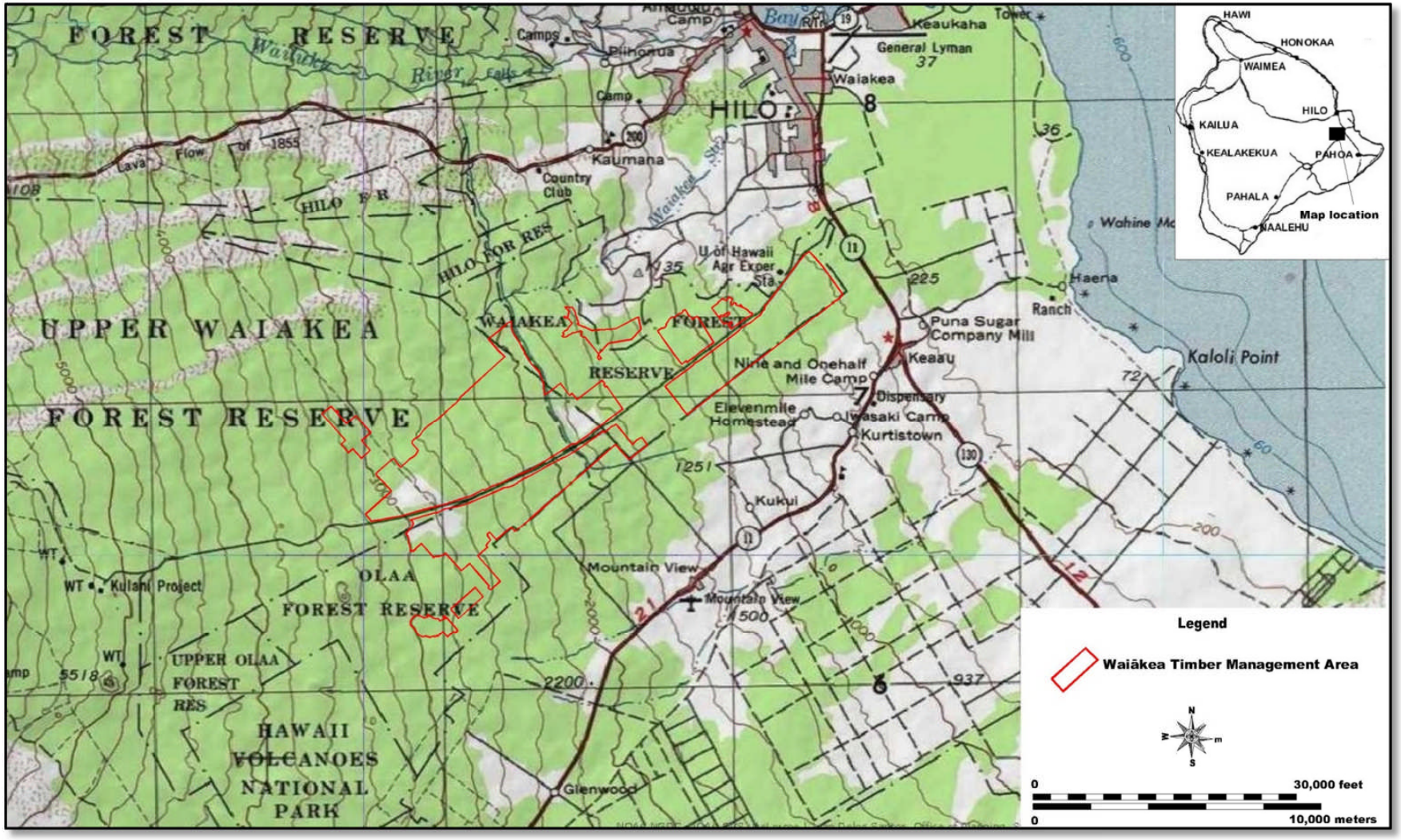


Figure 3. **Portion of USGS 7.5' Hilo (1995), Mountain View (1981) and Puu Makaala (1981) quadrangles showing the Waiākea Timber Management Area**

The WTMA occupies lands in the ahupuaʻa of Waiākea and ʻŌlaʻa, extending from approximately 400 to 3,200 feet in elevation (Figure 4). It is situated on relatively young, shallow ʻaʻā and pāhoehoe lava flows ranging in age from 150 to 9,000 years old, with the majority of the WTMA (71%) on lava flows dating between 750 to 1,500 years ago. Slopes within the WTMA are constant, averaging six percent (except in ravines where the slopes can exceed 45 percent).

The WTMA is bisected by the Stainback Highway that extends inland from Highway 11 and North Kūlani Road, which runs from Highway 11 near Mountain View towards Mauna Loa. Approximately 130 miles of unimproved access roads (with varying degrees of overgrowth) grid the WTMA into 245 40-acre blocks. Stainback Highway terminates at the newly reopened Kūlani Correctional Facility, a minimum security facility for approximately 200 inmates. Other land uses in the surrounding area include Waiākea Forest Reserve, Upper Waiākea Forest Reserve, ʻŌlaʻa Forest Reserve, Puʻu Makaʻala Natural Area Reserve, and rural residences.

Soils

Soils in the WTMA are thin, extremely stony (stones between 10 and 24 inches in diameter comprise at least 60 percent of the volume), and have formed over ʻaʻā and pāhoehoe lava. The soils are made up of "muck," which is well-decomposed organic soil material. The soils are well drained, with rapid permeability, slight erosion potential, and slow to medium runoff. Where the soil overlies ʻaʻā lava, the substrata is also rapidly permeable. Although the pāhoehoe lava is slowly permeable, water moves rapidly through cracks in the lava. In some low-lying areas, swampy conditions may occur.

Water

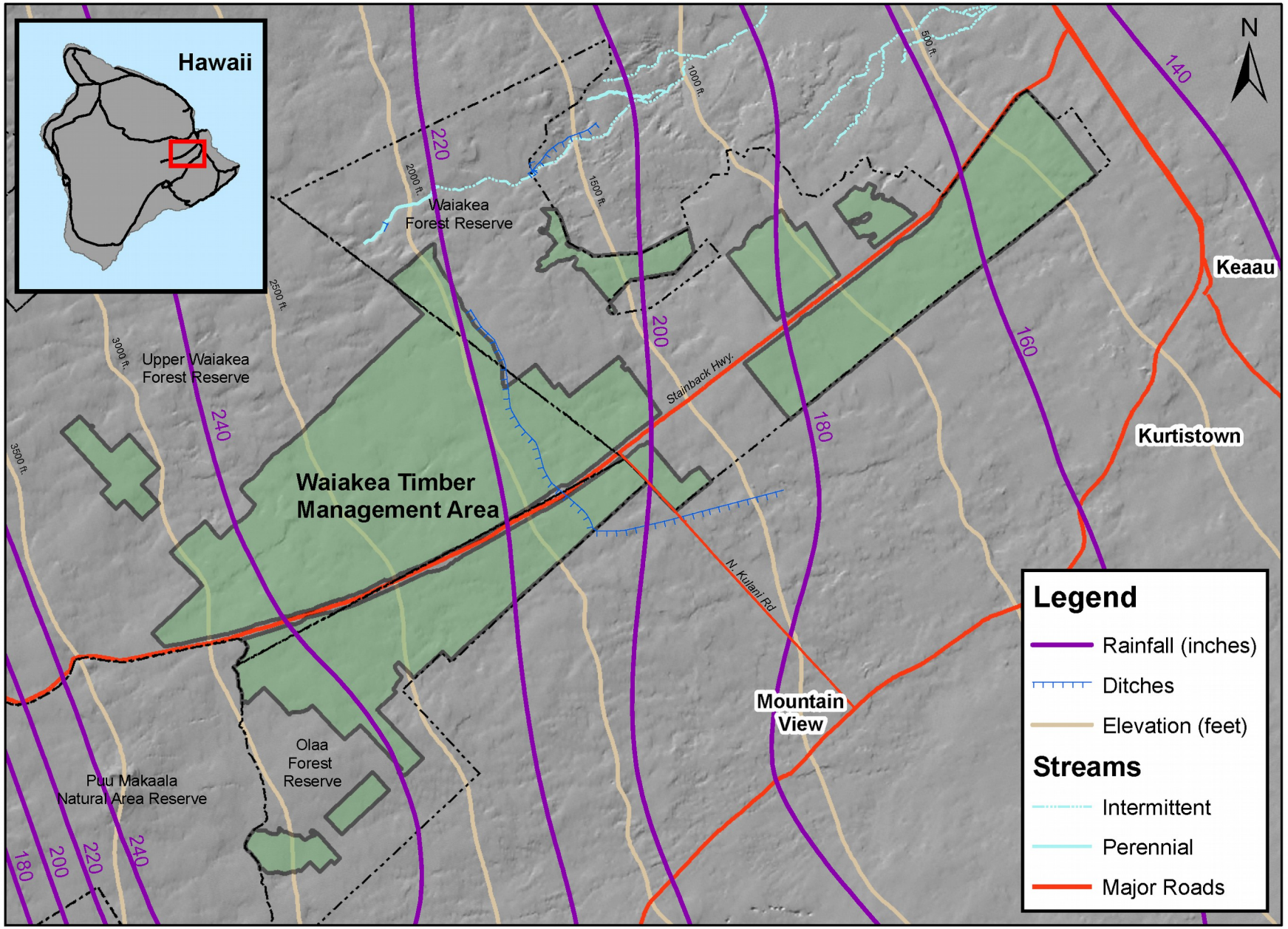
The WTMA has extensive tree and ground cover making the area a functional watershed. Spring-fed Waiākea stream is perennial in its upper reaches, and there are flumes that retain water much of the year. There is no known surface water sources used for domestic or agricultural purposes.

Median annual rainfall in the WTMA varies with elevation, with approximately 240 inches annually at 3,200 ft. elevation, and gradually decreasing to 150 inches at 400 ft. elevation (Figure 4). Most of the WTMA (73%) receives more than 200 inches of rain per year. Rainfall is distributed throughout the year; occasionally drought conditions occur for several months at a time. Overcast conditions are common, and humidity is high throughout the year.

Air

There is no data on ambient air quality specific to the WTMA, but there is a stationary monitoring station right outside WTMA in Mountain View collecting data on sulfur dioxide and fine particulate matter (PM 2.5). Data is reported on a website http://emdweb.doh.hawaii.gov/air-quality/ in near real-time on a continuous basis. In general, air quality in the genera area of WTMA is considered "good."

Figure 4. Hydrological features and elevation of Waiakea Timber Management Area (WTMA)



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B. Biological Resources

Threatened and endangered species: ʻōpeʻapeʻa

The Hawaiian hoary bat, or 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 Hawaii's only native terrestrial mammal and can be found from sea level to 14,000 feet in elevation. 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 primarily solitary, nocturnal and insectivorous. It 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 both native and non-native 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).

Because warm temperatures are strongly associated with reproductive success in this and other bat species, it has been suggested that key breeding habitat is likely to occur at sites where the average July minimum temperature is above 52ºF, which would occur on the island of Hawaiʻi below 4,200 ft. elevation. ʻŌpeʻapeʻa have been found roosting in ʻōhiʻa, *Eucalyptus*, and Sugi pine, among other species.

ʻŌpeʻapeʻa have been detected in the WTMA as recently as 2008, but the extent of their distribution and density is unknown. Auditory surveys were conducted by United States Geological Service (USGS) in May 2008 and January 2009 at 12 stations along Tree Planting Road in the WTMA. Bats were detected in May 2008 at only three of the twelve stations, and activity levels were low at each station with 16 or less passes per night (in comparison a station approximately 10 miles northwest of WTMA detected 131 passes in one night). No bats were detected in January 2009. Additionally, a total of 14 bats were captured in mist nests for data collection on Tree Planting Road, Flume Road and Quarry Road, between 2004 and 2008.

Threatened and endangered species: ʻio

The endangered Hawaiian hawk, or ʻio (*Buteo solitarius*), is the only broad-winged hawk known to have colonized Hawaiʻi and only occurs on the island of Hawaiʻi from sea level to about 5,600 feet in elevation. The most recent analysis of the abundance and distribution of the ʻio population estimate that there are approximately 3,000 individuals island wide (Gorreson et al. 2008). These birds of prey feed

on rodents, insects, and small birds, including young game birds. Breeding pairs typically nest in ʻōhiʻa trees (81%, n= 113), but non-native trees are also used (16%). The most frequently used non-native trees were *Eucalyptus* spp. at 5% (Klavitter et. al 2003). Nest construction is protracted, beginning up to two months before the first egg is laid, and continuing into the nestling period. Fledglings remain dependent on adults for up to nine months. The ʻio appears to be resistant to avian diseases, and has been able to shift to prey upon non-native food items that have increased in density and diversity. In February 2014, the United States Fish and Wildlife Service (USFWS) re-published a proposed rule to remove the Hawaiian Hawk from the Federal List of Endangered and Threatened Wildlife. The proposed delisting was based on several studies that had shown the range-wide population estimates to be stable for at least 20 years and concluding that the species was not threatened with becoming extinct throughout all or a significant portion of its range in the foreseeable future. To date, the USFWS has not published a determination on the proposed rule.

ʻIo are regularly observed in the WTMA and adjacent forest reserves. In 2007, the extrapolated density of ʻio in forestry plantations located in Puna was 0.5105 hawks/km (Gorreson et al. 2008). Island wide surveys in 2007 showed that Puna supported lower hawk numbers generally for all habitats compared to the other regions (Hamakua, Kaʻū, and Kona). ʻIo densities are relatively low in non-native timber, and there have been no recorded nesting sites in the WTMA. The nearest known nesting sites were located below the project area in the vicinity of Panaʻewa Zoo. The WTMA appears to be occupied primarily by juvenile hawks that have been ejected from prime nesting territories in adjacent native forests.

Threatened and endangered species: *Drosophila mulli*

*Drosophila (*picture-wing flies) are true flies (Order: Diptera). Numerous adaptive shifts and unusual evolutionary developments characterize the species found in Hawaiʻi. *Drosophila* are specialized microbivores that rely on over 40 families of native plants, and recent declines in the genus are associated with the loss of these host plants. In 2006, twelve species of *Drosophila* were listed as threatened and critical habitat was designated for these twelve species in 2008.

The WTMA is historically known to contain one of the listed species, *Drosophila mulli*. Found only on the island of Hawaiʻi from three locations, *Drosophila mulli* is restricted to the natural distribution of its host plant, the endemic Hawaiian fan palm *Pritchardia beccariana*. Adult flies of *Drosophila mulli* are found only on the undersides of the leaves of this long-lived (approximately 100 years) species. The larval host for *D. mulli* is still unknown, as rearing attempts with various decaying plant material from *P. beccariana* were unsuccessful (USFWS 2012).

Drosophila mulli was discovered within ʻŌlaʻa Forest Reserve at a site that has been surveyed at least 63 times between 1965 and 2001. Fewer than 10 individuals were observed on 4 different dates, with the last sighting being in 2001. *Drosophila mulli* was discovered at a second and third location in the Upper Waiākea Forest Reserve and along Stainback Highway in 1999 and 2000. No records of observations have been reported since 2001, but recent surveys have been limited. Bait can be used to survey for Hawaiian *Drosophila* but only to indicate presence or absence of taxa. Moreover, Hawaiian *Drosophila* life cycles are influenced by rainfall and other environmental variables, making survey

results difficult to compare over time and across sites. Because even the very common species of *Drosophila* fluctuate widely seasonally and daily, population estimates are difficult.

Threats to *Drosophila mulli* include threats to its host plant *P. beccariana*. Non-native scolytid beetles bore into the plant and feed on the nuts, and as a result, little natural regeneration of *P. beccariana* has been observed in the wild since the arrival of the beetle. In addition, the seeds, bark, and flowers of the palm are susceptible to herbivory by rats.

Threatened and endangered species: *Cyrtandra giffardii*

Only one species of endangered plant is currently known to occur within the WTMA. *Cyrtandra giffardii* (haʻiwale) was listed in 1994 as endangered, with critical habitat of 15,617 acres designated in 2003. It is a short-lived perennial, a small shrubby tree from the African violet family (Gesneriaceae). *Cyrtandra giffardii* is known historically in wet montane forest or lowland wet forest dominated by tree fern of the genus *Cibotium*, from 2,146 to 4,723 ft. elevation. Threats include degradation of habitat by feral ungulates and invasive plant species, human disturbance (due to proximity of recreational trails and roads), low numbers, and climate change.

Cyrtandra giffardii has been collected in four general areas, including Laupāhoehoe Natural Area Reserve (NAR), Upper Waiākea Forest Reserve, the Kūlani/Stainback Highway area, and Puʻu Makaʻala NAR. At the time of its listing, the species was known from less than 100 individuals. Additional populations were observed from surveys conducted prior to the completion of the 1996 recovery plan, reporting a total of eleven populations and over 1,000 individuals. At the time critical habitat was proposed in 2002, the species was known from seven populations with less than 500 total individuals. The most current reported information indicated that only two populations totaling less than 112 individuals remain, in Laupāhoehoe NAR and Hawaiʻi Volcanoes National Park (USFWS 2012). However, *Cyrtandra giffardii* was found during vegetation survey in June 2012 within timber stands along the western boundary, in an area regenerating into native forest.

Other rare and endangered plant species historically found in the WTMA (prior to the establishment of the timber plantations) or in the forest adjacent to the WTMA include *Cyanea platyphylla*, *Sicyos alba*, *Cyanea tritomantha*, *Gardenia remyi*, *Joinvillea ascendens* ssp. *ascendens*, *Phyllostegia floribunda*, *Phyllostegia vestita*, *Stenogyne scrophularioides*, *Trematolobelia grandiflora*. While only *Gardenia remyi* has been observed within WTMA recently, the presence of others is possible, especially in areas dominated by native species, and may be found upon additional survey.

Vegetation

Introduced timber species and other non-native plant species are the dominant vegetation of the WTMA. In general, intentionally planted timber species dominate the canopy of the WTMA. Timber species were planted in 40-acre blocks: in total, there are approximately 4,026 acres of with *Eucalyptus* species, 3,343 acres of Australian toon, 1,577 acres of tropical ash, 1,536 acres of Queensland maple, and smaller acreages of various other introduced timber species such as Sugi pine and Nepal alder. In addition, there are portions of native forest within the WTMA that were not bulldozed and remain relatively undisturbed and portions where planted timber species did poorly and the area has

regenerated into native dominated forest (779 acres).

During initial land clearing operations (1959-1968) in the WTMA, large native trees such as ʻōhiʻa lehua (*Metrosideros polymorpha*), koa (*Acacia koa*), and loulu (*Pritchardia* spp.) were left undisturbed. Today, these plants are intermixed with non-native timber species. There are other non-native tree species scattered throughout the WTMA and they include ironwood (*Casuarina equisetifolia*), blackwood acacia (*Acacia melanoxylon*), silk oak (*Grevillea robusta*), gunpowder tree (*Trema orientalis*), paperbark (*Melaleuca quinquenervia*), and African tulip (*Spathodea campanulata*). A species list of the plants and wildlife found in WTMA is included in Appendix D.

The majority of the understory of the WTMA is generally composed of non-native plants. Many of these are invasive weeds that occur in thick and fast-growing patches throughout the WTMA, including strawberry guava *(Psidium cattleianum*), palm grass *(Setaria palmifolia*), koster's curse (*Clidemia hirta* var. *hirta*), *Melastoma candidum*, glorybush (*Tibouchina* spp.) and *Melochia umbellata*. In large areas on the east and southern portion of the WTMA these invasive species have formed dense, almost monotypic stands. Emerging invasive weed problems include Australian tree fern (*Cyathea cooperi*), miconia (*Miconia calvescens*), yellow Himalyan raspberry (*Rubus ellipticus* var. *obcordatus*), and gunpowder tree.

While the majority of the understory is non-native, several native understory plants are present, including hāpuʻu (*Cibotium* spp.), uluhe (*Dicranopteris linearis*), olomea (*Perrottetia sandwicensis*), kōpiko (*Psychotria* spp.), moa (*Psilotum nudum*), pilo (*Coprosma* spp.), māmaki (*Pipturus albidus*), and manono (*Hedyotis* spp.).

Approximately 779 acres have been identified as native forest that will not be subject to harvesting. This acreage includes relatively undisturbed native forest classified as native ʻōhiʻa and ʻōhiʻa-hāpuʻu wet forest, or koa-ʻōhiʻa wet forest. These vegetation types have scattered to closed canopies (up to 75 feet tall in places) and contain a variety of native and non-native tree and shrub species. This acreage also includes some areas planted with Australian toon and tropical ash, where the timber species did poorly and the area has regenerated into native-dominated forest. The canopy in this area is a mix of non-native timber and the native ʻōhiʻa lehua. The understory is more than 90% native.

Birds

Forest birds are the dominant native wildlife in the WTMA. Endemic species inhabiting these forests are ʻapapane (*Himatione sanguinea*), ʻamakihi (*Hemignathus virens*), ʻōmaʻo (*Myadestes obscurus*), ʻelepaio (*Chasiempis sandwichensis sandwichensis*), and pueo (*Asio flammeus sandwichensis*). These birds are most frequently observed above 3,000 feet elevation, which is the upper extreme of the WTMA.

Other rare native bird species are found in native forests above the WTMA. These include the endangered ʻōʻū (*Psittirostra psittacea*), endangered ʻakiapōlāʻau (*Hemignathus munroi*), the endangered Hawaiʻi ʻākepa (*Loxops coccineus coccineus*), and the ʻiʻiwi (*Vestiaria coccinea*). It is unlikely that any of these rare bird species inhabit the WTMA, because these species are highly

susceptible to avian diseases transmitted by mosquitoes, and as such, are generally restricted to native forests above 4,000 ft in elevation.

Non-native bird species such as northern cardinal (*Cardinalis cardinalis*), Japanese white-eye (*Zosterops japonicus*), melodious laughing thrush (*Garrulax canorus*), house finch (*Carpodacus mexicanus*), and house sparrow (*Passer domesticus*) utilize the area for feeding, roosting, and nesting.

Game animals

Feral pigs (*Sus scrofa*) are the most common big game species found in the area, but goats (*Capra hircus*) may occasionally be present. Mouflon sheep (*Ovis aries*) has not been seen to date. No pig population studies have been conducted in the area, but the overall number of pigs in the area likely fluctuates depending on food and water availability, hunting pressure, and fencing of nearby conservation areas.

Kalij pheasants (*Lophura leucomelanos*) are the most plentiful game bird in WTMA. Other game birds such as wild turkey (*Meleagris gallopavo*) and Japanese quail (*Coturnix japonica*) are present, but are usually restricted to forest edges or along roadways and lava flows.

Invertebrates

Endemic Hawaiian invertebrates are sensitive to environmental changes such as forest clearing and invasion of alien plant and animal species, although research on direct impacts of timber harvesting in Hawai‘i still needs to be conducted. Many arthropods have evolved to specific habitats and require one or more native plants to complete their life cycle. Land clearing activities, including the bulldozing that occurred in the 1950s and 1960s, likely contributed to a loss of arthropod communities that are known to be associated with native flora. Recent invasions of non-native yellow jacket wasps (*Vespula pennsylvanica*) into WTMA are also likely to have negatively affected native insect populations.

Detailed invertebrate survey information for the WTMA is not currently available, but due to the previous disturbances and the prevalence of non-native plant species in the canopy and understory, native invertebrate composition in the WTMA is presumed to be lower than it would be in a native-dominated forest. A few native invertebrate species, such as native Lepidoptera (moths), have been documented inside the WTMA and are relatively abundant and exhibit some species diversity. Formal surveys for mollusks have not been conducted in WTMA, but the endemic snail *Succinea* is relatively common throughout Hawai‘i and are known to be present in the general area.

Significant and Sensitive Habitats

Approximately 48 acres of *D. mulli* critical habitat Unit 2 and Unit 3 are located within the WTMA. The primary constituent elements composing critical habitat, or those physical and biological features that are essential to the conservation of the species and may require special management or protection, are (1) wet montane ‘ōhi‘a forest between 1,955 ft and 3,585 ft, and (2) the host plant *P. beccariana*. *Pritchardia beccariana* is also known to be scattered throughout the timber plantations outside of the designated critical habitat.

The project area is not located in or near any of the following types of sensitive areas: flood plains, tsunami zones, beaches, rivers, oceans, estuaries, anchialine ponds, fresh or coastal waters, erosion prone areas, or geologically hazardous land.

C. Social and Economic Conditions

Although established for commercial timber management, the WTMA supports a range of public uses, including hunting, recreation, and passive enjoyment (Figure 5).

Hunting

The timber plantations of WTMA and the surrounding native forests are used extensively for feral pig hunting. The WTMA is located within hunting unit B; unit B is open for hunting game animals daily year-round. Bag limits are two pigs, one sheep and one goat per hunter per day. In the portion of WTMA between Tree Planting Road and Powerline Road, hunting by all means of take is permitted, with use of dogs allowed only between July and December; in the remaining portion of WTMA, dogs may be used year-round. Unit B is also open for game bird hunting on weekends and holidays from the first Saturday in November through the third Sunday in January. Hunters are required to check in and out at established checking stations and to report game harvests on official field forms. Refer to Chapter 123 "Rules Regulating Game Mammal Hunting" for specifics about this area.

Table VI-1. Reported hunter activity, 2011-2013, Waiākea Forest Reserve and Upper Waiākea Forest Reserve.

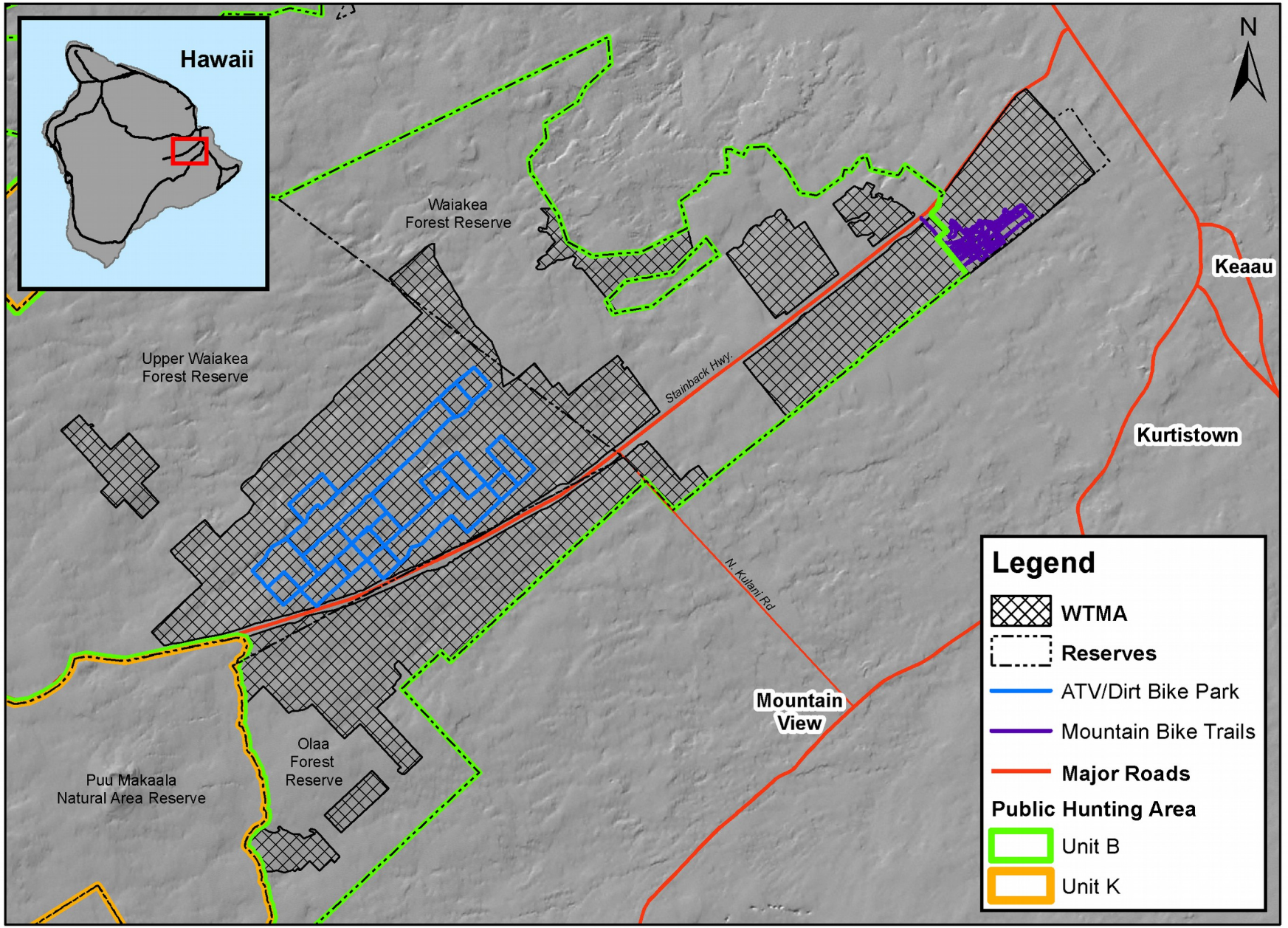
	Waiākea FR 2011	Upper Waiākea FR 2011	Waiākea FR 2012	Upper Waiākea FR 2013	Waiākea FR 2013	Upper Waiākea FR 2013
Hunter Trips	182	161	254	193	259	232
Pigs	98	62	74	62	70	85
Goats	0	0	0	1	0	0
Sheep	0	11	0	9	0	6

Recreational use

Motorcycle and all-terrain vehicle (ATV) riders use the well-developed road network within the area. Other recreational activities include mountain biking, horseback riding, bird watching, botanical exploration and hiking.

DOFAW's Nā Ala Hele Trails and Access program manages the Upper Waiākea ATV/ Dirt Bike Park which is located within the WTMA between Flume and Tree Planting Roads. It has been in operation since July 4, 2004, and offers 28 miles of trails that can be ridden in both directions. In order to use the park, permits and waivers must be obtained from the DOFAW office in advance.

Figure 5. Waiakea Timber Management Area Recreation and Access.



State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
February 2013

0 0.5 1 2 3 4 Miles

HAWAII STATEWIDE GIS PROGRAM

The Mauna Kea 200 motorcycle event (MK200), held nearly every year since 1976, utilizes the area for course mileage, and the Rock Island Riders (who implement the MK200) have volunteered time to keep many of the grid roads within WTMA open and identifiable.

There are also established mountain bike trails in the lower portion of WTMA, primarily in the area below Quarry Road in the former sugar plantation lands. There are approximately 11 miles of single track and 15 miles of double track mountain bike trails that traverse through approximately 230 acres of *Eucalyptus saligna* and *E. grandis* plantation timber. In order to use these mountain bike trails, permits and waivers must be obtained from the DOFAW office in advance. Permits have been issued to mountain bike clubs that sponsor riding events.

Equestrian use is common along the Puna boundary of the forest reserve. Bird watching, botanical exploration, and hiking occur less frequently; no trails or destinations within WTMA are regularly documented on social media sites.

Gathering

Tree fern harvesting occurs regularly, with approximately 500 linear feet of logs removed and sold for use in the flower and landscape industry each year. The tree fern market is relatively small, and the work to remove logs difficult.

The WTMA is accessible for traditional gathering of forest resources, which occurs primarily in native forest stands near Stainback Highway. Non-timber forest products most commonly collected within the WTMA include ferns, maile, hāpuʻu fronds, ti leaves, and flowers.

Gathering of material from plant species that are not on Federal or State threatened and endangered species lists is permitted and regulated by DOFAW through standard Forest Reserve System permit procedures as described in HAR §13-104. Gathering for personal use is regulated through issuance of a free collection permit; gathering in quantities determined to represent commercial use is regulated through issuance of a commercial harvest permit for a fee.

Research

Forest plantations in the WTMA provide opportunities for individuals, organizations, and institutions to study both native and introduced forest communities. From the 1960s to the 1970s, the State Department of Health conducted studies on the population dynamics of rodents in the Waiākea Forest Reserve. In the 1970s, the U.S. Fish and Wildlife Service conducted native forest bird surveys on the island of Hawaiʻi and several of the survey transects extended through the WTMA. During the Vietnam war, the U.S. Army conducted several research projects in the WFR, UWFR, and OFR including chemical gases, defoliants, and phosphate explosive devices. The USDA Forest Service, Institute of Pacific Island Forestry, has been monitoring forestry research projects in the WTMA since the late 1950s to the present. Some of the research projects have included nutrient cycling, watershed quality of various native forest plant communities, wood properties of commercial native tree species, and the occurrence of ʻōhiʻa lehua decline. Forestry instructors at the University of Hawaiʻi, Hilo campus use the WTMA for field laboratory exercises.

Visual resources
The project area itself is not visible from any public viewing area or public highway, due to its location on the island. The WTMA is visible from the air by helicopter tours departing from Hilo.

Economic use
The WTMA has an estimated economic stumpage value (the price paid for the right to harvest trees) of several million dollars. The actual stumpage value will depend on the market and the planned use of the timber resources, such as whether the timber will be used for biomass, minimally processed wood products, or value-added products like furniture, and whether the timber will be used locally or transported to another state or country for processing.

Traffic patterns
WTMA is accessed primarily through Stainback Highway, which is located off State Highway 11 (Mamalahoa Highway), about 5 miles southwest of Hilo. The single-lane paved road (no shoulder) provides east-to-west access to WTMA. North Kūlani Road provides a second access to State Highway 11 (Volcano Road) from WTMA, crossing north-south from approximately the middle of WTMA. Both Stainback Highway and North Kūlani Road are narrow roads designed for rural use, and users of these roads are regularly observed to drive faster than the posted speed limit.

Log trucks and possibly chip vans or similar transport will be used to haul logs and chips to and from the WTMA. Low-boy trailers will be used to haul equipment when moving from one site to another. Transporting forest products from the WTMA will increase the use of Stainback Highway, Highway 11, and to a lesser extent North Kūlani Road. The current traffic counts for these roadways are presented in Tables VI-2 – VI-5. Transportation on public roadways is expected to occur up to seven days a week, with regularly spaced hauling trips occurring throughout the day, during active harvest times, probably averaging one every 15 minutes during peak harvest periods for 8 to 10 hours per day.

Table VI-2: Traffic survey information for Stainback Hwy (DOT, 2012)

Location	**Date of Survey**	**Info Type**	**AM Peak**		**PM Peak**		**24 Hour Total Both Directions**
			West-bound	**East-bound**	**West-bound**	**East-bound**	
Stainback Highway between N. Kulani Road to Road to Panaewa Zoo	5/3/2011	Time	6:45-7:45	7:45-8:45	3:00-4:00	4:45-5:45	--------
		Volume	135	30	41	68	1173
	5/4/2011	Time	6:45-7:45	8:00-9:00	3:30-4:30	4:30-5:30	--------
		Volume	116	28	35	80	1003

Table VI-3: Traffic survey information for Route 11 (DOT, 2012)

Location	Date of Survey	Info Type	AM Peak		PM Peak		24 Hour Total Both Directions
			North-bound	South-bound	North-bound	South-bound	
Route 11: Kilauea Avenue to Macadamia Road - 377	4/11/2012	Time	6:30-7:30	7:00-8:00	3:00-4:00	4:30-5:30	--------
		Volume	2568	1009	1494	2407	41562
	4/12/2012	Time	6:45-7:45	6:45-7:45	3:00-4:00	4:30-5:30	--------
		Volume	2993	1042	1487	2356	43566
Volcano Road: between Old Keaau-Pahoa Rd (Rte 139) and Old Volcano Road - 666	4/10/2012	Time	6:45-7:45	6:45-7:45	3:00-4:00	4:45-5:45	--------
		Volume	1351	615	711	956	17595
	4/11/2012	Time	6:45-7:45	6:45-7:45	3:00-4:00	4:45-5:45	--------
		Volume	1335	631	720	1006	18217

Table VI-4: Traffic survey information for North Kūlani Road (DOT, 2012)

Location	Date of Survey	Info Type	AM Peak		PM Peak		24 Hour Total Both Directions
			North-bound	South-bound	North-bound	South-bound	
North Kulani Rd. between Ana Rd. and Volcano Road	2/3/2010	Time	6:30-7:30	7:00-8:00	3:30-4:30	5:00-6:00	--------
		Volume	159	82	78	112	2168
	2/4/2010	Time	6:15-7:15	7:00-8:00	5:15-6:15	5:00-6:00	--------
		Volume	151	90	77	106	2083

Table VI-5: Annual Average Daily Traffic (AADT) and 24-hour truck volume for Stainback Hwy and Route 11 (DOT, 2012)

Location	AADT	24 hour truck volume	
		Single unit trucks (Type 4-7)	Combination (Type 8-13)
Stainback Highway between N. Kulani Road to Road to Panaewa Zoo	1100	2	1
Volcano Road: Kilauea Avenue to Macadamia Road - 377	37300	988	2647
Volcano Road: between Old Keaau-Pahoa Rd (Rte 139) and Old Volcano Road - 666	17200	676	107

D. Cultural, Historic, and Archaeological Resources

The following steps were taken to determine the cultural, historical, and archaeological significance of the project area and impacts of proposed actions: (1) general literature review of reports or studies with relevant information related to this project area; (2) review of a cultural study prepared by Kumu Pono Associates in 2004 for the adjacent Puʻu Makaʻala NAR, providing a detailed overview of the natural and cultural landscape and history of land use in the vicinity of Puʻu Makaʻala NAR, and adjoining lands of Waiākea, in the District of Hilo, and ʻŌlaʻa, in the District of Puna (included as Appendix E); (3) pre-consultation with Native Hawaiian organizations, agencies, adjacent landowners, and individuals through the scoping process outlined earlier in section III; and (4) the preparation of an Archaeological Inventory Survey plan, followed by an Archaeological Inventory Survey (AIS), for the WTMA by Haun and Associates (included as Appendix F and G).

Summary of Archaeological Inventory Survey (2014)
Haun and Associates conducted an archaeological inventory survey of 556 acres in WTMA. The surveyed areas consisted of 550 acres identified in the sampling strategy proposed in the archaeological inventory survey plan for the project and an additional 6.5 acres surveyed during efforts to re-locate a previously identified burial cave. Two-thirds of the sample blocks were located below the 2,500 ft elevation. Predicted site types in the WTMA included temporary habitations, trails, shrines, and minor agricultural features.

The AIS concluded that the WTMA was certainly utilized prehistorically as evidenced by the previously identified burial cave, but that the majority of traditional land use in this area was likely for the procuring of natural resources (e.g., timber, medicinal plants, olona, and birds) and temporary habitation associated with this activity. As such, the physical evidence of these activities would have been ephemeral and left little if any surviving physical evidence.

The survey did identify nine subterranean features in the sample blocks, which were often wet due to high rainfall in the area. As such, the survey concluded that they would not have made suitable habitations locations, even temporarily. None of the features contained cultural remains or evidence of use, consistent with negative findings of previous archaeological work in and adjacent to WTMA. The AIS further noted that the absence of prehistoric sites in the survey blocks was not unexpected due to "the extensive ground disturbance that has occurred in the area since the early 1960s and the expected low site density predicted by McEldowney's (1979) settlement pattern model."

The 20 sample block survey revealed that all of the survey areas have been disturbed to varying degrees. The survey identified a badly disturbed remnant of the historic ʻŌlaʻa Flume associated with the sugarcane industry (site 50-10-34-20870) and documented a historic road (ʻŌlaʻa Back Road) that is currently in use by local residents as Ihope Road) (site 50-10-43-30088). The flume site and historic road were assessed as significant for their information content. These sites have yielded important information for understanding historic land use in the project area. The flume site is also assessed as significant for its association with the broad pattern of sugar cane plantation agriculture in Hawaiʻi. The

AIS concluded that documentation of these sites adequately documents them and that no further work or preservation is recommended.

Documentary research indicated the existence of a burial cave identified in WTMA in 1985 (site 50-10-35-18697). Efforts to re-locate the cave were unsuccessful during the 2014 survey. It is possible the entrance to the cave is obscured behind a large sheered-off section of ridge adjacent to Quarry Road or that the cave was inaccurately plotted in 1985. The AIS recommended that archaeological monitoring of any future land modification be conducted in a 500-square meter (61.7 acre) area centered on the reported location of the burial cave and oriented parallel to the Stainback Highway.

Summary of previous archaeological work

Haun and Associates summarized the previous archaeological research in the Final Plan for the Archaeological Survey (attached as Appendix F), noting that more than 40 archaeological projects have been conducted in the Waiākea and ʻŌlaʻa ahupuaʻa, with most in the seaward portion of Waiākea below 200 ft elevation. Three studies were conducted within or immediately adjacent to WTMA. A field inspection in 1985 by State staff archaeologist Wendall Kam, examined a cave discovered by a county official while conducting a review of a planned agricultural area. The cave was assigned a State Inventory of Historic Places Site No. 50-10-35-18697. In 1999, Cultural Surveys Hawaiʻi conducted an archaeological inventory survey of Stainback Highway in conjunction with proposed improvements to the road. No archaeological sites were found. In 1999, Cultural Surveys Hawaiʻi also conducted an inventory survey of an approximately 280-acre site proposed for a new correctional facility, located along the northern side of Stainback Highway, within the boundaries of WTMA. Three lava tubes were identified, but none had cultural remains or evidence of use. The remainder of the area was noted as extensively impacted by bulldozer activity associated with reforestation efforts. Overall, the previous archaeological studies conducted in the general vicinity of WTMA only identified a single possible agricultural mound and a lava tube used for burial, a low density attributed to the extensive ground-altering disturbance associated with sugarcane cultivation seaward of the project area and with clearing within the WTMA for reforestation, and the rugged nature of the terrain and abundance of rainfall.

Summary of historical documentary research: Haun and Associates

Haun and Associates provided a summary of the historical documentary research for the WTMA in the Final Plan for the AIS (attached as Appendix F), which is largely reproduced below:

> Waiākea Ahupuaʻa is one of the largest in the district of South Hilo covering over 95,000 acres and extending along the coast from the west side of Hilo Bay to the Puna District boundary and inland to approximately 6,000 ft elevation. Similarly, ʻŌlaʻa Ahupuaʻa is one of the largest land divisions in the Puna District (approximately 57,000 acres), second only to the Land of Keaau. ʻŌlaʻa is atypical of Hawaiian ahupuaʻa, in that it is land-locked with no ocean frontage. According to Maly and Maly, "the land of ʻŌlaʻa stood alone, almost independent of the other lands adjoining it in Puna, though it had no ocean frontage — being cut off by Keaʻau and Waiākea" (2004:6).
>
> The project area ahupuaʻa contained a variety of valuable resources that made Waiākea and

ʻŌlaʻa important locales. Waiākea served as the seat of chiefly residences as early as the mid-1500s with chiefly associations continuing out traditional times. Waiākea was retained by Kamehameha at the time of his death he, "...held Hilo lands including Pi'ihonua, Punahoa, and Waiākea, descended to Liholiho, his son and heir to the kingdom" (Kelly et al. 1981:11). According to Maly and Maly, the name ʻŌlaʻa, "connotes sacredness and sanctity; the root of the name being "*laʻa*." ʻŌlaʻa is famed in native tradition for its sacred lands, forest, native birds, and olonā resources" (2004:6).

Much of the following is summarized from *Hilo Bay: A Chronological History*, an extensive and thorough compendium of historical information about the Hilo area by Kelly et al. (1981) and from *He Moʻolelo ʻĀina: A Cultural Study of the Puʻu Makaʻala Natural Area Reserve* by Maly and Maly (2004). Hawaiian traditional and legendary accounts attest to the longstanding importance of the area. The chief of the Hilo region, Kulukuluʻa, who resided in Waiākea, was the first conquest of ʻUmi-a-Liloa in his campaign to unify the districts of Hawaiʻi Island. Hilo with its large bay, fishponds, wet taro fields, and abundant freshwater was a population center for commoners and royalty. Kamehameha I and his court resided in Hilo in the 1790s. In preparation for his planned invasion of Kauai in 1802, Kamehameha built a canoe fleet at Hilo, reportedly consisting of 800 vessels. Kamehameha gave his favorite wife, Kaʻahumanu, the *ili kupono* of Piʻopiʻo in Waiākea.

Maly and Maly (2004:8-19) present the tradition of Pikoi-a-ka-ʻalalā (Pikoi-son-of-the-crow), which was printed in the *Ku Okoa*, the Hawaiian language newspaper in 1865-1866. According to the account, this represents the earliest written accounts of the cultural practices within the vicinity of the project area, in the upland forests of Waiākea and ʻŌlaʻa. Pikoi-a-ka-ʻalalā was a kūpua, a supernatural being with the ability to change his body forms and was skilled at the pana pua or the use of bow and arrow.

In this tradition, Pikoi-a-ka-ʻalalā travels throughout the islands and competes against other archers. On his arrival in Hawaiʻi, he learns that the chief of Hawaiʻi Island, Keawenui a ʻUmi, needed help getting rid of two supernatural ʻelepaio birds that were interrupting the canoe makers in a clearing in upland ʻŌlaʻa called Kalehaupueo. The birds roosted in a large koa tree and when they would hear the striking of the adzes they would fly down and call out, "Say Keawenui a ʻUmi! Leave it behind; it is a bad canoe, a canoe that will shatter a rotted hull" (2004:10). The chief had already enlisted Mainele, an archer from Oʻahu to rid him of the troublesome birds, promising him the hand of his daughter Keakalaulani if he could accomplish the task. Although Mainele bragged of his abilities, he was not able to kill the ʻelepaio birds.

During this time, Pikoi-a-ka-ʻalalā` befriended the steward of the chief Waiākea, and takes up residence with him in Hilo. He hunts in the uplands of ʻŌlaʻa where he kills many birds and gives them to the chief for food. Learning that Mainele has not been able to kill the ʻelepaio birds, Waiākea asks the chief if his friend Pikoi-a-ka-ʻalalā` might be given a chance to kill the birds and Keawenui a ʻUmi agrees.

Pikoi-a-ka-ʻalalā` and Waiākea set out for the Kalehaupueo clearing. On the way they stop at a resting place called Mahinaʻakaaka along the trail to ʻŌlaʻa. There Pikoi-a-ka-ʻalalā` shoots a

large rat named ʻAkiʻakiaʻiole. Further along he stops at a place called Makaulele where he becomes engrossed in making leis from the fragrant red and white lehua blossoms. Eventually they reach Kalehaupueo and Pikoi-a-ka-ʻalalāʻ kills the two supernatural ʻelepaio birds with a single arrow while Waiākea strikes down Mainele and his companions. In gratitude Keawenui a ʻUmi tells Pikoiakaʻalalā that he can wed his daughter, and that he will inherit his kingdom.

Early historic accounts also document the importance of the general Hilo area. In 1823, the missionary William Ellis estimated the population to be 2,000 people in 400 houses and described the extensive use of lauhala thatch in house construction. Lauhala was gathered from eastern Waiākea beyond the Wailoa River. He described the land as intensively cultivated with plantains, bananas, sugar cane, taro, potatoes, melons, coconuts, and breadfruit. Wet taro was grown in mounds (*kipi*) in marshlands. Hilo was a center for trade between the people of Kaʻu, Hamakua, and Hilo. Between the 1790s and 1820s, sandalwood was cut and brought to Hilo for export. *Pulu* and *pia* (arrowroot) were also exported. Ellis also describes coastal fishing.

Ellis recalls a visit to the Puna District and describes the nearby community of Keaʻau (or Kaau) as "the last village in the division of Puna. It was extensive and populous, abounding with well cultivated plantations of taro, sweet potatoes, and sugar cane, and probably owes its fertility to a fine, rapid stream, which, descending from the mountains, runs through it into the sea" (1963: 60).

In 1824, a missionary station was established in Waiākea. Soon after, churches and schools were established. Whalers began stopping at Hilo in the mid-1820s. In the 1830s, a sawmill was built and two stores were opened. By the end of the decade, a sugar cane plantation and mill were established on Ponahawai lands. In 1840, the Wilkes Expedition arrived in Hilo and constructed an observatory on Waiākea Point on the east side of Hilo Bay.

In 1841, members of the United States Exploring Expedition, under the command of Charles Wilkes, accompanied by a party of native Hawaiians and foreign residents (numbering nearly three hundred individuals) traveled to the summit of Mauna Loa. The party departed from Waiākea, traveled *mauka* through ʻŌlaʻa, and on to Kīlauea. Observations and exploration were undertaken at Kīlauea, and then the party traveled through Keauhou, *mauka*, along the forest above ʻŌlaʻa and Puʻu Makaʻala, and on to Mauna Loa.

The Volcano Trail was the primary transportation route between Hilo and Kilauea, and potentially represents the route traveled by Wilkes. McEldowney describes this trail as follows:

> ...From here to Mountain View or just beyond the "halfway house," the trail crossed on to an extensive Kīlauea pahoehoe flow and continued along its western margin, which abutted mostly ash-covered Mauna Loa flows. The route of this old trail basically corresponds to the Ōlaʻa- Keaʻau boundary line on the current U.S.G.S. maps. Descriptions of scattered, stunted trees, mixed with ferns, grasses, ʻōhelo (Vaccinium sp.), and low shrubs, sound typical of pioneer or early successional plant communities. When compared to the previous portion of the trail, ferns became more dominant, *pia* disappeared, and scattered clumps of woods, probably small *kīpūkas*, replaced the groves.

> ...the woods started one or two miles SE and NW of the path, giving it the appearance of an unwooded corridor. Several villages, as well as scattered huts along the forest edge, were reported without much detail other than the presence of fertile soil and a burial cave marked with poles. Most describe leaving this open stretch somewhere beyond the "halfway house" by entering a thick forest, which Pickering [1840-41] placed at 1,500 ft elevation (1979:20).

In the 1840s, a political act of the Hawaiian Kingdom government would forever change the land tenure system in Hawai`i and have far-reaching effects on its people. The historic land transformation process was an evolution of concepts brought about by fear, growing concerns of takeovers, and western influence regarding land possession.

King Kamehameha III, in his mid-thirties, was persuaded by his *kuhina nui* and other advisors to take a course that would assure personal rights to land. One-third of all lands in the kingdom would be retained by the king; another one-third would go to *ali'i* as designated by the king; and the last one-third would be set aside for the *maka`ainana* or the people who looked after the land. In 1846, King Kamehameha III appointed a Board of Commissioners, commonly known as the Land Commissioners, to "confirm or reject all claims to land arising previously to the 10th day of December, AD 1845." Notices were frequently posted in *The Polynesian* (Moffat and Kirkpatrick, 1995); however, the legislature did not acknowledge this act until June 7, 1848 (Chinen 1958:16; Moffat and Kirkpatrick 1995:48-49) and the act is known today as *The Great Māhele.* In 1850, the Kingdom government passed laws allowing foreigners to purchase fee simple lands (Speakman 2001:91).

The Waihona 'Aina (2000) Mahele Database; which is a compilation of data from the Indices of Awards (Indices 1929), Native Register (NR n.d.), Native Testimony (NT n.d.), Foreign Register (FR n.d.) and Foreign Testimony (FT n.d.) provides information on the Land Commission Awards (LCA) awarded during the Mahele. This database lists 51 parcels claimed by 37 claimants within Waiākea, though only 26 of the claims were subsequently awarded. All of the awarded claims in the coastal portion of the ahupua'a, except two that are located at the approximately 100 ft elevation, are situated well seaward of the WTMA.

Land use described in the LCA claim testimony for Waiākea includes agriculture, pasture, burial, and residence. Thirty-four houses are mentioned and one describes the presence of a grave. Most of the claim testimony mentions cultivated fields. Crops include wet taro, sweet potatoes, breadfruit, coffee, and *kukui*. A *hala* (Pandanus spp.) grove and fishponds are also mentioned.

During the Māhele, 'Ōla'a Ahupua'a was relinquished by Kaunuohua to Kamehameha III and retained as Crown Land (Maly and Maly 2004:40). Only one Land Commission Award was claimed in 'Ōla'a. LCA 11049B was claimed by Naiilima for a parcel of land in the *ili* of Kupalu. The claim was not awarded (Waihona 'Aina 2000). The Crown Lands were further opened up for homesteading under the Land Act of 1895, and large section of 'Ōla'a Ahupua'a was segmented into the 'Ōla'a Lots, located to the south of the WTMA.

The first sugar plantation was established in the Hawaiian Islands on Kauai in 1836 (Kent 1983:22, 23, 29), although sugar cane was cultivated on all the islands at the time of Cook's arrived in 1778. According to Orr (2004:14), the Chinese on Lanai are credited with first producing sugar as early as 1802. The commercial cultivation of sugarcane occurred in 1835 to replace the declining sandalwood industry (Kuykendall and Day 1976:92).

Although sugar plantations were established in the Hilo and Kohala Districts by the 1860s, it wasn't until 1899 that a plantation was established in Puna. This plantation was the Puna Sugar Company founded by Benjamin Dillingham, Lorrin Thurston and James Castle (Dorrance 2000:105-107). A year later they founded the Olaa [Kea'au] Sugar Company (No. 49) on lands owned by the Shipman family.

The following is an excerpt from Sugar Waters by Dorrance (2000:105-107):

> The rocky, acidic Puna District south of Hilo had a much smaller number of plantations. In the 1890s the land was peppered with small homesteads, some devoted to coffee growing. After Hawai`i was annexed to the United States [1898], Benjamin Dillingham saw a sugar-growing opportunity in Puna. Along with investors that included Lorrin Thurston and James Castle, he incorporated Olaa Sugar Company to exploit the land. At the time Dillingham was building the Hilo Railroad Company and considered the new plantation a source of revenue for the railroad. By 1905 Olaa Sugar Company had a modern mill, and 7, 676 acres under cultivation serviced by the only gauge plantation railway in Hawai`i.
>
> Production increased when Olaa Sugar Company began milling Puna Sugar Company's harvest in and around Kapoho. But Olaa Sugar Company waxed and waned during the first 20 years of its life, paying dividends only twice in all that time. The land was rocky, sticky, acidic, and difficult to clear and cultivate. Not every acre received adequate rainfall, growth was stunted, and irrigation water was lacking. An infestation of leaf hoppers in 1916-1917 ruined 10,000 tons of sugar from the 1918 crop. In later years mechanical harvesting was limited because field equipment rusted and eroded too rapidly under the difficult conditions.
>
> In the 1930s, cultivated acreage stabilized at slightly over 15,000 acres. The fields extended up to 23 miles from the mill. Harvests were delivered via the Glenwood branch of Hawaiian Consolidated Railway, which ran from Olaa toward Kilauea Volcano, and stopped seven miles short of it at the village of Glenwood. Harvests from the Pahoa region were delivered by the Kapoho branch of tracks that extended 17 miles southwest of the mill. Flumes and the plantation's railroad took care of about half of each harvest, while the Hawaiian Consolidated Railway hauled the rest, and also transported product to the Hilo docks.
>
> In 1935 the plantation housed 5,648 workers and dependents in 1,086 company-supplied houses distributed among over 15 camps or villages. In addition, some 230 homesteaders lived and grew cane on family plots. Maximum production of the combined Olaa and Puna/Kapoho enterprises was 52,011 tons of sugar in 1937.

> The tsunami of 1946 struck a serious blow when it caused the Hilo railroad to shut down. Then the 1955 volcanic eruption covered thousands of acres in the Kapoho Division and isolated it. Despite all, the plantation company, renamed Puna Sugar Company in 1960 at the urging of landowner Herbert Shipman (1892-1976), struggled on.
>
> By 1982, the Olaa mill generated over 40 million kilowatt hours of electric power that was sold to Hawai`i Electric Light Company. The end of sugar operations came when its owners, Amfac, Inc. closed the Puna Sugar Company in the same year. But the mill's generating capability was perpetuated and increased. Oil was burned in the furnaces instead of the former mixture of bagasse and oil, and fulfilled a dire need for electrical energy.
>
> Shops in nearby Kea'au (Olaa) served the mill camps and homesteaders who supplied harvests to the Olaa mill. When it shut down in 1982, many small businesses were devastated. Highway 11 leading to Kilauea Volcano bypassed the town and further accentuated the demise of its prosperity.

In the early 1800s, missionaries established a mission station at Hilo because of its large population, abundant freshwater, and cultivation potential. Soon churches and schools were established. Whalers stopped at Hilo because of the protected anchorage and availability of freshwater and provisions. Sugar cane cultivation, cattle ranching, and trade in *pulu*, arrowroot, and sandalwood rapidly changed the traditional subsistence economy during the early to mid-1800s.

By the late 1800s, vast areas were in sugar cane production and large scale timber harvesting was underway. Transportation infrastructure including a railroad system and wharf facilities were established. The area underwent a dramatic increase in population as people came to the area to work for the plantations and other commercial developments.

By 1857, there were three sugar cane mills in the Hilo area. Large tracts of land were put in the cane cultivation and sugar cane was also grown by individuals around their houses. In 1861, a stone wharf was constructed at Waiākea landing on the west side of Waiākea Point. A sugar mill was established in Waiākea at the inland end of Waiākea Fishpond in the late 1870s. A railroad transport system was constructed for the Waiākea Mill between 1879 and 1880. By 1880, 1,400 acres of sugar cane were in cultivation and by the end of the decade over 5,600 acres were cultivated. In 1877, a 16 ft high tsunami struck the coast of Waiākea destroying all houses within 100 yards of the shore along with a wharf, storehouse, a quarantine hospital on Coconut Island, and a bridge.

Between 1900 and the 1930s, the population of the area grew dramatically with the expansion of sugar cane cultivation, pineapple production, the timber industry, and other commercial developments. In the 1910s, the Hilo Railroad Company expanded the rail system to Puna and Hilo Town. A railroad wharf was built north of the mouth of the Wailoa River. Between 1909 and 1913, the railroad was extended to North Hilo and Hamakua Districts.

The ʻŌlaʻa Flume passes through the WTMA in a north-south direction and angles to the southeast, terminating at the ʻŌlaʻa Mill. The flume fed an extensive network of smaller ditches that branch out and provided water to the plantation. Two flume houses that direct the flow of water are located on the main ditch line. The Lower Flume House is located within the boundaries of the WTMA and the Upper Flume House is situated to the north. The ʻŌlaʻa Flume originates in upper Kaumana at the ʻŌlaʻa Flume Spring located in Punahou Ahupuaʻa 2 at approximately 1,980 ft elevation. The ʻŌlaʻa Back Road extends from the flume to the southwest, passing through and long the southern side of portions of the WTMA.

While sugarcane was the dominant industry in the area, other agricultural pursuits were being undertaken at the turn of the 20th Century. According to Baldwin:

> The Olaa section of Puna is a fine agricultural region, but owing to the want of a market, small truck farming does not pay. However, vanilla, tobacco, pineapples, and bananas grow well; and the rubber industry is destined to be an important one, as the climate is particularly well adapted to the growth of rubber trees. The cultivation of coffee in Olaa has been abandoned, as the trees did not thrive.
>
> All the lower lands of Olaa are planted with the cane of the Olaa Sugar Company. This is one of the largest plantations on Hawaiʻi, and occupies nearly all of the available cane land of the Puna district... (1908:78-79)

The Stainback Highway extends through the WTMA in a northeast by southwest direction. According to Hammatt and Bush, this road was constructed by the Territorial Department of Institutions in 1945 and was used to provide access to the Kulani Prison (1999a:12). The prison was subsequently renamed the Kulani Honor Camp and is currently referred to as the Kulani Correctional Facility. The following description of the road's construction, from a 1945 Honolulu Advertiser article, is presented in Hammatt and Bush:

> Hacking out the land for the new Kuulani [sic] Prison is a rough job and the date of its completion would be a risky conjecture, according to Thomas Vance, Director of Institutions, who recently returned from Hawaiʻi where he observed the completed five mile stretch of road to the site.
>
> "Eight operational days were spent in building the first five miles with one bulldozer" he said, "but with two bulldozers and good weather we should cut our work in half."
>
> "Barring delays, the 10-mile road, the first step to completion of the prison project, should be completed in six weeks," he said. (1999a:12).

The Stainback Highway was named for former State Governor Ingram M. Stainback who was instrumental in annexing the Kulani Prison lands from the Upper Waiākea and Olaa Forest Reserves and setting aside the lands to the Department of Institutions for the Kulani Prison Farm (Maly and Maly 2004:98).

Summary of historical documentary research: Kumu Pono Associates

In 2004, Kumu Pono Associates conducted a detailed study of historical and archival literature documenting the natural and cultural landscape and history of land use in the vicinity of the Puʻu Makaʻala Natural Area Reserve, and adjoining lands of Waiākea and ʻŌlaʻa. The WTMA is situated in the same ahupuaʻa as Puʻu Makaʻala NAR: Waiākea, in the South Hilo District and ʻŌlaʻa, in the Puna District. A portion of Puʻu Makaʻala NAR was once part of the WTMA and contains stands of plantation timber that predate its designation as a NAR, which occurred in 1981. As such, the historical information documented in the 2004 study is similarly relevant to WTMA. The full study is included as Appendix E.

The Puʻu Makaʻala Cultural Study includes detailed oral testimonies—describing the lands, traditional and customary practices, and historical land use—from native residents of lands in the ʻŌlaʻa, Waiākea-Humuʻula, and Keauhou vicinity, collected in the 1870s to 1890s. The documentation reflects the product of years of research and includes specific research conducted for the study between October 2003 to April 2004. The research was conducted in private and public collections, and that documentation includes written narratives that cover the period from antiquity to the 1980s.

Portions of the Study are reproduced below:

> Cultural-Historical Context of the Lands and Forests of the Hilo and Puna Districts
>
> For generations following initial settlement, it appears that communities were clustered along the watered, windward (koʻolau) shores of the main Hawaiian Islands. Along the koʻolau shores, in areas such as Waiākea, Punahoa-Piʻihonua, and Laupāhoehoe, streams flowed, rainfall was reliable, and agricultural production could become established. To a lesser extent, locations in Puna, such as in the Keaʻau and Hāʻena vicinity, and in the Kapoho vicinity, early populations could also find the necessary resources for establishing community centers. Along these koʻolau shores, sheltered bays offered access to both deep sea and near shore fisheries. The latter, being enriched by nutrients carried in the fresh water flowing from the mountain streams, and in underground lava tube systems, and by which fishponds and estuarine systems could be developed. In these early times, the residents generally engaged in subsistence practices in the form of fishing, and in agriculture on lands extending towards the uplands from the bays (Handy, Handy and Pukui 1972:287).
>
> Over a period of several centuries, areas with the richest natural resources became populated and perhaps crowded, and by ca. 900 to 1100 AD, the population began expanding to the more remote sections of Puna and the larger Kona (leeward) side of the island (Cordy 2000:130).
>
> As a general summary of lowland residency and cultivation of food resources in the Waiākea section of Hilo, Handy, Handy and Pukui (1972) reported that:
>
> > Hilo as a major land division of Hawaii included the southeastern part of the windward coast...the northern portion, had many scattered settlements above streams running

> between high, forested kula lands, now planted with sugar cane. From Hilo Bay southeastward to Puna the shore and inland are rather barren and there were few settlements. The population of Hilo was anciently as now concentrated mostly around and out from Hilo Bay... The Hilo Bay region is one of lush tropical verdure and beauty, owing to the prevalence of nightly showers and moist warmth which prevail under the northeasterly trade winds into which it faces…
>
> In lava-strewn South Hilo there were no streams whose valleys or banks were capable of being developed in terraces, but cuttings were stuck into the ground and on the shores and islets for many miles along the course of the Wailuku River far up into the forest zone. In the marshes surrounding Waiakea Bay, east of Hilo, taro was planted in a unique way, known as kanu kipi. Long mounds were built on the marshy bottom with their surface two or three feet above water level. Upon the top and along the sides of these mounds taro was planted. Flood waters which occasionally submerged the entire mound are said to have done no harm, as the flow was imperceptible. This swampy land is now abandoned to rank grass. Kipi (mounds) were also formerly made along Alenaio Stream above Hilo… [Handy, Handy and Pukui 1972:538-539]

Cultural Practices and Significance of the Landscape

The native traditions and historical accounts associated with the neighboring lands of the upper Hilo-Puna forests span many centuries, from Hawaiian antiquity to the later period following western contact. The narratives describe customs and practices of the native people who resided on these lands, walked the trails, and who were sustained by the wealth of the forest lands.

Among the most detailed descriptions of the Hilo-Puna forest lands, including documentation of traditional and customary rights, are those found in the Kingdom collections, documenting the history of land tenure, and defining the boundaries of *ahupua‘a* of Waiākea and ‘Ōla‘a. In 1862, a Commission of Boundaries (the Boundary Commission) was established in the Kingdom of Hawai‘i to legally set the boundaries of *ahupua‘a* that had been awarded to *Ali‘i, Konohiki*, and foreigners during the *Māhele*. The primary informants for the boundary descriptions were old native residents of the areas being discussed (generally born between the 1780s to 1820s). The native witnesses usually spoke in Hawaiian, and their testimony was translated into English and transcribed as the proceedings occurred. These oral testimonies document the traditional knowledge and occurrence of native practices in the lands of Waiākea and ‘Ōla‘a.

The selected native testimonies describe a wide range of traditional practices in the uplands of Waiākea, ‘Ōla‘a, and in adjoining lands. The types of usage includes: travel on native trails, land use in a wide range of elevational zones; collection of resources; the collection of, or “hunting” of birds; canoe making; and the subsequent practices associated with hunting introduced ungulates—all under the control of *Konohiki*. The testimonies also record that changes had occurred on the landscape during the lifetime of the witnesses. It is of importance to note that the boundaries were known by the native tenants, and the rights to take or hunt

resources in traditional times were fiercely protected—individuals without chiefly, genealogical claims, or residency ties to given lands were not allowed to trespass and take resources from the *ahupua‘a*.

In regards to hunting, it will be noted that descriptions of traditional hunting practices are limited to native species of birds, including the *ua‘u, nēnē, mamo* and *‘ō‘ō*; while description of historical hunting practices are limited to goats, which were hunted under contract of *Konohiki*, the Crown, or the Government.

These records also reflect native traditions and beliefs, that Hawaiians shared spiritual and familial relationships with the natural resources around them. Each aspect of nature from the stars in the heavens, to the winds, clouds, rains, growth of the forests and life therein, and everything on the land and in the ocean, was believed to be alive. Indeed, every form of nature was a body-form of some god or lesser deity. As an example, in this context, *Kū-ka-‘ōhi‘a-Laka*, is a deified guardian of the *‘ōhi‘a* growth of ‘Ōla‘a; *Ua-kuahine*, is the body form of a goddess of the rains in ‘Ōla‘a; and *Kū-lili-ka-ua* is the god of the thick mists that envelop the forests of the upper Puna, Waiākea, and Keauhou lands. Indeed, tradition also demonstrates that the gods and goddesses of these forest lands were very protective of them. In olden times, travel through them was accompanied by prayer, and care. Traditions tell how many a careless traveler, or collector of resources, found themselves lost in a maze of overgrowth and dense mists as a result of disrespectful and careless actions.

In the Hawaiian mind, care for each aspect of nature, the *kino lau* (myriad body-forms) of the elder life forms, was a way of life. This concept is still expressed by Hawaiian *kūpuna* (elders) through the present day, and passed on in many native families. Also, in this cultural context, anything which damages the native nature of the land, forests, ocean, and *kino lau* therein, damages the integrity of the whole. Thus caring for, and protecting the land and ocean resources, is a way of life.

**

We find that shortly after western contact—the introduction of alien herbivores, and financial value being placed upon resources of the forests and mountain lands—the health and integrity of the resources began to decline. After western contact, the forests were primarily evaluated in the terms of the western economic system. While in the centuries prior to the arrival of westerners in 1778, and subsequently into the reign of Kamehameha I, the system of land tenure and management mirrored the natural landscape of the islands, later management systems focused on what, and how much could be gotten from the land.

Immediately, upon western contact, foreigners looked at the land—first as a source of provisions for ships; and second as a means for earning money, through the trade of natural resources such as *‘iliahi* (sandalwood). In 1778, European boars, goats, rams, and ewes were introduced by Captain Cook. While offered as a “gift,” one of the motivating factors was that

leaving the animals behind would produce a breeding stock to supply other foreign ships. Later, in 1793, cattle were brought to Hawai‘i by Captain Vancouver. Given as gifts to Kamehameha I, the cattle were first let off at Kawaihae (then at Kealakekua), and were placed under a ten-year *kapu* to protect them and allow them to reproduce. Between 1793 and ca. 1811, new stock was added, and the numbers of cattle had increased dramatically. The introduced cattle, goats and sheep rapidly became a problem to the native population and forests.

While the introduced animals were making their way into the higher elevations, other economic pursuits also led to the clearing of large tracts of land. In the early 1800s (ca. 1810-1829), tens of thousands of pounds of *‘iliahi* (sandalwood) were cut from the forests above Waiākea and Keauhou, Ka‘ū. Describing the collection of *‘iliahi* in 1823, from the uplands of the Waiākea region, Ellis wrote:

In Hilo, the party was under the care of the chief Ma‘alo (written Maaro), Ellis and companions offer the following narratives, describing the land there about and activities of the people, among which included hundreds of residents being required to go to the mountains above, and gather sandalwood for their chiefs:

> …we overtook Maaro, the chief of Waiakea, and three or four hundred people, returning with sandal wood, which they had been cutting in the mountains. Each man carried two or three pieces, from four to six feet long, and about three inches in diameter. [Ellis 1963:214] The bark and sap had been chipped off with small adzes, and the wood appeared lighter in colour than what is usually sold at Oahu, probably from its having been but recently cut down…. Although a plant of slow growth, it is found in abundance in all the mountainous parts of the Sandwich Islands, and is cut in great quantities by the natives, as it constitutes their primary article of exportation.
>
> It is brought down to the beach in pieces from a foot to eighteen inches in diameter, and six or eight feet long, to small sticks not more than an inch thick and a foot and a half long. It is sold by weight, and the merchants, who exchange for it articles of European or Chinese manufacture, take it to the Canton market, where it is bought by the Chinese for the purpose of preparing incense to burn in their idol temples. …Dense fogs and heavy rains are more frequent at Waiakea, and over the whole division of Hilo, than in any other part of the island... [Ellis 1963:215].

By the 1830s, the forest had been stripped of sandalwood and many other plants of the forest were impacted by the clearings made for collection and transportation of the *‘iliahi*. Another reason that large sections of the lower forests were cleared, was to develop lands on which western-introduced food crops could be cultivated and harvested for sale to visiting ships.

Contemporary cultural practices

Gathering of plant material for lei making, medicinal use, or other Native Hawaiian traditional uses is believed to occur within the WTMA; however, no specific cultural practices were identified by consulted parties during pre-consultation.

VII. ENVIRONMENTAL IMPACTS AND PLANNED MITIGATION MEASURES

This section provides an analysis of the environmental consequences of implementing the proposed action as compared to current conditions. Impacts are described for the main aspects of the environments described above, including physical, biological, socio-economic, and cultural resources. The potential effects to these resources as a result of implementing the proposed action is then assessed. In addition to the previous section, DOFAW staff experience, existing databases and inventories, relevant plans, studies, and past and current research were used for this analysis. Cumulative impacts, including impacts to resources from reasonably foreseeable events and impacts resulting from interaction of DOFAW actions with actions taking place outside the WTMA, are addressed in the final subsection.

The qualitative terms intermediate, minor, and negligible are used to describe the magnitude of the effect:

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 may 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 could include the irretrievable loss of the resource.

Effects may also be short-term (generally would last less than 1 year or season) or long-term (would last for longer than one year).

Table VII-1 provides an overview of the anticipated environmental effects of the proposed action. The effects are described in terms of the change from current conditions.

Table VII-1. Summary of effects

	Proposed Action
EFFECTS TO PHYSICAL ENVIRONMENT	
Effects to Soils	Minor to intermediate, negative
Effects to Water	Minor, negative
Effects to Air Quality	Negligible
Effect on Wildfire Potential	Negligible
EFFECTS TO BIOLOGICAL RESOURCES	
Effects to Threatened or Endangered Species	
Effects on ʻōpeʻapeʻa	Minor, negative
Effects on ʻio	Minor, negative
Effects on *Drosophila mulli*	Negligible
Effects on *Cyrtandra giffardii*	Negligible
Effects to Vegetation	Minor to intermediate, negative
Effects to Birds	Minor, negative
Effects to Game Animals	Minor, negative
Effects to Invertebrates	Minor, negative
Effects on Significant and Sensitive Habitats	Negligible
EFFECTS TO SOCIAL AND ECONOMIC CONDITIONS	
Effects on Hunting	Short-term, intermediate, negative; Long-term, minor, negative
Effects on Recreational Use	Short-term, intermediate, negative Long-term, minor, positive
Effects on Gathering	Minor, negative
Effects on Research	Negligible

	Proposed Action
Effects on Visual Resources	Short-term, minor, negative
Effects on Economics	Minor to intermediate, positive
Effects on Traffic Patterns	Intermediate, negative
EFFECTS TO CULTURAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES	
Effects to Cultural, Historic, and Archaeological Resources	Minor, negative

A. Effects to Physical Environment

Effects to soils

The proposed action involves the use of heavy equipment for harvesting, road maintenance, site preparation, and replanting activities. Timber harvesting operations also require the construction of temporary skid trails and landings. Additional soil disturbance is possible during tree felling, while logs are skidded to landings, decked, and loaded, and when preparing a site for replanting (which involves crushing or removing existing vegetation).

The soils in the WTMA are well drained with rapid permeability, slight erosion potential, and slow to medium runoff (USDA 1973). Average slope is six percent throughout the WTMA (although much higher in ravines). Where the soil overlies ʻaʻā lava, the substrata is also rapidly permeable. Although the pāhoehoe lava is slowly permeable, water moves rapidly through cracks in the lava.

Management objectives for the long-term productivity and sustainability of the WTMA forest resources necessitate the protection of soil resources on site. Best management practices will be incorporated to minimize the potential for soil movement, erosion, and compaction during tree thinning and harvesting, road maintenance, and site preparation and would include, for example, proper engineering in the design and location of skid trails and landings, avoiding the use of heavy equipment in the steeper and more erosion-prone portion of the project area, phasing harvesting to reduce exposed ground areas, avoiding earthwork in inclement weather or periods of excessively wet soil conditions, using vegetative buffers for erosion control and soil stabilization, and revegetating of bare areas with vegetative cover as an interim measure between harvest and replanting.

It is anticipated that negative effects to soils would be minor to intermediate, because the soils have slight erosion potential, the long-term viability of the timber management area depends on protecting the existing soils, and best management practices would be incorporated into each phase of the proposed action. Effects would not be widespread throughout the WTMA, but would be localized in the specific areas being harvested or undergoing reforestation, and would be temporary.

Effects to Water

The proposed action involves timber harvesting, road maintenance, site preparation, and replanting

activities. The major sources of water quality degradation from these activities are sediment, nutrients, pesticides, and debris. The project area has no running streams except during periods of heavy rainfall, and normal patterns in the area consist mainly of storm water runoff and percolation. All forest management activities would be designed to comply with State water quality standards.

Best management practices would be incorporated to minimize the potential for erosion and encourage normal runoff patterns. These include for example, proper engineering in the design and location of skid trails and landings, avoiding any disruption of natural drainages, preventing excessive soil displacement, providing drainage in case of slope instability, providing culverts, dips, water bars, and cross drainages on roads and skid trails to minimize erosion, avoiding earthwork in inclement weather or periods of excessively wet soil conditions, using vegetative buffers for erosion control and soil stabilization, and revegetating of bare areas with vegetative cover as an interim measure between harvest and replanting. To minimize water quality degradation from nutrients and pesticides, best management practices would be incorporated including choosing pesticides or herbicides suitable for use on the target species and used in strict adherence with all label requirements and incorporating protocols for transportation, storage, use, and disposal of chemicals to minimize opportunities for spills or contamination. Spray will be limited to manual applications in an area about two to three feet in radius around seedlings. Chemical quantities would be carefully prescribed at levels to control the specified target population, and would not be applied in DOFAW-identified buffer zones.

Due to distance from the ocean and the incorporation of best management practices, no impacts to marine water quality are anticipated. Further, due to 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. Overall, it is expected that the proposed action will have minor negative impacts on water quality.

Effects to Air Quality

Limited air pollution from use of heavy machinery and small power tools will be unavoidable; however, emissions from these forest management activities are not expected to exceed the state and national standards. Additionally, discharge of visible fugitive dust, if any, is not anticipated to travel beyond the property line of the forest reserve. Further, any spraying of approved herbicides (e.g., backpack spraying) would be done 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) to avoid spray drift. Loads will be covered if cargo characteristics indicate potential fugitive dust potential, and dust abatement measures will be implemented as necessary.

Based on the characteristics of the planned action, the planned best management practices to be incorporated, the location of the project within a forest reserve and away from development, and the surrounding environment, effects to air quality from the proposed action are anticipated to be negligible. Proximity to an erupting volcano (a significant source of air pollution on the island) is likely to obscure any effect on air quality this project may have. However, due the proximity of a stationary air quality monitoring station in Mountain View, unanticipated impacts to air quality from the proposed action may be identified and remedial steps taken as necessary.

Effect on wildfire potential

The WTMA is located in a high rainfall zone where wildfire occurs only during extreme drought conditions. Though rare, the potential occurrence of drought does require active fire control planning. In February 1926, an escaped trash fire burned 125 acres in WFR, and in March 1926, a land-clearing fire escaped and burned 20 acres of forest. In late March 1926, a fire started from a fisherman's camp on the coast burned 4,000 acres, 700 of which were in the Panaʻewa Forest Reserve. Smaller fires occurred more recently in 1970-1972, and in 1998.

Typically, fire risk increases in forested areas with increased human activity. This area normally is very wet and does not burn readily. During dry periods, DOFAW will post fire prevention signs, distribute brochures, and employ Public Service Announcements to increase public awareness of fire risk. In extreme conditions, DOFAW will consider public access restrictions and minimize timber management activities to mitigate increased risk due to drought.

The proposed action involves timber harvesting, road maintenance, site preparation, and replanting activities using heavy equipment that may get hot and pose a fire threat. Best management practices to be incorporated include no smoking or open fires and the development and implementation of a fire response plan. Maintenance of the road network within the WTMA for timber management activities would have a secondary benefit of improving access and facilitating rapid containment of fire should one occur.

Based on the environmental conditions within WTMA, the incorporation of best management practices, and the maintenance of the road network, effects on wildlife potential from the proposed action are anticipated to be negligible.

B. Effects to Biological Resources

Effects to threatened or endangered species: ʻōpeʻapeʻa

The endangered Hawaiian Hoary Bat, or ʻōpeʻapeʻa, has been detected in the WTMA, but the extent of their distribution and density is unknown. Even though there are no known observations of roosting or breeding ʻōpeʻapeʻa in the area, there is insufficient data to rule out the possibility that they are utilizing forest within the project area for those purposes. Noise and activities associated with commercial harvest operations, road maintenance, and replanting may temporarily disrupt the activities of the ʻōpeʻapeʻa.

The following measures will be taken to avoid any impacts to the ʻōpeʻapeʻa from harvesting or other silviculture activities within the WTMA:

- Timber felling will not be allowed between June 1 and September 15, which is the period when non-flying juveniles may occur in the project area;
- If any ʻōpeʻapeʻa fall to the ground during operations, the operator must immediately cease all activities in the immediate area and contact DOFAW;

- Loss of habitat due to harvesting will be minimized by utilizing lower impact harvesting methods (selective harvest, patch cut, regeneration harvest limited to 40-acre blocks, and no simultaneous harvest of adjacent 40-acre blocks).

However, the restriction on timber felling between June 1 and September 15 may be modified or lifted upon additional surveys and the development and implementation of additional mitigation actions, if DOFAW Wildlife staff and USFWS concur that the proposed mitigation actions will adequately protect the bat from take during ongoing harvesting activities.

Any loss of habitat due to harvesting will be temporary in nature as reforestation efforts and natural regeneration will replace the vegetation in the harvested area. Harvesting of 40 acre blocks may potentially be beneficial to the bats by increasing open areas adjacent to forest stands which are preferred for foraging by the ʻōpeʻapeʻa.

The negative impact on the ʻōpeʻapeʻa is anticipated to be minor because no ʻōpeʻapeʻa have been observed roosting in the project area, harvesting activities will be restricted from June 1 to September 15 to prevent harm to undetected juveniles, ʻōpeʻapeʻa are crepuscular and harvesting activities would occur during the day, and harvesting activities could provide short-term benefits by increasing foraging opportunities.

Effects to threatened or endangered species: ʻio

The endangered Hawaiian hawk, or ʻio, has been detected foraging in the WTMA, but the extent of their distribution and density is unknown. Hawks commonly hunt in forests, but also forage in agricultural and residential areas. Even though there are no known observations of breeding ʻio in the area, there is insufficient data to rule out the possibility. Noise and activities associated with commercial harvest operations, road maintenance, site preparation, and replanting may temporarily disrupt the activities of the ʻio. While human activity appears to have little effect on foraging birds, disturbance at nest sites is known to cause nesting failure and abandonment of young (Griffin 1985).

The following measures will be taken to avoid any impacts to the ʻio from harvesting and related silviculture activities within the WTMA:

- If any breeding ʻio or potential ʻio nests are encountered during operations, the operator must immediately contact DOFAW and suspend all activity in the immediate area until all young ʻio have fledged.

Any loss of habitat due to harvesting will be temporary in nature as reforestation efforts and natural regeneration will replace the vegetation in the harvested area. The negative impact on the ʻio is anticipated to be minor because ʻio density is lower in Puna than in equivalent habitat elsewhere on the island and ʻio density is relatively low in non-native timber plantations, ʻio have not been observed nesting in the project area, ʻio populations on the island appear to be stable, and harvesting activities will be suspended if ʻio nests are discovered.

Effects to threatened or endangered species: Drosophila mulli

D. mulli is historically known from the WTMA, which contains approximately 48 acres of critical habitat for this species. This species is found only associated with its host plant, the endemic palm *P. beccariana*. To avoid negative impacts to *D. mulli*, a buffer will be placed around designated critical habitat within the WTMA and no harvesting related activities will be allowed within the critical habitat or surrounding buffer. Moreover, DOFAW will conduct surveys for the palm prior to the commencement of any timber harvest activities in a particular 40-acre unit, and will place a buffer around any individual trees present outside designated critical habitat. The proposed action is anticipated to have a negligible impact on *D. mulli*, because *D. mulli* has not been observed since 2001, populations are extremely variable depending on rainfall and environmental factors, and the only known host plant will be protected during all timber harvesting activities.

Effects to threatened or endangered species: *Cyrtandra giffardii*

Cyrtandra giffardii has been observed within the WTMA, within timber stands along the western boundary, in an area regenerating into native forest. No harvesting activities will occur in this area. Discussions will take place with the Hawai‘i DOFAW botanist, and with the PEP (Plant Extinction Prevention) program as needed, to determine if cuttings or seed collection is warranted and to identify any additional mitigation measures that should occur. Because no harvesting activity will occur in the vicinity of this plant, the proposed action is anticipated to have a negligible negative impact on *C. giffardii.* Because this plant was not previously known from WTMA, and because it was discovered due to surveys related to the proposed action, the long-term impact to the species may be positive, as cuttings or seeds may be collected to contribute to the establishment of stable populations of this plant in other protected areas.

Effects on Vegetation

The proposed action involves timber harvesting, road maintenance, and site preparation for replanting activities, all of which involve clearing or removing vegetation in varying degrees. All intensive forestry operations will be conducted on areas that were previously converted to non-native timber stands for the purpose of future harvest; native forest areas will not be disturbed. Non-native trees and shrubs dominate the WTMA, and of the few remaining native species in the WTMA, most are common. Because the number of and percent cover of native plants in the WTMA is low, minor overall damage to existing native vegetation is anticipated from the proposed action.

Botanical surveys will be conducted prior to harvest in a particular 40-acre block to ensure that no rare or threatened or endangered plant species are accidentally destroyed. Though not anticipated, if any rare or listed plants are found during harvesting or replanting activities, rare species protocols (e.g., flagging plants, identifying buffer zones, etc.) would be implemented to minimize impact to rare or listed plant species. Known locations of rare or listed plant species would be visited to collect seed or cuttings for propagation as needed, and outplanting of these seeds or cuttings would occur in areas actively managed for rare plant species where possible.

Conversely, the effect on non-native plant species would be greater than on native plant species because of their dominance in the WTMA. These effects are anticipated to be temporary in nature.

Non-native trees will be cut and removed from the site during thinning and harvesting, and competitive weedy vegetation will be controlled mechanically and/or chemically prior to planting. Timber harvesting will be limited to 40-acre blocks and no adjacent 40-acre blocks will be harvested simultaneously. Intentional reforestation through plantings and re-growth from existing on-site seed banks is anticipated to replace vegetation after harvest. Given that the timber species were planted specifically for the purpose of future harvest, that replanting will occur within six months of harvesting activities, and that much of the non-native understory vegetation is common elsewhere, the negative effect of harvesting activities on non-native species is anticipated to be minor.

Introduced timber species planted in the WTMA have the potential to impact native forests by spreading into adjacent native ecosystems. Proposals for utilizing new timber species during replanting activities would be evaluated under the Hawai‘i Pacific Weed Risk Assessment and other appropriate methods to determine invasiveness before any planting may occur. The potential for the spread of non-native timber species into native forest would be increased if a large disturbance event such as fire or hurricane should occur and create suitable habitats for them to become established, but this potential also exists under the no-action alternative. As such, the impact on vegetation of replanting timber species is considered minor.

Invasive plant species such as strawberry guava and glorybush have spread across large areas of the WTMA. Intensive forestry operation could potentially spread these species further across the timber management area on machinery, gear, and equipment. Harvest operations will be strongly encouraged to move from upper elevations down to lower elevations to minimize opportunities for spreading common low-elevation weeds, such as *Clidemia hirta*, into upper elevations where these weeds are not yet found. A sanitation protocol for machinery, gear, and equipment will be prescribed to minimize the potential for introduction of new species and prevent the movement of established and incipient invasive species found within the WTMA, covering plants, invertebrates (such as fire ants and coqui frogs), soil-born organisms, etc. Species-specific protocols will be developed as necessary to contain problem species known to occur in portions of WTMA and prevent their spread in WTMA and to adjacent native forest areas.

Stands of native forest will not be harvested under the proposed action. It should be noted that although native forest initially was cleared for the establishment of non-native forest plantations in Waiākea, DOFAW has not cleared any native forest on the island of Hawai‘i since the early 1970s and introduced legislation (enacted in 1997) that prohibits the conversion of native forests to introduced forest plantations on public lands.

Effects on Birds

Native forest birds are infrequently observed within WTMA, due to the density of disease-carrying mosquitoes below 4,000 ft elevation. Key habitat for the native forest birds is native forest, and there are no known observations of breeding native forest birds in the timber plantations of WTMA. Noise and activities associated with commercial harvest operations, road maintenance, site preparation, and replanting may temporarily disrupt the activities of the few native forest birds foraging or transiting the WTMA. However, because sizable native forest bird populations are unlikely within WTMA due to the

low elevation and lack of native forest habitat, because native forest birds have not regularly been observed using the WTMA, and because areas of native forest within WTMA will not be subject to harvesting activities, the negative impact on native forest birds is anticipated to be minor.

Noise and activities associated with commercial harvest operations, road maintenance, site preparation, and replanting may temporarily disrupt the activities of non-native bird populations as well. The native effect of the proposed action on non-native birds is anticipated to be minor given that non-native bird species were introduced to the WTMA, that non-native bird species largely exist in sizable populations outside the WTMA, and that these birds can easily fly to other locations.

Effects on Game Animals

Game animals may be disturbed by noise and activity associated with timber harvesting, road maintenance, site preparation, and replanting, but these activities will be temporary in nature at specific locations. The clearing of areas as part of harvesting activities may have a positive impact on game populations, but again, may be temporary in nature. The negative effect of the proposed action on game animals is anticipated to be minor given that game animals were introduced to the WTMA, that these non-native species largely exist in sizable populations outside the WTMA, and that these animals can move easily to other portions of WTMA.

Effects on Invertebrates

Given the lack of data on invertebrate numbers and diversity in the WTMA and their habitat needs, it is difficult to assess the impact the proposed action would have on native or non-native invertebrate populations. Existing invertebrates could be disturbed by timber harvesting and site preparation activities, but because of harvest restrictions (regeneration harvest will be limited to 40-acre non-adjacent blocks) and planned replanting, the negative impacts are anticipated to be short-term and minor, as invertebrate communities could re-colonize as vegetation is re-established. Because invertebrate species may occupy protected habitats in the nearby Upper Waiākea, Waiākea and ʻŌlaʻa Forest Reserves and in the Puʻu Makaʻala NAR, the long-term negative effect of the proposed action on invertebrate abundance and diversity is anticipated to be minor.

Effects on significant and sensitive habitats

WTMA overlaps with approximately 48 acres of critical habitat for *D. mulli*. To avoid negative impacts to *D. mulli*, a buffer will be placed around designated critical habitat within the WTMA and no harvesting related activities will be allowed within the critical habitat or surrounding buffer. As such, the impact of the proposed action on critical habitat of *D. mulli* is anticipated to be negligible.

C. Effect on Social and Economic Conditions

Effect on hunting

As noted, game animals may be disturbed by noise and activity associated with timber harvesting, road maintenance, site preparation and replanting, but these activities will be temporary in nature at specific locations. Public access for hunting will be restricted to portions of the WTMA during active harvesting and transporting operations for safety, but restrictions will be temporary and limited in

duration. Signs will be put in place at least one month in advance to alert the public. Habitat changes will occur, as timber is cut and new seedlings are replanted, but access throughout the WTMA is anticipated to improve over time as roads are maintained to support harvesting operations. The proposed action is anticipated to have a short-term intermediate negative impact and a long-term minor negative impact on hunting given that the majority of WTMA is anticipated to remain open to hunting at any given time, that game animals are expected to move throughout the WTMA as harvesting activity occurs, and the existing acreage available for hunting in the general area outside the WTMA (Upper Waiākea Forest Reserve, ʻŌlaʻa Forest Reserve, Puʻu Makaʻala NAR).

Effect on recreational use

Besides hunting, recreational use is primarily composed of use by all-terrain vehicles and motorcycles, mountain biking, and horseback riding. These recreational activities will still be allowed within the WTMA, but public access will be restricted in portions of the WTMA during active harvesting and transporting operations for safety. These restrictions will be temporary and limited in duration. When harvesting activities are occurring in any block containing or adjoining any of the trails used recreationally, it is anticipated that those trails will be closed. Signs will be put in place at least one month in advance to alert the public.

The nature of harvesting activities (felling timber, crushing slash, replanting seedlings) will necessarily alter the recreational landscape. Upon completion of harvesting, existing access roads will be restored to their condition prior to harvest. Existing off-road single and double track routes will be re-established in coordination with the recreational users, with routes planned to limit impacts to replanted seedlings. For the area below Quarry Road, some slash may be specifically moved to provide obstacles for mountain bike trail riders. It is anticipated that the proposed action may increase overall opportunities for recreational use as harvesting activities clear and maintain access roads and trails that have become overgrown. Given that closures will be temporary in nature and the potential for improved access within the WTMA, the proposed action is anticipated to have a short-term minor negative impact and potential long-term minor positive impact on recreational use.

Effect on gathering

Gathering activities within the WTMA for personal, cultural, religious or traditional use will still be allowed within the WTMA, but public access will be restricted in portions of the WTMA during active harvesting and transporting operations for safety. These restrictions will be temporary and limited in duration, and potential gatherers will be redirected into other open locations (either in WTMA or in adjacent Forest Reserves) where possible. Given that closures will be temporary in nature, and that gathering may be redirected into other areas, the negative impact of the proposed action is anticipated to be minor.

Effect on research

Harvesting activities are not planned for units that have been previously identified as important for long-term research, and there is potential for additional field studies within the WTMA, especially in regard to introduced timber species in Hawaiʻi. The impact of the proposed action on research is anticipated to be negligible because existing research is likely to continue unaffected and specific

future research is currently speculative.

Effect on visual resources

Generally speaking, the remote, undeveloped nature of WTMA and the surrounding topography means the area is not visible from any public highways or from homes or vantage points in Hilo or Volcano. It is visible as part of a larger forested greenscape viewed by tour helicopters visiting the volcano or touring the island.

During initial planting efforts in the WTMA, a native forest corridor was left intact along Stainback Highway (approximately 100 feet wide on each side) for aesthetic and wildfire pre-suppression purposes. This buffer will not be disturbed during harvesting activities, and as such, visual impacts along the Stainback Highway should be negligible.

The visual aesthetics of the project area will be temporarily impacted by the proposed action because of rapid reduction in vegetative cover. To minimize this impact, regeneration harvest is limited to 40-acre units, and adjacent units will not be harvested simultaneously. All harvested areas will be replanted within six months. As such, negative visual impacts from the air should be short-term and minor.

Effect on economic conditions

DOFAW plans to issue a request for proposals for harvesting the WTMA in a manner that supports a consistent flow of timber from the land over time, rather than a short-term intense harvesting operation. This would support continual direct employment of persons associated with harvesting, transporting, and replanting activities, and would also support continued employment of persons associated with processing or using the timber and wood resources.

The 2004 survey “Economic Value of Hawaii’s Forest Industry in 2001” revealed that over 900 workers were employed in the Hawai‘i forest industry, with a corresponding payroll of $30.7 million (Yanagida et al. 2004). The retail value of Hawai‘i-grown forest products was estimated at $23.9 million, among all the main islands; however, the majority of this value (75 percent) was associated with sales of koa (Friday et al. 2006).

Some local purchases associated with harvesting activities may include rental of heavy equipment, lodging for harvesting crews, purchase of seedlings, herbicide, and other supplies, and transportation costs associated with moving the timber from the site for processing. Salary spending associated with harvesting, site restoration, and timber license monitoring could generate secondary benefits by providing jobs in other industries where monies are spent. Personal spending could include rent, utilities, food, entertainment, gas, etc.

The WTMA has an estimated economic stumpage value of several million dollars, which would be paid to DOFAW over the life of the timber land license (estimated at 10 to 20 years) as timber is harvested. The value-added economic gain may be significant, if the raw materials are processed into products of higher value (such as furniture, veneer, etc.). DOFAW's goal is for the timber resources of the WTMA to be used to manufacture locally desired wood products or to be used as biofuel to reduce

dependence on imported oil, but the actual use of the timber resources will depend largely on market interest demonstrated during the RFP process. All revenues received would be deposited into the Forest Stewardship Special Fund and be spent on future forest reserve management.

The project is not expected to have any negative economic impacts. Positive economic impacts are the creation of new jobs and additional revenues for forest management. Given the size of the project relative to the overall DOFAW budget or to other economic inputs into the local economy, the effects to economic resources are minor to intermediate.

Effect on traffic

Transporting forest products from the Waiākea Timber Management area will increase the use of Stainback Highway, Volcano Road (Route 11), and to a lesser extent North Kūlani Road, which may be used on a temporary basis if needed. It is anticipated that a fully operational active harvesting operations will require no more than 28 truckloads, regularly spaced, per day.

Transportation on public roadways is expected to occur up to 7 days a week during active harvest times. DOFAW will require that all transportation of timber comply with applicable state and county requirements regarding oversize and overweight vehicles. In addition, loads will be covered as necessary to prevent logging debris (leaves, limbs, etc.) from blowing off and becoming a safety hazard for other vehicles. Clearing or sweeping of the paved road will be conducted as necessary to remove mud, gravel and other debris from the paved road.

During timber transportation, operators will be required to utilize appropriate road and traffic warning signs and use signal cars, if necessary. Additionally, a press release will be issued to inform the public of their activities along these roadways. The County of Hawai‘i (Pana‘ewa Zoo) and the State Department of Public Safety (Kūlani Correctional Facility) will be specifically notified about anticipated use patterns.

Overall, the impact to local traffic along Stainback Highway and Volcano Road (Route 11) from the proposed action is not anticipated to be significant based on observations of the impact of transporting timber from a similarly sized harvesting operation in Hamakua. Recognizing that differences do exist between the two areas, DOFAW will monitor the transportation situation, and restrictions regarding the timing of timber transport (e.g., reduce or restrict transport during peak traffic times) may be implemented or alternate transportation routes may be explored. Given the low annual average daily traffic (AADT) and 24 hour truck volumes as determined by Hawai‘i Department of Transportation (HDOT) surveys for the roadways, the low traffic volume contribution of this project, the characteristics of Stainback Road, and the driving habits of the local residents, the anticipated negative impact on existing traffic is intermediate.

D. Effects to Cultural, Historic and Archaeological Resources

An Archaeological Inventory Survey completed in April 2014 concluded that the WTMA was utilized prehistorically as evidenced by the previously identified burial cave, but that the majority of traditional

land use in this area was likely for the procuring of natural resources (e.g., timber, medicinal plants, olona, and birds) and temporary habitation associated with this activity. As such, the physical evidence of these activities would have been ephemeral and left little if any surviving physical evidence. The AIS further noted that the absence of prehistoric sites in the survey blocks was not unexpected due to "the extensive ground disturbance that has occurred in the area since the early 1960s and the expected low site density predicted by McEldowney's (1979) settlement pattern model."

The AIS documented two modern historical features: a badly disturbed remnant of the historic ʻŌlaʻa Flume associated with the sugarcane industry and a historic road (ʻŌlaʻa Back Road) that is currently in use by local residents as Ihope Road). While assessed as significant for their information content, and (for the flume) in association with the broad pattern of sugarcane agriculture, the AIS concluded that existing documentation is adequate and no further work or preservation is recommended.

A previously documented burial cave could not be re-located, despite repeated efforts. The entrance may have been blocked by a sheared off section of ridge or the cave may have been inaccurately plotted in 1985. To minimize the possibility of harm to this cave during timber harvest operations, DOFAW will require archaeological monitoring for any activities within a 500-square meter (61.7 acre) area centered on the reported location of the burial cave, as recommended by the AIS.

The negative impact on archaeological and cultural resources is anticipated to be minor because the area was mechanically cleared approximately fifty years ago, no known features are listed on the State or National Register of Historic Places, no new cultural resources have been discovered within the WTMA, and consultation did not uncover any cultural activities that could be impacted by the proposed action.

Should evidence of any undetected archaeological or cultural property (e.g., burial cave) be encountered during timber harvest, road maintenance, site preparation or replanting, activities will stop and the appropriate parties be consulted immediately. Where possible, cultural resources will be avoided. Minimization options, in addition to site avoidance, would include data recovery, using either collection techniques or in-site site stabilization protection.

Cumulative Impacts

HAR §11-200-2 defines cumulative impact as

> *"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 or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

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.

DOFAW is not aware of any past, present, or planned actions that would result in a significant cumulative impact when added to the proposed action.

VIII. ANTICIPATED DETERMINATION

The Division of Forestry and Wildlife anticipates a **Finding of No Significant Impact (FONSI)** declaration for this project.

IX. FINDINGS AND REASONS SUPPORTING ANTICIPATED DETERMINATION

In determining whether the proposed action will have a significant impact on the environment, the Division considered the phases of the proposed action (from planning through implementation, including timber harvest, transporting the timber, and replanting), the expected consequences, both primary and secondary, and the cumulative as well as short and long-term effects of the action. In addition, the Division specifically evaluated the project under the following 13 significance criteria, as provided in HAR §11-200-12:

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

Sustainable timber harvesting operations would create a temporary disturbance to portions of the forest, and all harvesting activities will be followed by replanting. Existing native forest will not be harvested. The WTMA will remain a working forest and continue to support existing recreational uses of the forest. As discussed more fully above, the proposed action is anticipated to have a minor negative impact on water quality, the endangered ʻōpeʻapeʻa, the endangered ʻio, and cultural resources, and a minor to intermediate negative impact on soils and vegetation. No irrevocable loss or destruction of natural or cultural resources is involved.

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

The proposed project does not curtail the range of beneficial uses of the environment. Opportunities for public enjoyment and outdoor recreation activities, such as hunting, off-road vehicle use, mountain biking, and horseback riding, will continue, though access to specific areas of WTMA will be

temporarily limited during periods of active harvesting and loading operations. Gathering plant material from the project area for personal, cultural, religious, and traditional uses will still be encouraged, though access to specific areas of WTMA may be temporarily limited during periods of active harvesting and loading operations and alternate gathering locations within WTMA may be recommended. Finally, road maintenance conducted to support harvesting and transportation of timber should positively impact public use, by improving access within the WTMA.

3. Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in HRS Chapter 344;

HRS §344-3 provides in part:

> It shall be the policy of the State, through its programs, authorities, and resources to:
> (1) Conserve the natural resources, so that land, water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which humanity and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawaii. …

HRS §344-4 provides in part:

> In pursuance of the state policy to conserve the natural resources and enhance the quality of life, all agencies, in the development of programs, shall, insofar as practicable, consider the following guidelines:
> …
> (2) Land, water, mineral, visual, air, and other natural resources
> (A) Encourage management practices which conserve and *fully utilize* all natural resources; …
> (D) Encourage management practices which conserve and protect watersheds and water sources, forest, and open space areas; …
> (5) Economic development.
> (A) Encourage industries in Hawaii which would be *in harmony* with our environment; …
> (D) Encourage all industries including the fishing, aquaculture, oceanography, recreation, and forest products industries to protect the environment; … (emphasis added).

The proposed action is based on sound forest stewardship and sustainable, long-term productivity. The existing timber in WTMA is mature, and harvesting the timber as proposed in this document would improve forest health and vigor while encouraging an emerging forest products industry in a manner harmonious with the environment.

In addition, the proposed action is consistent with DLNR-DOFAW's existing Forest Products Development program and with DOFAW's mission statement "to grow high quality forest products in sustained yield systems and practices to create job opportunities in rural areas and to broaden Hawaii's

economic base." This project will provide employment opportunities, and the State's economic base will be enhanced. The proposed action focuses on utilizing the resources of an existing non-native timber forest and supports development of a forest products industry that does not rely upon exploitation of native forest. As such, the proposed action does not conflict with the state's long-term environmental policies or goals and guidelines as expressed in HRS Chapter 344.

4. Substantially affects the economic welfare, social welfare, and cultural practices of the community or State;

The proposed action does not substantially affect the economic welfare, social welfare or cultural practices of the community or State. The economic and social welfare of the community and state will be improved with the implementation of the proposed project through the creation of new jobs and additional revenues for forest management. The WTMA has an estimated economic stumpage value of several million dollars. However, the value-added economic gain to the local economy is anticipated to many times that of the actual stumpage value. DOFAW's goal is for the timber resources of the WTMA to be used to manufacture locally desired wood products or to be used as biofuel to reduce dependence on imported oil, but the actual use of the timber resources will depend largely on market interest demonstrated during the RFP process. All revenues received would be deposited into the Forest Stewardship Special Fund and be spent on future forest reserve management. No specific cultural practice has been identified that would be affected by the proposed action.

5. Substantially affects public health;

The proposed action does not substantially affect public health.

6. Involves substantial secondary impacts, such as population changes or effects on public facilities;

The proposed action does not involve substantial secondary impacts (such as population changes or effects on public facilities).

7. Involves a substantial degradation of environmental quality;

The proposed action does not involve a substantial degradation of environmental quality. The WTMA will remain forested watershed; harvesting will be spread over time and re-planting of an area will occur within six months of harvest. Invasive species protocols will be incorporated to minimize the potential spread of invasive species into and within the WTMA during all activities.

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

The proposed action does not have considerable cumulative adverse effects nor does it involve a commitment for larger actions.

9. Substantially affects a rare, threatened or endangered species or its habitat;

The proposed project does not substantially affect a rare, threatened, or endangered species, or its habitat. As noted earlier, the native Hawaiian Hoary Bat, or ʻōpeʻapeʻa, has been detected in the WTMA, but the extent of their distribution and density is unknown. Because no ʻōpeʻapeʻa have been observed roosting in the project area, because harvesting activities will be restricted from June 1 to September 15 to prevent harm to undetected juveniles, because ʻōpeʻapeʻa are crepuscular and harvesting activities would occur during the day, and because harvesting activities could provide short-term benefits by increasing foraging opportunities, the anticipated negative impact on the ʻōpeʻapeʻa is minor.

The endangered Hawaiian hawk, or ʻio, has been detected foraging in the WTMA, but the extent of their distribution and density is unknown. Because ʻio density is lower in Puna than in equivalent habitat elsewhere on the island and because ʻio density is relatively low in non-native timber plantations, because ʻio have not been observed nesting in the project area, because ʻio populations on the island appear to be stable, and because harvesting activities will be suspended if ʻio nests are discovered, the anticipated negative impact on the ʻio is anticipated to be minor.

The threatened picture-wing fly, *Drosophila mulli* is historically known from the WTMA, which contains 48 acres of critical habitat for this species. Because *D. mulli* has not been observed since 2001, because populations are extremely variable depending on rainfall and environmental factors, because no harvesting activities will occur within the critical habitat, and because the only known host plant (*Pritchardia beccariana*) will be protected by a buffer where found outside critical habitat from all timber harvesting activities, the proposed action is anticipated to have a negligible impact on *D. mulli.*

The endangered plant *Cyrtandra giffardii* has been observed within the WTMA, within timber stands along the western boundary, in an area regenerating into native forest. No harvesting activities will occur in this area. Because no harvesting activity will occur in the vicinity of this plant, the proposed action is anticipated to have a negligible negative impact on *C. giffardii.* Because this plant was not previously known from WTMA, and because it was discovered due to surveys related to the proposed action, the impact to the species may be positive, as cuttings or seeds may be collected to assist in the establishment of stable populations of this plant in other protected areas.

There are no other known threatened and endangered species in the project area. Botanical surveys will be conducted throughout areas that will be immediately impacted by timber harvesting activities to ensure that no rare or threatened and endangered plant species are present. Though not anticipated, if any endangered plants are found during harvesting or replanting activities, rare species protocols (e.g., flagging plants, identifying buffer zones, etc.) would be implemented to avoid impact to any rare plant species. Known locations of rare or threatened and endangered plant species would be visited to collect seed or cuttings for propagation as needed, and outplanting would occur in areas actively managed for rare plant species.

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

The proposed action does not detrimentally affect air or water quality or ambient noise levels.

Effects on air quality from the proposed action are anticipated to be negligible based on the characteristics of the planned action, planned best management practices to be incorporated, location of the project within a forest reserve and distance to the nearest development, and the surrounding environment. Proximity to an erupting volcano (a significant source of air pollution on the island) is likely to obscure any effect on air quality this project may have. However, unanticipated impacts to air quality from the proposed action may be identified through the nearby stationary air quality monitoring station in Mountain View and remedial steps taken as necessary.

Due to distance from the ocean and the incorporation of best management practices, no impacts to marine water quality are anticipated. Further, due to 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. Overall, it is expected that the proposed action will have minor negative impacts on water quality.

Periodic noise from heavy equipment, power tools and other activities associated with this project will be unavoidable. The WTMA for the most part, is contained within the forest reserve. There are only a few adjacent residences located primarily on the southern boundary of the project location. Noise impacts are anticipated to be negligible to the general public, including visitors to the forest reserve on weekends.

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

The proposed action does not affect nor is likely to suffer damage by being located in an environmentally sensitive area such as a floodplain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters. The Waiākea Timber Management Area is not located in or near any of the above-mentioned environmentally sensitive areas.

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

The proposed action does not affect scenic vistas and viewplanes identified in county or state plans or studies.

The WTMA is not identified as a scenic vista or viewplane. Generally speaking, the remote, undeveloped nature of WTMA and the surrounding topography means the area is not visible from any public highways or from homes or vantage points in Hilo or Volcano. It is visible as part of a larger forested greenscape viewed by tour helicopters visiting the volcano or touring the island.

During initial planting efforts in the WTMA, a native forest corridor was left intact along Stainback

Highway (approximately 100 feet wide on each side) for aesthetic and wildfire pre-suppression purposes. This buffer will not be disturbed during harvesting activities, and as such, visual impacts along the Stainback Highway should be negligible.

The visual aesthetics of the project area will be impacted by the proposed action, through a rapid reduction in vegetative cover. To minimize this impact, regeneration harvest is limited to 40-acre units, and adjacent units will not be harvested simultaneously. All harvested areas will be replanted within 6 months. As such, negative visual impacts from the air should be short-term and minor.

13. Requires substantial energy consumption.

The proposed action does not require substantial energy consumption. Petroleum fuels will be used by the heavy equipment utilized for timber harvesting, road maintenance, timber transportation, and site replanting, but this energy consumption is not anticipated to be substantial, especially in comparison to island-wide energy consumption.

X. LIST OF PERMITS REQUIRED

Implementation of the proposed action may require the following permits and permissions:

Permit	**Issuing Agency**	**Comment**
National Pollution Discharge Elimination System (NPDES) General Permit	State Department of Health Clean Water Branch	NPDES general permit coverage required if construction activities involve clearing, grading and excavation that result in the disturbance of one or more acres.
Board approval	Board of Land and Natural Resources	HRS §183-16.5 requires BLNR approval of a Forest Management Plan before timber harvest on state-owned land.

XI. ENVIRONMENTAL ASSESSMENT PREPARATION INFORMATION

This environmental assessment was prepared by the Division of Forestry and Wildlife of the Department of Land and Natural Resources, with assistance from Anden Consulting.

XII. REFERENCES

Bonaccorso, F., Gorresen, P.M., Todd, C. and C. Cornett. 2008. Seasonal Movements and the Occurrence of Hoary Bats in Hawai‘i. Oral presentation. Hawai‘i Conservation Conference. Honolulu, HI, July 29-31, 2008.

Forest Solutions, Inc. 2014. Commercial tree species for Waiākea Forest. Kamuela, HI.

Foote, Donald E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil Survey of the Islands of Kaua‘i, Oahu, Maui, Molokai and Lanai, State of Hawaii, U.S. Dept. of Agriculture. U.S. Government Printing Office, Washington, D.C.

Friday, J.B., J. Yangida, P. Illukpitiya, R. Mamiit, and Q. Edwards. 2006. Characteristics of Hawaii's Retail Forest Industry in 2001. Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. El-8.

Giambelluca, Thomas W., Michael A. Nullet, and Thomas A. Schroeder. 1986. Rainfall Atlas of Hawai‘i. Department of Land and Natural Resources, Honolulu.

Google Earth. 2010. Aerial photographs of Hawaii. Google, Inc. Mountain View, CA. Accessed at www.google.com/earth.html

Gorreson, Marcos, R. Camp, J. Klavitter, and T. Pratt. 2008. Abundance, Distribution and Population Trend of the Hawaiian Hawk: 1998-2007. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo. Technical Report HCSU-009.

Gorreson, M.P., F.J. Bonaccorso, C.A. Pinzari, C.M. Todd, K. Montoya-Aiona, and K. Brinck. 2013. A Five Year Study of Hawaiian Hoary Bat (Lasiusus cinereus semotus) Occupancy on the Island of Hawaii. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo and United States Geological Survey, Hawaii National Park. Technical Report HCSU-041.

Griffin, Curtice, P. Paton, and T. Baskett. 1998. Breeding Ecology and Behavior of the Hawaiian Hawk. In The Condor, Vol. 100.

Handy, E.S. and Elizabeth Green Handy. 1972. Native Planters in Old Hawaii: Their Life, Lore, and Environment. Bishop Museum Press: Honolulu.

H.T. Harvey and Associates. 2014. Best Management Practices and Conservation Measures for the Hawaiian Hoary Bat for Commercial Timber Harvest Operations. Final Report.

Haun and Associates. 2014. Final Archaeological Inventory Survey Waiākea Timber Management Area.

Haun and Associates. 2013. Final Plan for Archaeological Inventory Survey Waiākea Timber Management Area.

Hawai‘i Department of Business, Economic Development, and Tourism, Office of Planning, Coastal Zone Management Program. 2010. Hawai‘i Watershed Guidance. Available at:

http://files.hawaii.gov/dbedt/op/czm/initiative/nonpoint/HI%20Watershed%20Guidance%20Final.pdf

Hawai‘i DLNR, Division of Forestry and Wildlife. 1999. Final Environmental Assessment for Commercial Harvesting of Forest Products and Subsequent Reforestation of Waiakea Timber Management Area. http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Hawaii/1990s/1999-08-08-HA-FEA-WAIAKEA-TIMBER-MGMT-AREA-COMMERCIAL-HARVESTING.pdf

Hawai‘i DLNR, Division of Forestry and Wildlife. 1996. Best Management Practices for Maintaining Water Quality in Hawai‘i. Honolulu, HI.

Hawai‘i Department of Transportation, Planning Survey Section. 2012. personal communication.

Hawai‘i Forest Industry Association. 2007. HFIA Association News, vol. 2 issue 7.

Howarth, F.G. and W.P. Mull. 1992. *Hawaiian Insects and Their Kin*. University of Hawai‘i Press: Honolulu.

ITIS (Integrated Taxonomic Information System). Accessed on-line at http://www.itis.gov (August 19, 2014).

Klavitter, John, J. Marzluff, and M. Vekasy. 2003. Abundance and Demography of the Hawaiian Hawk: Is Delisting Warranted? In The Journal of Wildlife Management, Vol. 67, No. 1.

Kumu Pono Associates. 2004. He Mo‘olelo ‘Āina: A Cultural Study of the Pu‘u Maka‘ala Natural Area Reserve. http://dlnr.hawaii.gov/ecosystems/files/2013/07/Cultual-Study-Puu-Makaala.pdf.

Lucas, Paul, F. Nahoa. 2004. No Ke Ola Pono O Ka Lāhui Hawai‘i: The Protection and Perpetuation of Customary and Traditional Rights as a Source of Well-Being for Native Hawaiians. In Hūlili: Multidisciplinary Research on Hawaiian Well-Being. Vol. 1, No. 1. Kamehameha Schools.

Menard, T. 2001. Activity patterns of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) in relation to reproductive time periods. MSc Thesis. University of Hawai‘i at Manoa.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawai‘i Comprehensive Wildlife Conservation Strategy. Honolulu, HI. Available at: http://www.dofaw.net/cwcs/.

Pukui, M.K., S.H. Elbert, and E.T. Mookini. 1974. Place Names of Hawai‘i. University of Hawai‘i Press: Honolulu.

Pukui, M.K. and S.H. Elbert. 1986. Hawaiian Dictionary. University of Hawai‘i Press: Honolulu.

USFWS. 1998. Recovery plan for the Hawaiian hoary bat. U.S. Fish and Wildlife Service, Portland, OR.

USFWS. 2012. Cyrtandra giffardii. 5-year review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc4085.pdf

USFWS. 2012. Drosophila mulli (Picture-wing fly). 5-year review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc4098.pdf

USFWS. 2014. Proposed Rule: Removing the Hawaiian Hawk from the Federal List of Endangered and Threatened Wildlife. Federal Register, Vol. 79, No. 29, February 12, 2014. http://www.gpo.gov/fdsys/pkg/FR-2014-02-12/pdf/2014-02982.pdf

Yanagida, John, J. Friday, P. Illukpitiya, R. Mamiit, and Q. Edwards. 2004. Economic Value of Hawaii's Forest Industry in 2001. Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. El-7.

Ziegler, A.C. 2002. Hawaiian Natural History, Ecology, and Evolution. University of Hawai‘i Press: Honolulu.

Appendix A: List of Consulted Parties

Federal:

- US National Park Service, Hawai‘i Volcanoes National Park
- US Army Garrison, Pōhakuloa
- US Fish and Wildlife Service, Pacific Islands Field Office
- US Geological Survey, Biological Resources Division
- USDA Farm Service Agency
- USDA Forest Service, Institute of Pacific Islands Forestry
- USDA Natural Resources Conservation Service
- NRCS Hilo Service Center
- Waiākea, Puna, Ka‘ū, and Hamakua Soil and Water Conservation Districts
- US Senator Daniel Akaka
- US Senator Daniel Inouye
- US Representative Mazie Hirono

State:

- Agribusiness Development Corporation
- Department of Agriculture
- Department of Business, Economic Development & Tourism
- Department of Defense (Youth Challenge Academy)
- Department of Hawaiian Home Lands
- Department of Health
- Department of Health, Environmental Planning Office
- Department of Land and Natural Resources
    - Division of Conservation and Resources Enforcement
    - Division of Historic Preservation
    - Division of Historic Preservation, Hawai‘i Island Office
    - Hawai‘i Island Burial Council
    - Land Division
    - Land Division, Hawai‘i Land Agent
    - Natural Area Reserves Commission
    - Office of Conservation and Coastal Lands
    - State Parks Division
- Department of Public Safety
- Department of Transportation
- Libraries (Hilo Public Library, Mountain View Public and School Library, Kea‘au Public Library, Edwin H. Mookini Library)
- Office of Environmental Quality Control
- Office of Hawaiian Affairs
- University of Hawai‘i Environmental Center
- University of Hawai‘i, College of Tropical Agriculture and Human Resources, Cooperative Extension Office
- University of Hawai‘i, Pacific Cooperative Studies Unit
- State Representative Robert Herkes

Appendix B: WTMA Draft Forest Management Plan (2014)

Forest Management Plan for the Waiākea Timber Management Area

Revised December 2014

Prepared by:

State of Hawai‘i

Department of Land and Natural Resources

Division of Forestry and Wildlife

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FOREST MANAGEMENT PLAN SIGNATURE PAGE

Hawai‘i District certification: This plan was prepared by a team of Division of Forestry and Wildlife (DOFAW) staff to provide a management framework for the Forest Reserves listed. The plan was developed in consultation with other governmental agencies, community, and environmental organizations.

_____ _____

Steven T. Bergfeld - Hawai‘i District Branch Manager Date

DOFAW Administrator’s approval: I have reviewed the enclosed Forest Management Plan and concur with the recommendations herein. I agree that resource management implementation will follow those specified in the Management Plan for the Forest Reserves listed.

_____ _____

Lisa J. Hadway - Administrator Date

Department of Land and Natural Resources Board approval: This plan meets the criteria established for State Forest Reserve Management Plans as mandated by Chapter 183, Section 16.5, Hawai‘i Revised Statues.

_____ _____

William J. Aila, Jr. - Chairperson Date

I. INTRODUCTION

The Division of Forestry and Wildlife proposes to harvest timber from the Waiākea Timber Management Area (WTMA) to meet the goals stated in Section V of this document. After Board of Land and Natural Resources approval of the WTMA plan and the accompanying Environmental Assessment, the following actions will be taken:

1. A Request for Proposals (RFP) will be issued under the authority of Chapter 103D, HRS
2. A Land License will be issued to the selected project(s).

The 2004 survey "Economic Value of Hawaii's Forest Industry in 2001" revealed that over 900 workers were employed in Hawai‘i forest industry, with a corresponding payroll of $30.7 million (Yanagida et al. 2004). This is an increase in forestry jobs from the 1991 report in which the forest industry in Hawai‘i contributed $29 million and 736 jobs to our economy. This places the average wage rate for forest industry employees at over 50 percent higher than the average for farm labor (Robinson 2007). Additionally, the retail value of Hawaii-grown forest products was $23.9 million, distributed among all the main islands; 75 percent of which were sales of koa (Friday et al 2006). Sustainable commercial forest management can bring economic stability; enhance the environment, while retaining the rural character of the islands. The island of Hawai‘i is the best location in the State to stimulate local forest industry as it has high unemployment, thousands of acres of vacant and/or under-utilized high quality forest land, and an existing commercial forest resource base that can support a range of value added forest processing options.

An aggressive yet attainable integrated forest industry initiative of 60,000 acres of forest plantations on the island of Hawai‘i could support sustainable long-term direct employment of nearly 500 people. This does not take into account indirect benefits such an industry would have on the local economy. The forest growing and harvesting program would employ over 200 people, with peaks of over 300 in the early establishment years. The processing sector would provide additional long term employment of 235 people. Using a multiplier factor of 2.2 for each direct job, the creation of 1,000 jobs is a realistic possibility. A large number of skilled workers will be required to staff these plants, including engineers, computer operators, marketing personnel and accountants.

Based on current Hamakua Coast logging operations and U.S. West Coast estimates, about 15 to 20 new jobs for harvest operations, transportation, and replanting could be created by implementation of this Forest Management Plan, and perhaps twice that many indirect and manufacturing jobs could be created or retained. As the local wood products industry develops and faster growing plantations become established, additional jobs could be created. Currently there are estimated to be approximately 50 people on Hawaii Island that are full time timber or wood product employees.

Although the economics of forestry has been variable, the State can provide a strategic role by guiding public timber assets into local processing facilities that will optimize jobs for the local community, provide for local energy needs, as well as contribute to carbon sequestration. The Waiākea Timber Management Area, which contains substantial timber resources on the island of Hawai‘i, will influence how the forest industry develops and help define the role of public forest assets in overall commercial forestry development throughout the State.

II. DIVISION OF FORESTRY & WILDLIFE

The Division of Forestry and Wildlife (DOFAW) is one of the Divisions of the Department of Land and Natural Resources. DOFAW is the largest land management entity in the State and has direct responsibility for over 900,000 acres of State-owned trust lands. These lands are managed through an integrated system of forest and natural area reserves, wildlife sanctuaries, and wilderness and game management areas. Within this system lie the vast majority of America's tropical rainforests and the world's most unique and threatened biodiversity. Ecosystems managed by DOFAW include subalpine communities, mesic forests, montane and lowland rainforests, tropical dry forests and woodlands, coastal strand forests, and introduced forest plantations. On the Island of Hawai‘i, DOFAW currently has the direct management responsibility for over 700,000 acres of which approximately 440,000 acres are within the forest reserve system. Of the over 440,000 acres, under five percent or 18,441 acres could be managed for timber harvesting.

Principal responsibilities for DOFAW statewide include watershed protection, forest product development, nursery seedling production, native and endangered species protection, wildland fire suppression, public trails and access, and game management programs. A variety of landowner assistance programs that focus on conservation, restoration and/or forest products are also available through DOFAW to non-industrial private forest landowners.

III. PURPOSE OF THE FOREST MANAGEMENT PLAN

The Waiākea Timber Management Area (WTMA), as revised, is designed to meet the requirements of Chapter 183, Hawai‘i Revised Statues regarding timber harvesting on State lands. DOFAW's vision for the WTMA is to provide a model for developing and utilizing timber management areas throughout the State that will sustainably supporting the growth of the forest industry in Hawai‘i.

> **"Environmentally sustainable, economically profitable, accommodating the needs of the people of Hawai‘i, fitting within a landscape of forest watersheds and healthy native ecosystems."**

The WTMA has several important public uses in addition to timber resources, including recreation, gathering, hunting, habitat for native biodiversity and watershed protection. Developed with the most currently available data, the WTMA plan will ensure that all of these uses are considered and that Best Management Practices (Appendix A) will be employed to mitigate any potential negative impacts from commercial forestry activities. Plan revisions will be conducted as necessary to reflect environmental and cultural changes as well as technical advancements.

The WTMA plan, approved September 1998, included open dialogue and input from the community and interest groups resulting in a mutually agreeable plan for the management of the WTMA. The plan is intended to guide the growing forest industry of Hawai‘i and fit within the broader management context of native forest protection. Input and assistance from special interest groups and local communities were solicited and community field trips were held so interested parties can see the WTMA first hand. The revised Forest Management Plan incorporates new information and data, and management decisions consider the previously provided community input. The plan is the basis for an environmental assessment (EA) developed under Chapter 343, HRS. Both the WTMA plan and EA will be used as the basis for soliciting additional community and public input on the use of WTMA. The State of Hawai‘i intends to engage the private sector in the sale of timber and other wood fiber resources in WTMA through traditional timber licenses in order to develop a sustainable local wood products industry, and at the same time, maintain native forest ecosystems, preserve hunting and established recreational uses, and accommodate existing traditional gathering practices.

IV. THE WAIĀKEA TIMBER MANAGEMENT AREA

A. Purpose and history: The original purpose of the WTMA was to establish a forest resource base that could provide a consistent wood and forest products supply for the forest product industry in Hawai‘i. From 1956-1960, the Waiākea Arboretum was used to test adaptability and growth potential of 84 introduced timber species to be planted within the WTMA. Major planting efforts began in 1959 and continued through 1968. Approximately 330 acres of land, formerly leased to the Puna Sugar Company, was also planted in the early 1980's. Some WTMA plantation units were weeded or fertilized in the early years, but the majorities were allowed to grow without any timber stand improvement (TSI) activity. From 2001 to 2011, the majority of acres within the WTMA were under timber land license agreements; however, due to a myriad of start-up problems there has been very little timber harvest or further developed in WTMA. To date, there is approximately 1,000 acres of WTMA under a timber land license, which is set to expire within the next one to five years.

B. Location: The WTMA is located on the slopes of Mauna Loa volcano, approximately five miles southwest of Hilo town along the Stainback Highway and within the South Hilo and Puna Districts. Portions of the Waiākea (WFR), Upper Waiākea (UWFR), and ‘Ōla‘a Forest Reserves (OFR) comprise the approximately 12,500 acre WTMA unit (Figure 1). The WTMA represents less than three percent of the forest reserve acreage managed by DOFAW on the Island of Hawai‘i. Approximately 330 acres of former Puna Sugar lands (TMK 2-4-08-22) are currently included at the east end of WTMA. The land was added to the Waiākea Forest Reserve in September 2009 in Executive Order 4296.

Table 1. Government Tax Map Key (TMK) parcels currently comprising public lands of Waiākea Timber Management Area

TMK Number	Owner	Tax Acres (entire TMK)	GIS Acres (entire TMK)	GIS WTMA Acres
318012001	State of Hawai‘i	5292.760	5089.990	2775.939
324008001	State of Hawai‘i	62855.855	61933.945	8325.493
324008006	State of Hawai‘i	150.000	150.930	29.579
324008010	State of Hawai‘i	259.679	261.277	261.277
324008022	State of Hawai‘i	1159.881	1095.597	1095.597
			TOTAL	12487.885

C. Physical site data: Waiākea Timber Management Area currently occupies lands in the ahupua‘a of Waiākea and ‘Ōla‘a (See Figure 1), extending from 400 to 3,200 feet in elevation. Median annual rainfall in the WTMA varies with elevation, exceeding 200 inches annually at 400 feet elevation, and gradually decreasing to 150 inches at 3,200 feet elevation. Mean annual temperature at 1,800 foot elevation is approximately 79 °F (See Figure 2). The WTMA is situated on relatively young, shallow ‘a‘ā and pāhoehoe lava flows ranging from 150 to 9,000 years old. Soils overlay lava substrata and are composed primarily of thin ash layers with high to extreme leaching conditions. Swampy conditions are found in some areas due to impermeable substrata. Slopes within the WTMA are very constant, averaging six percent.

D. Existing vegetation: During initial land clearing operations in WTMA, many large native trees such as ‘ōhi‘a lehua *(Metrosideros polymorpha)*, koa *(Acacia koa)*, and loulu *(Pritchardia spp.)* were left undisturbed. Today, these plants are intermixed with non-native timber species. Primary understory species include hāpu‘u *(Cibotium spp.)* and scattered native understory shrub species and non-native, invasive plants. The heavy equipment used to clear and level land also created rocky areas where a portion of the soil was removed and re-deposited in some of the many depressions in the area. Approximately 480 acres of native forest that was not bulldozed remain in the WTMA. These areas are classified as native ‘ōhi‘a and ‘ōhi‘a-hāpu‘u wet forest, or koa /‘ōhi‘a wet forest. These vegetation types have scattered to closed canopies (up to 75 feet tall in places) and contain a variety of native and non-native tree and shrub species. The invasive species densities in the low

elevation native forest are similar to those of other native forests in area. Inventory data summarizes the acreage breakdown based on dominant overstory tree species (Appendix B and Figure 3).

The historical plantation establishment in the 1960s and 1970s, cleared the majority of native forest remnants in the WTMA and impacted the native plants that once were found in the WTMA. Rare and uncommon plant species historically and presently found in the WTMA area include:

- *Cyanea platyphylla*. Endangered (Present in Upper Waiakea FR adjacent to the WTMA, last observed in 2012).
- *Cyrtandra giffardii*. Endangered (Present in the WTMA, last observed in 2012).
- *Sicyos alba.* Endangered (Present in Puu Makaala NAR adjacent to WTMA, observed 2011).
- *Cyanea tritomantha*. Candidate for Listing as Endangered (Present in Puu Makaala NAR and Upper Waiakea FR adjacent to the WTMA, last observed in 2012).
- Na`u or Nanu (*Gardenia remyi*). Candidate for Listing as Endangered (Present in the WTMA, Last observed 2010).
- ʻohe (*Joinvillea ascendens ssp. ascendens*). Candidate for Listing as Endangered (present in Puu Makaala NAR adjacent to the WTMA, last observed in 2010).
- *Phyllostegia floribunda*. Candidate for Listing as Endangered (Present in Upper Waiakea FR adjacent to the WTMA, last observed in 2012).
- *Phyllostegia vestita*. Species of Concern (Present in Upper Waiakea FR adjacent to the WTMA, last observed in 2012).
- *Stenogyne scrophularioides*. Species of Concern (Present in Upper Waiakea FR adjacent to the WTMA, last observed in 2012).
- *Trematolobelia grandifolia*. Species of Concern (Present in Upper Waiakea FR adjacent to the WTMA, last observed in 1998).

E. Existing wildlife: The WTMA supports several species of game and non-game wildlife (Appendix C). Feral pigs are the most common and actively managed big game species found in the area. Pig hunting is allowed year-round; however, the use of dogs is restricted between Tree Planting Road and Powerline Road between January and June. Hawaiʻi Wildlife Branch has constructed a series of gates and berms across certain roadways to improve game management and redirect hunter access throughout the WTMA.

Kalij pheasants are the most plentiful game bird inhabiting the WTMA. Other game bird species are present, but are usually restricted to forest edges or along roadways and lava flows. Game bird hunting is open on weekends and holidays from the first Saturday of November through the third Sunday in January. Game bird populations are managed primarily by opening and closing hunting season and by setting bag limits.

Native birds are the primary form of native wildlife found in the WTMA. Common endemic species inhabiting the forest are ʻamakihi (*Hemignathus virens*), ʻapapane, (*Himatione sanguinea*),ʻiʻiwi (*Vestiaria coccinea*), ʻōmaʻo (*Myadestes obscurus*), ʻelepaio, (*Chamsiempis sandwichensis*) and pueo (*Asio flammeus*). These birds are most frequently observed above 3,000 feet elevation, which is the upper extreme of the WTMA. In recent years, no threatened or endangered birds, except the Hawaiian hawk or ʻio (*Buteo solitaries*), have been observed in the WTMA. However, other rare species have been known to occur in native forests adjacent to the WTMA. These include the ʻōʻū (*Psittirostra psittacea*), ʻakiapolaʻau (*Hemignathus munroi*), and Hawaiʻi ʻākepa (Loxops coccineus). It is unlikely that any of these rare species permanently inhabit the WTMA as introduced timber species fail to provide the necessary habitat requirements for these rare birds. Native birds and the Hawaiian hoary bat are protected under Hawaiʻi Administrative Rules, Chapter 123, Indigenous Wildlife, Endangered and Threatened Wildlife and Introduced Wild Birds. The Federal Endangered Species Act of 1973 also applies to officially listed species.

The native bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) is the only endemic land mammal in Hawaiʻi. This rare mouse-like creature is a subspecies of the mainland hoary bat and is officially

listed as endangered. Hawaiian hoary bats roost solitarily in the foliage of trees. They are most active at dusk when they forage on flying insects. Bats have been seen in the WTMA and its environs, but no information on the density and distribution of these animals is available. There are no records of bats breeding in the area.

F. Cultural resources: Historically the lands of the WTMA were used for transit to other areas, collection of vegetation resources, collection of birds, and canoe making. Gathering of vegetation still continues for lei making, and other cultural activities.

G. Access: Vehicular access to the WTMA area is available via paved highways, and the area itself is well-roaded. Stainback Highway provides the primary access and is maintained by the State Department of Public Safety and the County of Hawai‘i. North Kūlani Road runs from Stainback Highway to Highway 11 near Mountain View, which can be used to access the area. Approximately 130 miles of unimproved access roads grid the WTMA tree planting area into 40 acre blocks. These roads provide access for DOFAW and the public for hunting, recreation, non-timber forest product gathering, forest protection and timber management.

H. Timber resources: From 1985 to 1988, Puna Sugar Company and the State entered into a timber harvest agreement for 2000 acres of *Eucalyptus* in WTMA; no other planted hardwoods were harvested within WTMA at this time with the exception of small-scale sales and timber salvage operations. The majority of WTMA has been under a timber land license from 2001 to present to either or both Tradewinds Forest Products, LLC and/or Hawaii Island Hardwoods, LLC. Large scale harvesting operations were never untaken by either of these parties.

Tree fern harvesting occurs with approximately 500 linear feet of logs removed and sold for use in the flower and landscape industry per year. The market for tree ferns is small and the work to remove the logs is arduous. In some areas, tree ferns have subsequently grown back vigorously in some of the planted areas.

I. Non-timber forest products: Non-timber forest products are commonly collected within the WTMA, including:

- Ferns
- Ti leaves
- maile
- flowers.

Gathering of material from plant species that are not on Federal or State threatened and endangered species lists will be permitted and regulated by DOFAW through standard forest permit procedures. Gathering of plant materials from threatened or endangered species may be allowed if individuals have obtained special collecting permit from DLNR. Permits for gathering plant material can be obtained from the DOFAW-Hilo office at 19 E. Kāwili Street, Hilo, Hawaii 97620. Hours are Monday through Friday except State holidays from 7:45 am to 4:30 pm. These permits are free and are available for non-commercial, home use only. Approximately 750 permits are issued for the Waiākea area on an annual basis.

J. Other public uses: Although established for commercial timber management, the WTMA provides several other important public uses. The plantations and surrounding native forests are used extensively for feral pig hunting. Motorcycle and all-terrain vehicle (ATV) riders use the well-developed road network within the area. Other recreational activities include mountain biking, horseback riding, bird watching, botanical exploration and hiking.

DOFAW's Nā Ala Hele Trails and Access program manages the Upper Waiākea ATV/ Dirt Bike Park which is located within the WTMA between Flume and Tree Planting Roads. It has been in operation since July 4, 2004, and offers 28 miles of trails that can be ridden in both directions. In order to use the park, permits and waivers must be obtained from the DOFAW office in advance.

The Mauna Kea 200 motorcycle event (MK200), held nearly every year since 1976, utilizes the area for course mileage, and the Rock Island Riders (who implement the MK200) have volunteered time to keep many of the grid roads within WTMA open and identifiable.

There are also established mountain bike trails in the lower portion of WTMA, primarily in the area below Quarry Road in the former sugar plantation lands. There are approximately 11 miles of single track and 15 miles of double track mountain bike trails that traverse through approximately 230 acres of *Eucalyptus saligna* and *E. grandis* plantation timber. In order to use these mountain bike trails, permits and waivers must be obtained from the DOFAW office in advance. Permits have been issued to mountain bike clubs that sponsor riding events.

Equestrian use is common along the Puna boundary of the forest reserve. Bird watching, botanical exploration and hiking occurs less frequently.

K. Education and research: Forests plantations in the WTMA provide excellent opportunities for individuals, organizations and institutions to study both native and introduced forest communities. In the 1960's to the 1970's, the State Department of Health conducted studies on the population dynamics of rodents in Waiākea Forest Reserve. In the 1970's, the U.S. Fish and Wildlife Service conducted native forest bird surveys on the Island of Hawai‘i and several of the survey transects extended through the WTMA. During the Vietnam war, the U.S. Army conducted several research projects in the Waiākea, Upper Waiākea and ‘Ōla‘a Forest Reserve including chemical gases, defoliants and phosphate explosives devices. The USDA Forest Service, Institute of Pacific Island Forestry, has been monitoring forestry research projects in the WTMA since the late 1950's to present day. Some of their research projects include nutrient recycling, watershed quality of various native forest plant communities, wood properties for commercial native tree species and ‘ōhi‘a decline occurrence.

There is a significant potential for field research within the WTMA especially related to introduced timber species in Hawai‘i. Growth plots may be implemented in a joint DOFAW UHH study. In addition, the University of Hawai‘i at Hilo (UHH), the Hawai‘i Community College (Forest TEAM Program) and DOFAW developed a forestry curriculum in their agriculture program. The close proximity of UHH to the WTMA have allowed forestry students the opportunity for hands-on-training in applied forest management techniques. DOFAW faculty have used the WTMA for giving talks and demonstrating forest measurement techniques to university students in the recent past, and there are plans to conduct many more in the future.

V. MANAGEMENT GOALS FOR THE WTMA

The following nine guiding principles were used to develop this plan and will be used in the disposition of the commercial forest resources within the WTMA:

Guiding Principle # 1

The State should utilize its land and timber within the WTMA to maximize local processing where feasible, create jobs, and encourage development of *integrated processing facilities* that provide suitable outlets for the range of species and grades of wood that currently exist . The availability of plantation forest resources within the WTMA could allow for development of a variety of wood processing plants (e.g., lumber and veneer) and biomass power or biofuels facilities. This will provide *immediate employment opportunities*. It will also encourage other investors and landowners to become involved in plantation forestry at the onset, stimulating additional employment opportunities. DOFAW should also look at current market and future demand projections, to help decide what will be the most valuable and in demand timber to replant.

Guiding Principle # 2
Effective soil erosion control practices, including harvesting methods and replanting; safe use of herbicides; and visual buffers along major transportation corridors will be required for all commercial forest operations within the WTMA as outlined in the State's *Best Management Practices* (attached as Appendix A).

Guiding Principle # 3
The State will not replant non-native invasive species with a score rating of seven or higher on the Hawaii Weed Risk Assessment within the WTMA. Further, the State will evaluate all non-native species proposed for planting in the WTMA for their potential invasiveness if they have not been evaluated through the Hawaii Weed Risk Assessment. All species currently in the WTMA have the option of being replanted.

Guiding Principle # 4
The need to *involve the public* in project planning and development is important to account for the appropriate use of the resources, especially when it affects local communities. Careful integration of timber management with *hunting*, *recreational and gathering activities* will aid in developing community support for growing and processing timber resources.

Guiding Principle # 5
A portion of the timber within the WTMA should be reserved to *supply local entrepreneurs and small businesses*, thus increasing community recognition regarding the economic opportunities offered by sustainable forest management. This reservation percentage will be based on the amount of local demand. The *higher value timber* within the WTMA can provide wood needed to take advantage of new forest marketing programs to stimulate the creation *of niche market for locally grown woods*. Portions of the WTMA should also be used for the development of non-timber forest products.

Guiding Principle # 6
The public forest estate in Hawai‘i (11th largest in the U.S.) has *a low level of public investment* (e.g. one forester per 150,000 acres of public forest reserve on the Island of Hawai‘i). This investment is not expected to increase significantly with the current fiscal situation in Hawai‘i. In order to manage the WTMA sustainably, a portion of the timber proceeds should be reinvested back into the forest.

Guiding Principle # 7
Timber management and research activities in the WTMA can provide a valuable educational role in extension and training, contributing practical information to both the government and private sectors while helping create a professional forestry work force. Portions of the forest can be used as an outdoor laboratory for the forestry curriculum for various colleges within the University of Hawai‘i system.

Guiding Principle # 8
There will be no timber harvesting, forest clearing, or other commercial timber operations within designated **native forest** sections of the WTMA. Special harvesting permits for the cultural gathering of native species may be granted.

VI. FOREST MANAGEMENT OPPORTUNITIES

Timber inventory data from 1997 indicated that the WTMA contains over 17,000,000 ft^3 of timber on a gross merchantable basis (Table 2). This represents enough wood to build and panel approximately 6,800 houses.

Table 2. 1997 Forest inventory data summary for the WTMA [1]

Tree Species	Acreage	Cubic Feet
Queensland Maple *(Flindersia brayleyana)*	1,485	2,607,000
Eucalyptus saligna and *grandis*	3,749	9,669,000
Eucalyptus robusta	227	1,177,000
Eucalyptus deglupta and *pilularis*	54	94,000
Toon or Australian red cedar *(Toona ciliata)*	3,500	2,667,000
Tropical ash *(Fraxinus uhdei)*	2,060	1,052,000
Sugi *(Cryptomeria japonica)*	102	25,000
Nepal alder *(Alnus nepalensis)*	24	119,000
TOTALS	11,704	17,410,000

These estimates have been further refined from field observations. Some acreage of toon and tropical ash have been recategorized as native forest to reflect the poor growth of certain plots and the regeneration of native forest in those areas.

Table 3. Current summary of primary timber species within WTMA

Tree species (common name)	**Scientific name**	**Likely Use; Other uses**	**Acreage in WTMA**	**Estimated volume (ft3)**	**Estimated board foot (BF)***
Sydney bluegum and grand eucalyptus	*Eucalyptus saligna & E. grandis*	Biofuel; paper production, saw timber, veneer	3,745	8,176,042	37,132,760
Swamp mahogany	*E. robusta*	Wood products; biofuel	227	1,007,433	4,816,112
Indonesian gum and Blackbutt eucalyptus	*E. deglupta & E. pilularis*	Biofuel; saw timber	54	88,711	401,217
Australian toon	*Toona ciliata*	Wood products; biofuel	3,343	2,588,887	9,504,944
Tropical ash	*Fraxinus uhdei*	Biofuel	1,577	863,971	3,324,086
Queensland maple	*Flindersia brayleyana*	Wood products; biofuel	1,536	2,539,213	10,287,031

* Scribner's BF, using modified data from the 1997 timber inventory survey.

[1] *Data represent total stem volume from one foot stump height to a four inch diameter top, and for all tree stems having a minimum diameter of eight inches at breast height.*

A. *Eucalyptus* species: Most commercial species of *Eucalyptus* are well suited to the growing conditions found in the WTMA. Rapid growth rates, high yields, and straight form of these trees make them desirable for a wide variety of processing opportunities including dimensional lumber, veneer and plywood, poles and chips. *Eucalyptus* has not spread readily into adjacent areas of native forest in the WTMA area. Current *Eucalyptus* wood resources within the WTMA range from seedlings, to stands that contain medium or "pole" sized (6-12" diameter) trees, and mature or "saw timber" sized (> 12" diameter) trees. Most *Eucalyptus* stands are in the latter two categories, indicating a great potential to begin harvesting mature stands immediately, allowing pole stands to continue growing, while simultaneously expanding the *Eucalyptus* acreage by planting additional seedling acreage.

B. Queensland maple: While initially planted on a smaller scale than the *Eucalyptus*, Queensland maple *(Flindersia brayleyana)* has proven to be well adapted to the growing conditions in the WTMA. This species produces a high quality, light colored wood that is useful for finish grade dimensional lumber, veneer and plywood. This wood represents an important resource for high quality, value added operations such as furniture or cabinet making. For these reasons, Queensland maple is considered to be a key species for intensified timber management activities within the WTMA. As with the *Eucalyptus*, a full range of stand ages and tree sizes are present, allowing for both immediate harvest opportunities, and new plantings.

C. Other species: Large areas (Figure 3) of the WTMA were originally planted with Tropical ash (*Fraxinus uhdei*) and Australian red cedar *(Toona ciliata)*. While Australian red cedar grows well only on the best quality sites, Tropical ash has proven to be poorly adapted to local site conditions. After more than 35 years of growth, most stands of these species contain only scattered pole sized trees. These areas could play an important role in future timber management by being made available to community groups or small businesses interested in managing parcels for salvage operations. After the trees are removed from the poorly stocked stands, site conversion to other high-value species can be realized. Other areas could be made available to community groups or small businesses interested in managing parcels for production of specialty timber or non-timber forest products.

VII. FOREST MANAGEMENT PRESCRIPTIONS

All field management prescriptions related to commercial timber management will be guided by Best Management Practices (BMP) policies (Appendix A). DOFAW has more than 40 years of management experience in the WTMA and recommends the following general guidelines for commercial timber management:

A. Commercial forest management:

1. Species selection: In general, species selection will depend largely on what species was harvested, growth potential for a given site, specific qualities of a species (e.g., growth rate, disease resistance, wood characteristics, ease of removal, tolerance to volcanic emissions), seedling availability, available or future markets for the specific species, and goals for that unit. Site productivity for tree growth in the WTMA can be broadly linked to lava flow type and age. Older flows are more productive sites than younger, while ʻaʻā sites are more productive then pāhoehoe. In addition, depressions in the landscape and drainage areas seem to provide the highest growth potential, due to higher accumulation of geologically recent ash deposits and perhaps soil scraped from higher ground when the area was leveled in the 1960s and 1970s . Non-native species selection will incorporate evaluation through the Hawaii Weed Risk Assessment to determine the potential invasiveness of the species as indicated by a scoring of seven or higher.

2. Site preparation: Site preparation is achieved by the removal of competing vegetation and exposure of surface soils to aid planting operations. Site preparation is often the most costly

silvicultural operation. Manual clearance using saws and machetes can be implemented where brush and trees are relatively sparse and short in height. Manual clearance is useful for cutting planting lines in existing plantations for supplemental planting and where planting sites are small and scattered.

The primary form of site preparation recommended for the WTMA is mechanical crushing of existing vegetation. This is usually conducted with heavy crawler tractors, which run over shrub and weed species, and scatter tree debris. This method of site preparation has two primary merits. First, soil disturbance is minimized, which helps maintain soil productivity and nutrient cycling potential. Second, desirable stems of both native and non-native tree species can be left standing, contributing to future stand diversity and value. The rocky nature of much of the area also constrains other site preparation mechanical options.

Herbicides are sometimes used for site preparation. Herbicides are used to reduce competition from grass along planting lines before planting and undesired remnant woody vegetation. When herbicides are applied, all Federal and State rules and regulations need to be followed to protect both the worker and the environment. All label instructions will be followed for any herbicides used in the WTMA. Use of fire for site preparation is prohibited.

3. Timber stand improvement: Fertilizer application is essential for satisfactory seedling survival and growth. During and after planting, commercial fertilizer applications will be manually applied as needed. Weed control may be required in newly planted stands to reduce seedling mortality and competition. Herbicide use will be limited to manual applications in an area about two to three feet in radius around seedlings. Chemical quantities will be carefully prescribed at levels to control the specified target population, and will not be applied in buffer zones for surface waters. Only approved chemicals will be used in the WTMA in strict accordance with the manufacturer's label.

Young tree stands may require side branch pruning to maximize potential value of crop trees. Pruning will be conducted manually on species that can produce high-value solid wood end products, such as Queensland maple or African mahogany *(Khaya spp.)*.

4. Harvesting: All timber harvesting activities will be conducted according to a timber harvesting plan approved by DOFAW. The timber harvesting plan shall include all of the forest management practices that are specified in the State's Best Management Practices (BMPs) for timber harvesting. All efforts will be taken to harvest trees in such as way that the least amount of ecological damage occurs, including avoiding sensitive and/or threatened and endangered species.

DOFAW will not prescribe a specific management regime for harvesting timber with the WTMA (e.g., regeneration harvest vs. selective harvest of specific trees). Due to the age of the trees, efficiency considerations related to mobilizing equipment and labor, and replanting considerations, DOFAW recognizes that cutting entire stands will be necessary. At the same time, DOFAW acknowledges the public perception and visual impacts related to regeneration harvest of large areas. Therefore, to address these concerns, harvesting restrictions for the WTMA include:

- Regeneration harvest, where previously planted trees and other vegetation are cleared, is limited to 40-acre blocks,
- Adjacent 40-acre blocks may not be harvested simultaneously,
- Harvested blocks must be replanted within six months, and new growth must reach 15 to 20 feet tall, before adjacent blocks may be harvested,
- Up to 600 acres of regeneration harvest may be done annually,
- Thinning and selective tree removal may occur in other units (in addition to the 600 acres), and
- DOFAW may identify specific tree(s) to be left standing for visual buffers, wildlife habitat, or other reasons.

Restricting harvest of entire stands to 600 acres a year provides a secondary benefit of facilitating a sustained supply of timber from the WTMA over time.

Transportation of logs and other wood products, such as chips, will be planned and coordinated with state and local authorities. In the case of Stainback Highway, this would include the County of Hawai‘i (Pana‘ewa Zoo) as well as the State Department of Corrections (Kūlani Prison).

5. Replanting: Replanting of a harvested area will usually be implemented within six months of the harvest to reduce the establishment of invasive or weed species in the area. For areas that may be susceptible to increase soil erosion, an annual crop cover may be established until replanting operations can occur. The replanting of a harvested area will be coordinated with harvesting operations to ensure that they are being implemented seamlessly. All planting specifications, such as density, species selection, site preparation, planting method, seedling protection and minimum survival expectations will be included in a replanting plan for the area.

6. Repair and maintenance of existing road infrastructure: Approximately 130 miles of unimproved access roads grid the WTMA into 245 40-acre blocks. These roads can be utilized for timber harvest purposes, and with this network of roads in place, no new permanent roads need to be constructed. Improvements to the existing road, such as clearing, grading, or reconstruction of water bars, dips, culverts and cross drainages, may be required to accommodate harvesting activities and to repair or restore the existing roads after harvesting activities are complete. Temporary skid trails, used to move logs from the forest to the landing area, and landings, where logs are loaded into trucks for transportation, will be permitted, with locations determined in advance after collaboration with DOFAW. Temporary trails and landings will be allowed to revegetate naturally or artificially revegetated after harvesting activities are complete. All roads, skid trails, and landing sites utilized within the WTMA must be mapped and approved by DOFAW prior to any harvest activities. Because forest roads have the potential to create more erosion than any other forestry activity, all improvements and maintenance of the existing access roads and all work related to temporary skid trails will conform to the BMPs attached in Appendix A.

B. Native forest management:

Within the WTMA, approximately 779 acres of native forest (defined as areas containing 50 percent or more native forest cover) remain. Commercial timber harvest will not occur in these areas. The primary goal in these areas will be forest protection and management of threatened and endangered plants, and they will remain accessible for traditional gathering of forest resources, research, hunting, and recreation.

Road Q Native Forest Withdrawal: The approximately 779 acres of native forest include the 40-acre blocks located above road Q on the North side of Stainback road, which are high-quality, predominantly native forest with some struggling, poor quality tropical ash (*F. uhdei*). These blocks will be retained for their native forest character and composition and will not be managed for timber production.

Endangered plant information in this plan is derived from The Nature Conservancy of Hawai‘i’s Rare Plant Database and should not be considered comprehensive. If threatened or endangered species are encountered within existing introduced timber plantations, a buffer zone of 50 feet of undisturbed vegetation will be fenced around the plant individual or population in question. Known locations of threatened and endangered plant species will be visited to collect seed or cuttings for propagation efforts as needed. Fencing will be constructed as appropriate for each site and species. Such activity will lead to out-planting in areas actively managed for rare plant species that are within that species historical range. Potential out-planting sites include the blocks of native forest scattered throughout the WTMA. A map and associated database for threatened and endangered species within the WTMA will be maintained by DOFAW.

C. Invasive species management: Although it has not been a major problem to date, non-native timber species may spread into native forest areas adjacent to the WTMA. This encroachment may be exacerbated if a major disturbance such as fire or hurricane occurs and opens the native forest canopy, providing suitable habitat for exotic and pest species to become established. Additionally, recently cleared areas may represent suitable establishment sites for invasive species. DOFAW will monitor any spread that occurs and control if necessary.

Invasive weeds are a serious threat within WTMA and can be spread rapidly by birds, wind and mammals, including humans. Invasive weed species that occur in thick and fast-growing patches in the WTMA include strawberry guava *(Psidium cattelianum)*, palm grass *(Setaria palmifolia)*, *Clidemia hirta var. hirta*, *Melastoma candidum*, and *Tibouchina urvilleana*. Many of these weeds are found only in specific locations (such as lower elevations), and not throughout the WTMA. Additional fast-growing species that could cause weed problems in this area include Australian tree fern *(Angiopteris evecta)*, miconia *(Miconia calvescens)*, yellow Himalayan raspberry (*Rubus ellipticus var. obcordatus)*, and gunpowder tree *(Trema orientalis)*. These latter species are scatted throughout the area, but have the potential to become dominant in a given location. Other problematic invasive species include fire ants, coqui frogs, and soil-born organisms.

Intensive forestry operation could potentially spread invasive species further across the timber management area on machinery, gear, and equipment. Harvest operations will be strongly encouraged to move from upper elevations down to lower elevations to minimize opportunities for spreading common low-elevation weeds, such as *Clidemia hirta*, into upper elevations where these weeds are not yet found. A sanitation protocol for machinery, gear, and equipment will be prescribed to minimize the potential for introduction of new species and prevent the movement of established and incipient invasive species found within the WTMA, covering plants, invertebrates (such as fire ants and coqui frogs), soil-born organisms, etc. Species-specific protocols will be developed as necessary to contain problem species known to occur in portions of WTMA and prevent their spread in WTMA and to adjacent native forest areas.

D. Insects and disease monitoring: *Phytophthora cinnamomi* (root rot disease) will cause limited damage to some tree seedlings planted on pāhoehoe lava flows that have poor water drainage. The tree species affected are Spanish cedar *(Cedrela odorata)*, *Casuarina spp.* and various mahogany species. Whenever this disease problem is known or observed to occurs, other tree species will be selected for planting such as Australian red cedar, Queensland maple, or Eucalypts. The black twig borer *(Xylosandrus compactus)* has been problematic at lower elevations in the WTMA, especially for seedlings of koa, Queensland maple, African mahogany, Spanish cedar, and Australian red cedar. These insects do not kill tree seedlings, but do hinder their growth and development.

Trees within the WTMA will be monitored by DOFAW employees for evidence of insect damage or disease. If problems arise, qualified entomologists or plant pathologists will be consulted to identify the problem and develop a solution to control or minimize the damage.

E. Fire prevention and control: The WTMA is located in a high rainfall zone where wild fire occurs only during extreme drought conditions. Though rare, the potential occurrence of drought does require active fire control planning. In February, 1926, an escaped trash fire burned 125 acres in Waiākea Forest Reserve, and in March, 1926, a land-clearing fire escaped and burned 20 acres of forest. In late March, 1926, a fire started from a fisherman's camp on the coast burned 4,000 acres, 700 of which was in the Panaʻewa Forest Reserve. Smaller fires occurred more recently in 1970-1972, and 1998.

Typically, fire risk increases in forested areas with increased human activity. However, intensification of management activities within the WTMA is expected to have negligible impact on fire risk. This area is normally very wet and will not readily burn. Maintenance of the road network within the WTMA for timber management activities will improve access and facilitate rapid containment of fire.

During dry periods, DOFAW will post fire prevention signs, distribute brochures, and employ Public Service Announcements to increase public awareness of fire risk. In extreme conditions, DOFAW will consider public access restrictions and minimize timber management activities to mitigate increased fire risk. Operators in WTMA will be informed for fire dangers and the appropriate prevention measures during timber and/or replanting operations.

F. Watershed management: The WTMA has extensive tree and ground cover making the area a valuable watershed. Spring-fed Waiākea stream is perennial in its upper reaches, and there are flumes that retain water much of the year. There are no known surface water sources used for domestic or agricultural purposes. Tree and ground cover will ensure steady infiltration of rapid runoff of storm flows, prevent soil erosion, improve water quality, prolong periods of stream flow and aid in recharging underground aquifers. A 50 foot buffer adjacent to all streams and wetlands will be established within the WTMA prior to timber management activities to ensure maintenance of water quality and reduce stream sedimentation.

G. Wildlife management: Wildlife in the WTMA offers opportunities for hunting for recreational and subsistence purposes, bird watching and rare species restoration.

1. Public hunting: DOFAW promulgates hunting rules to regulate seasons and bag limits while wildlife enforcement responsibilities lie with the Division of Conservation and Resources Enforcement. Hunting rules are set forth in Chapter 122, Rules Regulating Game Bird Hunting and Chapter 123, Rules Regulating Game Mammal Hunting. The WTMA includes sections of three Hunting Units: B, H, and K. Hunters are required to check in and out at established checking stations and report game harvests on official field forms.

Most timber management blocks within the WTMA are too overgrown with introduced weeds to offer good game animal habitat. Timber harvesting activities will encourage production of young herbaceous vegetation and create edges between vegetation types. Both of these habitat conditions favor the production of wild turkeys, Kalij pheasants, wild pigs and other game species.

2. Native species: The impact of timber harvesting activities on native bird populations is expected to be minimal. Very few native birds nest in non-native timber trees.

Timber felling will not be allowed between June 1 and September 15 due to potential impacts to the Hawaiian hoary bat, or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*). However, this restriction may be lifted upon additional surveys and the development and implementation of additional mitigation actions, if DOFAW Wildlife staff and USFWS concur that the proposed mitigation actions will adequately protect the bat from take during ongoing harvesting activities. Other project activities, including loading and transporting timber, road maintenance, site preparation, and replanting, may still occur within the WTMA during the “no-harvest” period.

In addition to a Timber Harvest Management Plan, surveys for threatened and endangered bats and birds will be made and provided to DOFAW prior to the commencement of harvest activities. If any rare animal roosting trees or active nests are encountered, a no harvest zone (250 feet in radius) will be established around each site and no new harvest will take place until authorized by DOFAW.

H. Public access and other public uses: When harvesting or transporting timber or equipment on the roadways, special attention will be directed towards traffic safety and informing the public prior to the start date of operations.

1. Stainback: Since Stainback Rd. is regularly used by the people living on North Kulani Rd. to access Route 11, signs will be utilized to alert drivers when harvesting operations begin. The size

and location of the signs will be determined by DOFAW. A public notice will also be issued to the local newspaper.

2. ATV Park: The Na Ala Hele Trails and Access Hawaii District Program manager will be informed at least 2 months in advance of any operations occurring in the timber stands surrounding the ATV Park (See Fig. 4). When harvesting operations are occurring in any block containing or adjoining any of the ATV trails, the affected trails will be closed. Signs will be put in place to alert the public prior to the closure of any roads.

3. Bicycle Trails: Advanced noticed will be given to the mountain bike community who ride the trails located below Quarry road (See Fig. 4) before harvesting is to take place in the area. Trails to be cleared and re-established after harvest will be designated by DOFAW prior to harvest. Some slash may be left as desired by the mountain bike community to provide obstacles for the trail riders.

I. Cultural resources: In the event any unanticipated sites or remains such as bone or charcoal deposits, human burials, rock or coral alignments, paved sites or walls are encountered, all activities in the near vicinity shall stop and the State Historic Preservation Division will be contacted immediately.

VIII. SPECIES SPECIFIC CONSIDERATIONS

Each of the introduced commercial timber species or species groups grown and managed within the WTMA has unique management requirements. These are due to differences in physiology, growth potential, utilization value, and products.

A. Queensland maple (*Flindersia brayleyana*)**:** DOFAW considers Queensland maple to be the most valuable introduced timber species in this forest because of its high wood quality, desirable growth characteristics, and site adaptability. This timber species will be managed under the guidelines of selective tree harvesting to create and maintain an uneven age timber stand. Six type classes of Queensland maple currently exist within the WTMA, coded FB00, FB11, FB22, FB33, FB44 and FB55 (Appendix D). Initially, intensive forest management practices will be applied to type class FB33 and FB44. These two type classes are comprised of 290 acres of medium and high-stocked timber, with a merchantable volume of 1,338,000 ft^3 or approximately 50 percent of the total wood volume, on only 20 percent of the area for all Queensland maple stands in the WTMA.

An annual goal of commercial thinning on 100 acres of Queensland in FB33 and FB44 could provide as much as 55,000 ft3 of wood to the island's markets each year for 15 years. Wood marketing and utilization will both need to be enhanced to accommodate this level of production. If local markets do not absorb such wood production, DOFAW will shift forest management activities to focus on timber stands which are young or composed primarily of smaller diameter trees. Such activities would include re-planting, weeding and pre-commercial thinning. DOFAW will also consider making wood available for export or energy production should there be a demand for small diameter logs.

B. *Eucalyptus* species (*Eucalyptus saligna, E. grandis, E. robusta, E. deglupta, E. pilularis*) **:** The WTMA contains a total merchantable volume of 10,941,000 ft3 of various *Eucalyptus* species. *E. grandis* and *E. saligna* constitute 88 percent of the total *Eucalyptus* volume in the WTMA, with minor components of other species (Table 2). The following are the recommended harvesting guidelines for the *E. grandis and E. saligna* species.

1. Harvest units will not exceed 40 acres. A modified regeneration harvest will be required *Eucalyptus* because these species require an open, well prepared site to regenerate and grow vigorously.

2. Specific conditions or leave or residual trees within the 40 acre harvesting blocks will be specified in the Timber Land License. These residual trees are for wildlife habitat, regeneration enhancement, and aesthetics.
3. All harvested areas will be replanted with Eucalyptus species, Queensland maple, or other high value hardwood timber species. Trees grown for the specific purpose of biofuel may be considered in appropriate locations when sufficient potential demand exists and economics permit. In no case will biofuel plantings take place in designated native forest areas or where higher-value species with good current or potential markets could be planted instead.

To manage the 4,030 acres of *Eucalyptus* species on a sustained yield basis, up to 500 acres of *Eucalyptus* could to be harvested and replanted annually based on a 14-year rotation cycle. The 14 year cycle is desirable for maximizing wood production over time and maintaining harvest log size near a 12 inch DBH, since larger logs are prone to splitting and checking. This prescription may be changed based on commercial experience and silvicultural research .

DOFAW considers *E. robusta* to be a valuable introduced timber species because of its high wood quality, desirable growth characteristics, site adaptability, and apparent local and regional markets. Ideally, this timber species will be managed under the guidelines of selective tree harvesting to create and maintain an uneven age timber stand. However, selective harvest may not be feasible in all locations due to the mature age and size of much of the *E. robusta*.

Annual wood productions from the harvest of *Eucalyptus* in the WTMA may contribute to supporting local wood manufacturing companies which currently obtain wood from other sources. *Eucalyptus* appears to grow well in all areas of the WTMA except on very shallow pāhoehoe lava flows.

C. Tropical ash (*Fraxinus uhdei*) **and Australian red cedar or toon** (*Toona ciliata*)**:** After more than 35 years of growth, a majority of Australian red cedar and tropical ash trees are still pole sized (e.g., 4 to 10 inches in diameter at breast height). Due to this poor performance, no additional plantings of either species will take place. DOFAW will prioritize conversion of acreage containing Australian red cedar and tropical ash to *Eucalyptus* species and Queensland maple, and other prospective high-value species such as brush box (*Lyphostemon confertus*), Spanish cedar, African mahogany, or koa (*Acacia koa*). Prior to replacement plantings, salvage sales will be conducted to utilize any Australian red cedar or tropical ash wood resources with commercial value.

IX. OPTIONS FOR DISPOSITION OF TIMBER

DOFAW has received numerous requests from the private sector for access to the timber within the WTMA. These have primarily come from entrepreneurs interested in wood chips, veneer, plywood, lumber, other higher value forest products, and biofuel. DOFAW has in the past attempted to sell larger quantities of timber through forms of public bidding with a final timber license approved by the Board of Land and Natural Resources. Small-scale sales or timber salvage operations, where commercial value did not exceed $10,000, were handled directly by the Hawai‘i District.

While this process may still be used, more flexible forms of sale of forest products are of interest to optimize the commercial forest and job potential within the WTMA. DOFAW is charged to make the Forest Reserve System as self-sustaining as possible. Increased monitoring and compliance responsibilities associated with timber operations will also demand more concentrated staff time.

For any major commercial harvesting activities to occur within the WTMA, reforestation and other essential forest management activities must be supported. This can be done by reinvesting portions of the value derived from existing forest resources in the WTMA. Reinvesting revenues can improve forest health, as well as stimulate job creation and value-added processing, without impacting existing funding sources. It is recognized that the public is likely to respond more favorably to the use of its

forest resources if proceeds derived from harvesting can be reinvested in local forests to create a sustainable local wood products industry and improve forest health and growth.

Figure 1: Current extent of Waiakea Timber Management Area

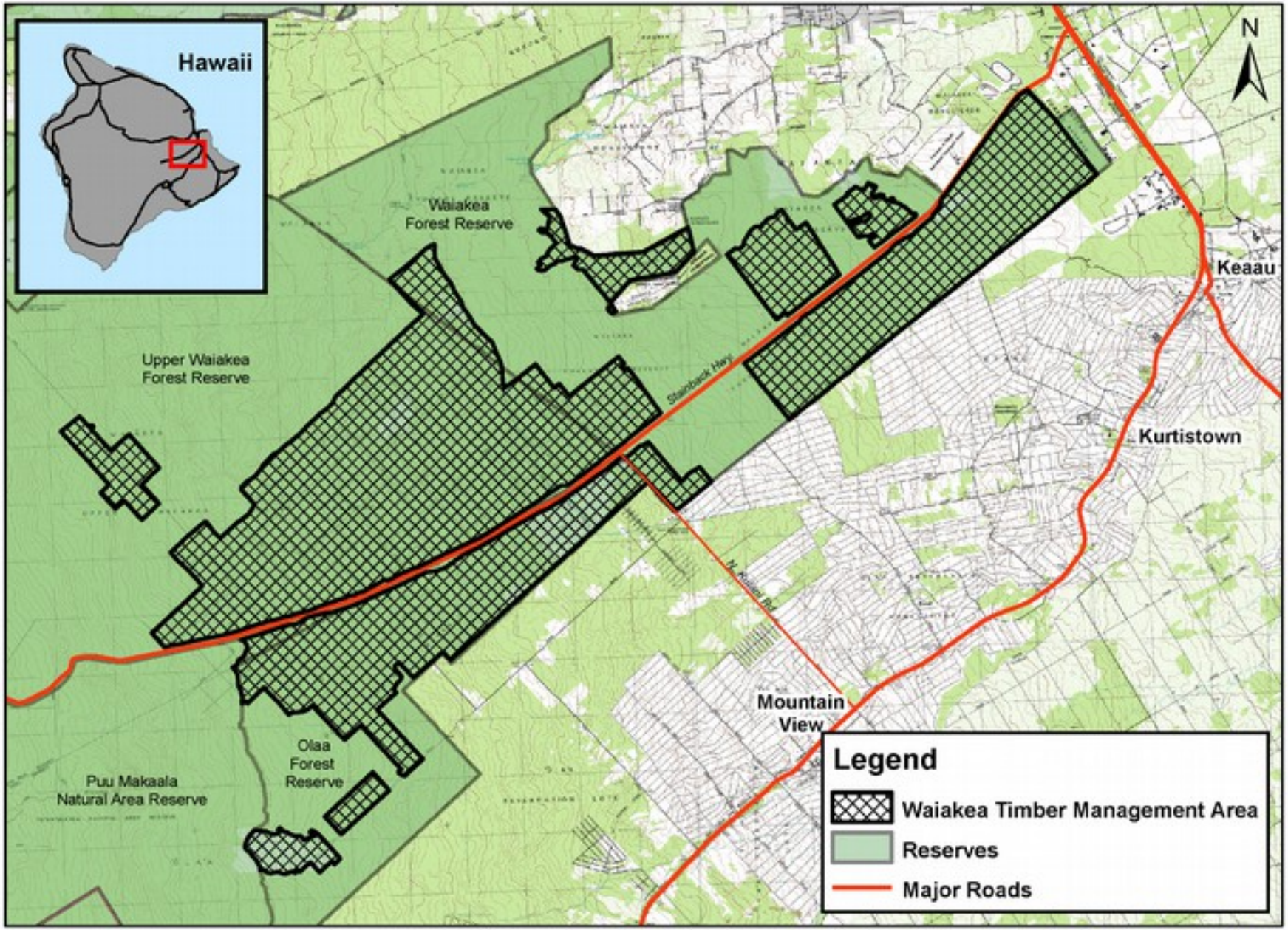


Figure 2: Hydrological features and elevation of Waiakea Timber Management Area (WTMA)

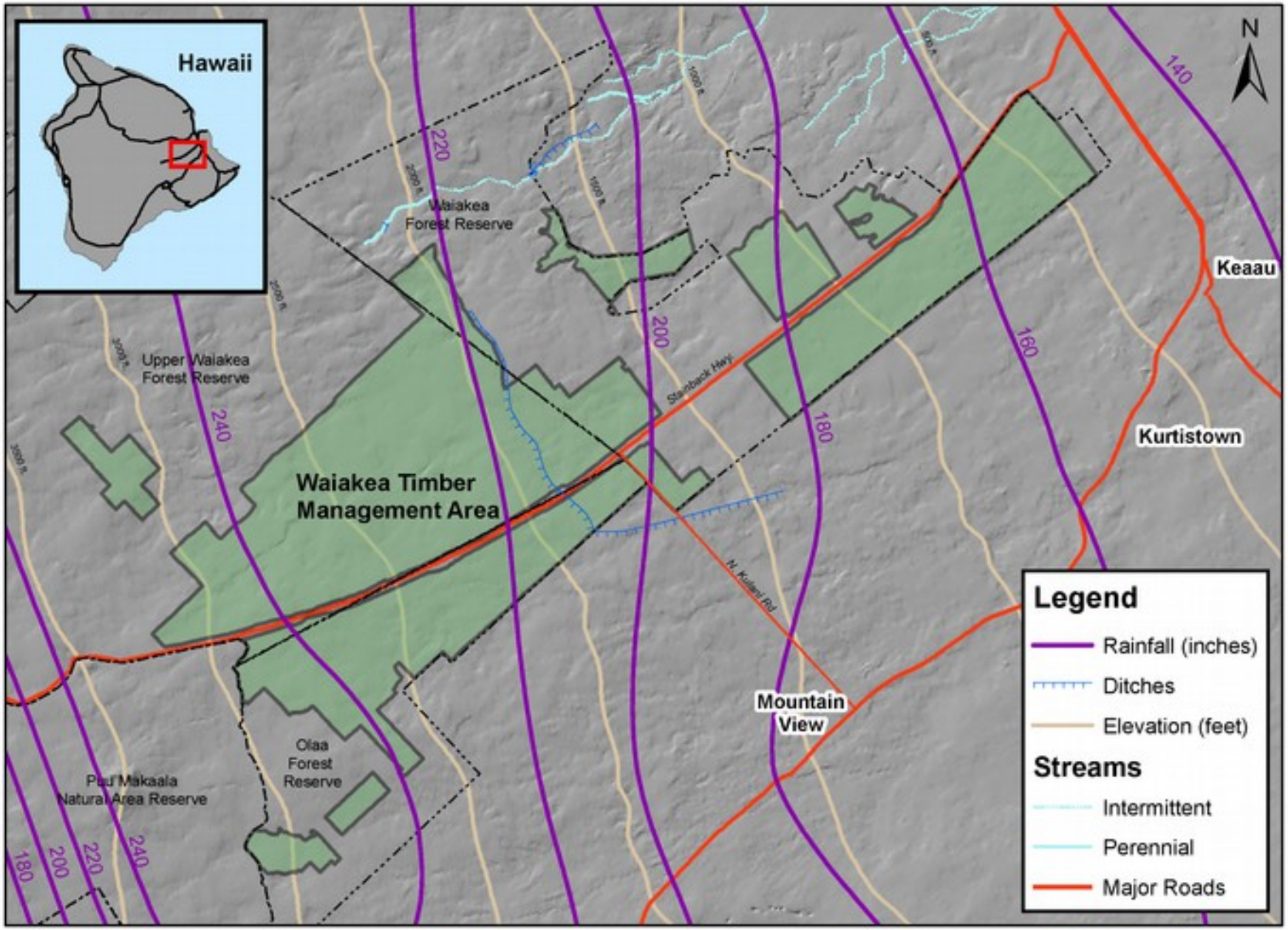
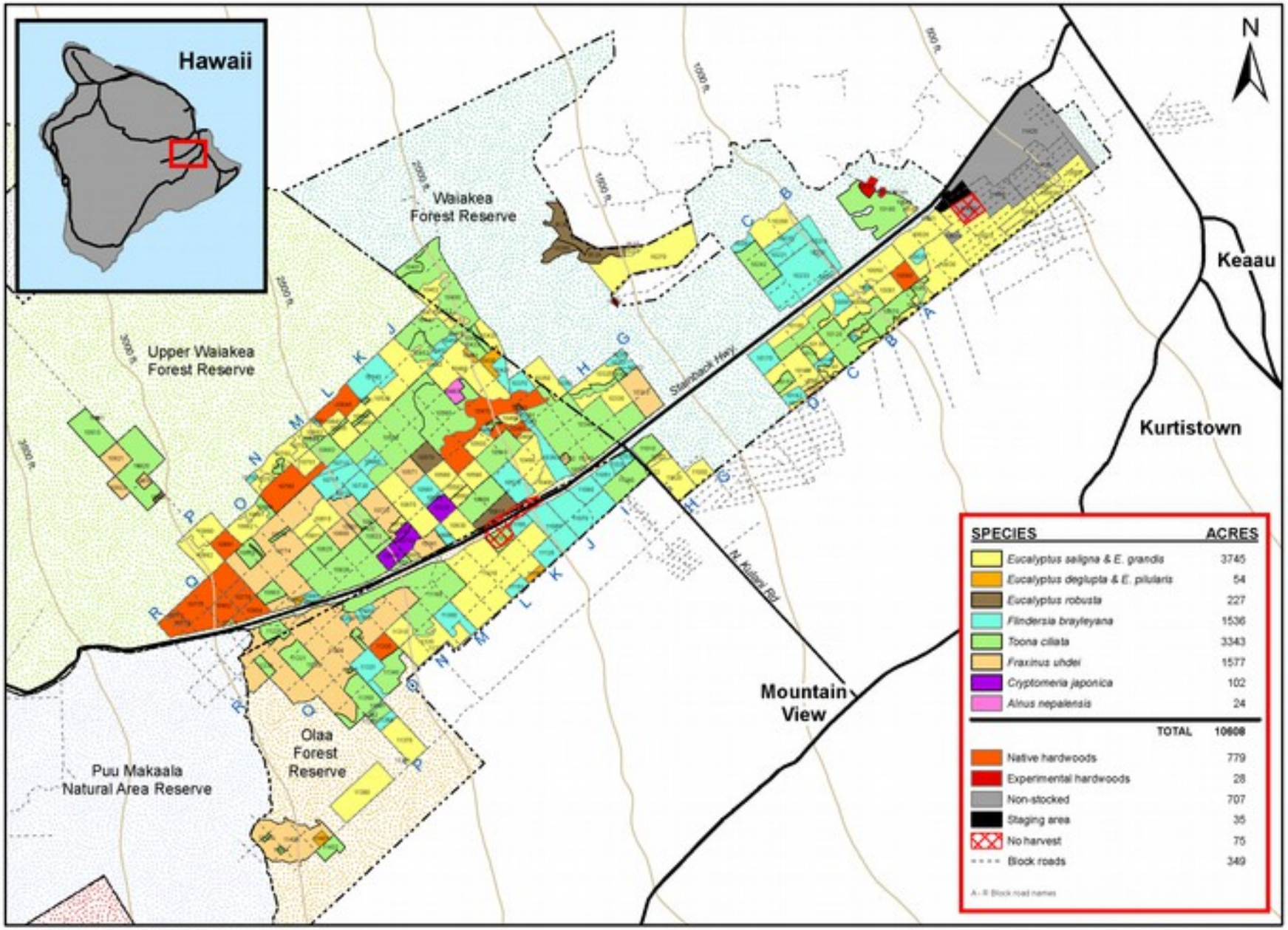


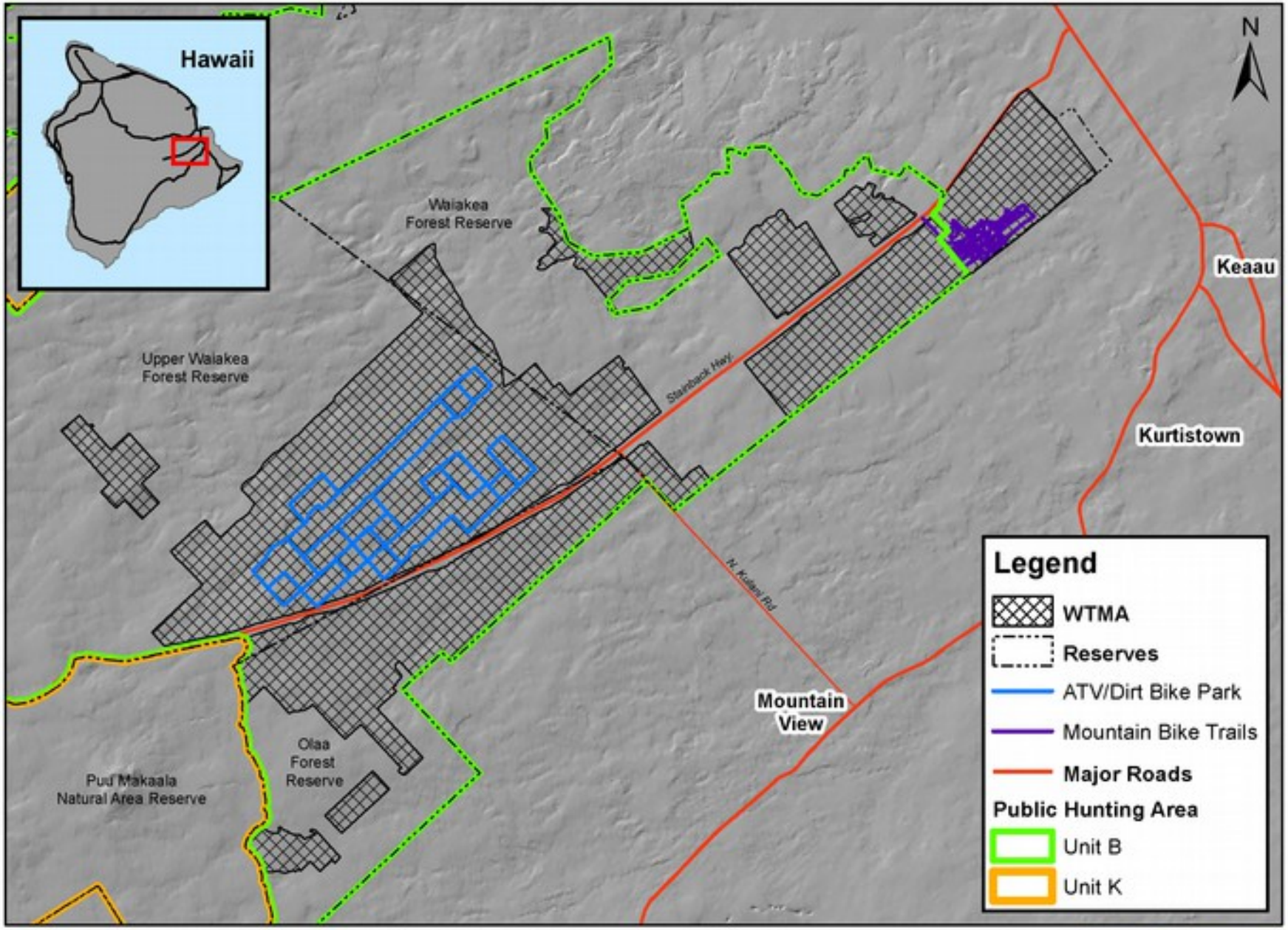
Figure 3: Waiakea Timber Management Map
Primary Tree Species - Based on 1997 Timber Inventory



State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
October 2013

HAWAII STATEWIDE GIS PROGRAM

Figure 4: Waiakea Timber Management Area Recreation and Access.



State Representative Cliff Tsuji
State Senator Gilbert Kahele

County of Hawai‘i:
County Civil Defense
County Fire Department
Department of Public Works
Department of Water Supply
Office of the Mayor
Planning Department
Research and Development
County Councilmember J. Yoshimoto (District 3)
County Councilmember Brittany Smart (District 6)

Organizations:
American Association of University Women
American Forest Management, Inc.
Association of Hawaiian Civic Clubs
Big Island Bird Hunters
Big Island Bow Hunters
Big Island Invasive Species Committee
Bishop Museum
Conservation Council of Hawai‘i
Earthjustice Legal Defense Fund
Edith Kanakaole Foundation
Environment Hawai‘i
Hawai‘i Audubon Society
Hawai‘i Forest Industry Association
Hawai‘i Forest and Trail
Hawai‘i Hunting Advisory Council
Hawai‘i Hunting Association
Hawaiian Botanical Society
Hawaiian Civic Club of Hilo
Historic Hawaii Foundation
Hoopuloa Hawaiian Civic Club
Hui Mālama I Na Kūpuna o Hawai‘i Nei
Island Transitions
Ka Nohona Pono Inc
Kahea
Kamehameha Schools
Mālama O Puna
Mauna Kea Recreational Users Group
Native Hawaiian Legal Corporation
Native Hawaiian Advisory Council
‘Ohana Hoopakele
Pig Hunters of Hawai‘i
Plant Extinction Prevention Program

Prince David Kawananakoa Hawaiian Civic Club
Sierra Club, Moku Loa Chapter
Society of American Foresters Hawai‘i Chapter
The Kohala Center
The Nature Conservancy of Hawai‘i
Three Mountain Alliance
Volcano Art Center
Volcano Community Association
Volcano Rare Plant Facility
Wildlife Conservation Association of Hawai‘i, Hilo Chapter

Individuals:

Becky Ostertag
Dan Taylor
Danny Li
Debbie Ward
Don Drake
Edwin Ung
Eldridge Naboa
Fred Stone
George DeCosta
J.B. Friday
Jack Jeffrey
Jim Juvik
Jon Price
Karl Magnacca
Kuulei Kiliona
Martha Lockwood
Pat Conant
Pat Hart
Rhonda Loh
Rick Warshauer
Rob Shallenberger
Ron Terry
Ronald Fujiyoshi
Sheila Conant
Sierra McDaniel
Steve Montgomery
Steven Hess
Thane and Linda Pratt
Tim Tunison
Zach Judd

Neighboring Landowners:

Albert Lindsey Bicknell Jr
Alberta B Turner
Charles and Eleanor Arakaki

Bang San Ho Temple
Benjamin K S Sr./Ramona HU TRST
Bong Hee Park
Brigham Nephi Clifton
Bruce James Morgan
Carol Kanoelani Lum TRST
Casimir K Ah Yo
Charlotte Nobue NG
Christopher J Linden
Clifford Muragin
Cory Harden TR
Daniel R B Grice and Kathleen Christensen
Daniel J Lutkenhouse
Daniel Y N Yee Family TR
David Harold Ung
Delbert T Cambra
Dennis Delfin Sr
Dorian Marvin
Duane Rapoza TTEE
Edward H Aki
Eleanor R Chow TRST
Elspeth Kalani Vandaele
Emily M Eissner
Francis M Toyama TRST
Gary L Sisneros
Gary M Urasaki
Gary R Guenther
Gary Robert Kozanecki
Gene Alan Rynkewicz
Glenda M White
Glenn Y Toyama
James Chow TRS
James Cobb
James T Hiyane
Jason T Macmurray
Jeffrey Robert Hoguchi
John William Ikaika Crabbe
Jonathan P Kurtzweil
Kaipo Saiki
Kanoe M Mc Tavish
Kathleen Michelle Demello TRST
Kathryn Anne Burton TRST
Katrina A Ka‘auomoana
Keith & Betty Wilhelm
Keith Eric Hompstead
Kirk Black
Lance J Wilson TRST

Lau Family TR
Lenore M Vincent
Lori Ann C Lindsey TRST
Lorna S Ortega
Louie S Ondo
Lucille Kozanecki TRST
Manuel Arruda Jr TR
Margaret L Lipinski TRST
Maria Elena Calso Andaya
Maria L S Fasone Trust
Marsahll A Luke TR
Melissa L Pang Ching
Michael J Donald
Michael P Kelley
Michel Dean Daak
Milton Kaneko
Miriam L Tocman
Monte Roldan
Natalie Ann Veriato TRST
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BEST MANAGEMENT PRACTICES

FOR

MAINTAINING WATER QUALITY

IN HAWAII

State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
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FOREWORD

Best Management Practices (BMPs) are effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of silvicultural activities. These practices are developed to achieve a balance between water quality protection and the production of wood crops within natural and economic limitations.

A thorough understanding of BMPs and the flexibility in their application are of vital importance in selecting BMPS which offer site specific control of potential nonpoint source pollution. With each situation encountered at various sites, there may be more than one correct BMP for reducing or controlling potential nonpoint source pollution. Care must also be taken to select BMPs that are practical and economical while maintaining both water quality and the productivity of forest land.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 (and as amended by Sec. 319, 1986), require the management of nonpoint sources of water pollution from sources including forest-related activities. BMPs have been developed to guide forest landowners, other land managers and timber harvesters toward voluntary compliance with this act. Maintenance of water quality to provide "fishable" and "swimmable" waters is central to this law's objectives. The Environmental Protection Agency (EPA) recognizes the use of BMPs as an acceptable method of reducing nonpoint source pollution.

Nonpoint source is diffuse pollution that comes from almost everywhere; it even occurs naturally to a certain extent. The amount of pollutants from any particular spot is small and insignificant, but when combined from over the landscape, can create water quality problems. **Although it is unrealistic to expect that all nonpoint source pollution can be eliminated, BMPs can be used to minimize the impact of forestry practices on water quality. These practices must be reasonable, achievable and cost effective.** The adoption and use of BMPs will provide the mechanism for attaining the following water quality goals:

* to maintain the integrity of stream courses;

* to reduce the volume of surface runoff originating from an area of forest management disturbance and running directly into surface water;

* to minimize the movement of pollutants i.e. pesticides, nutrients, petroleum products, etc. and sediment to surface and ground water;

* to stabilize exposed mineral soil areas through natural or artificial revegetation means.

The intent of this guide is to promote better stewardship of the forest resources. This guide delineates environmentally responsible land management methods which, when applied properly, minimizes adverse impacts on the forest ecosystem and maximizes landowner objectives. Unusual situations may arise or pollution control measures other than those recommended here may be found. In these cases, common sense is most often the best guide.

Information presented in this guide is not to be used as the basis for setting water quality standards or as the basis of required use of watershed protection practices. Compliance with any watershed protection practices would be on a voluntary basis backed up with a public water quality education and awareness program. Changing of water quality standards or the required use of protection practices should not be attempted without careful study of the beneficial effects gained from modifying existing silvicultural practices now in use.

INTRODUCTION

The Division of Forestry and Wildlife (DOFAW) is mandated by HRS, Chapter 183 to "...devise ways and means of protecting, extending, increasing, and utilizing the forests and forest reserves, more particularly for protecting and developing the springs, streams, and sources of water supply to increase and make that water supply available for use..."

The number one resource that is generated by the forest is water. Since the establishment of the Department of Agriculture and Forestry in 1900, the concern for the protection of forest lands for the purpose of water has been a high priority. Fencing to keep out wild cattle and other feral animals and reforestation efforts to re-establish watersheds have been the key to the continuance of the production of high quality water.

In 1961, Hawaii created, by law, the nation's first statewide zoning districts, and today approximately 95% of the Hawaii's four million acres are zoned for agricultural or conservation uses. The Conservation district, which is under the jurisdiction of the Department of Land and Natural Resources (DLNR), encompasses almost one-half of the State, of which one million acres is state-owned. The majority of Conservation lands are covered by forests, but also contain grasslands, coastlines, cliffs, offshore islets, and wetlands. Vegetative communities include lowland and montane rainforests and unique examples of tropical biodiversity, much of it endangered.

The Division of Forestry and Wildlife recognizes the need for responsible stewardship of the natural resources, which include soil and water. **The success of BMPs to protect water quality within Hawaii depends on mutual cooperation and trust among landowners, industry, environmentalists, wood producers, regulatory agencies, governmental officials, and the general public.** All have an interest in good land management as it relates to water quality.

THE FOREST/WATER RELATIONSHIP

The forest and water resources are mutually dependent upon one another. Forests depend on water, namely rain, surface water, and groundwater for their growth and reproduction. Major long-term changes in the water supply can cause permanent changes in the content, quality and vitality of forest lands.

On the other hand, surface and groundwater quantity and quality are largely influenced by the surface on which rain falls and through which it percolates. The tremendous filtering capacity of forest lands provide effective and high quality groundwater recharge.

Hawaii's streams and aquifers all benefit from the presence of forests. In addition to these water quality benefits, forests provide needed wood and fiber products, wildlife habitat, aquatic resources and habitat, recreation values and aesthetic benefits. It is in managing forests for these benefits that damage to the water resource can result. Following is a brief discussion of the most commonly used forest management practices and the impacts they can have on the quality of the water resource.

Timber Harvesting

The removal of trees from a site has little impact on water quality, as long as the trees do not provide vital shade to streams and as long as the slope of the land is not excessive. The natural warmth of many streams can be exaggerated by removing shading vegetation from their banks. Increased water temperature promotes lower dissolved oxygen levels, placing stress on fish and other aquatic organisms.

Removing timber per se does not directly cause significant water quality changes, since ground cover is not excessively disturbed during proper logging operations. On steep slopes, however, careless timber removal can increase the likelihood of runoff and soil loss. This may lead to water quality degradation as well as a loss of site productivity. Steep areas should therefore be logged carefully using proper harvesting techniques for the sake of both water quality protection and site protection.

Road Construction and Drainage Techniques

All facets and phases of a sound forest management program rely heavily on accessibility to the forest. Consequently, temporary and permanent access roads are necessary components of all management programs. They are also one of the most costly investments made in a forests.

Temporary access roads are constructed to facilitate harvesting operations, site preparation and planting and often abandoned after the new stand is established. When abandoned, these temporary roads are normally allowed to revegetate naturally or are planted with trees.

Pollutants from Silvicultural Activities

The major types of water pollutants that can be generated from forest management disturbances to the forest ecosystem include sediment, nutrients, pesticides, and debris.

1) Sediment

Sediment is the most common pollutant resulting from silvicultural activities. Sediment principally results from erosion of soil, but may also include organic matter. Excessive sediment upsets balanced ecology within streams by smothering bottom dwelling organisms in the water, interfering with photosynthesis by reducing light penetration, serving as carriers of nutrients and pesticides, inhibiting fish reproduction and altering stream flow.

2) Nutrients

Nutrients, primarily phosphorous and nitrogen fertilizers, are sometimes applied to the forest to stimulate tree growth. Soluble nutrients may reach surface or ground water through runoff, seepage, and percolation. Insoluble forms may be absorbed on soil particles and reach water by direct wash-off of debris and recently applied fertilizer. Excessive nutrients lead to an imbalance in natural life cycles of water bodies.

3) Pesticides

Pesticides, if applied during silvicultural activities, may be soluble or insoluble. Pesticides in surface or ground water may result in toxicity problems, affecting water quality and food sources for aquatic life.

4) Debris

Tree limbs, tree tops, and other waste materials are the principal organic pollutants from silviculture. They reach streams through direct pushing or felling into water drainages, and washout during storms. Organic materials may place an oxygen demand on the receiving water body during the decomposition process. In addition, associated problems may include odor, color, taste and nutrients. Inorganic material such as oil cans and pop bottles are also considered nonpoint source debris.

BEST MANAGEMENT PRACTICES

1.0 Forest Roads

Standards and Use

Forest roads are managed to provide adequate access to lands for timber management, fire suppression, wildlife habitat improvement and a variety of dispersed and developed recreational activities. Generally, these are low volume roads that must carry heavy loads for short periods of time. The potential for adverse impacts from forest roads exists in areas where steep slopes, erodible soils, or where forest roads are located near water. **Forest roads cause more erosion than any other forestry activity.** Most of this erosion can be prevented by locating, constructing, and maintaining roads to minimize soil movement and pollution of streams. The need for higher standard roads can be alleviated through better road-use management. Design roads to the minimum standard necessary to accommodate anticipated use and equipment.

Planning, Design, and Location

A well planned access system is a sound method of reducing erosion and sedimentation in areas requiring frequent or temporary access. Proper location and construction of roads will provide for safety, longer operating periods, lower maintenance and operating costs, and minimal impacts to water quality. The value of the resource served and site characteristics will influence the choice of road construction standards and maintenance activities. The following practices are recommended:

(1) Use a design to minimize damage to soil and water quality.

(2) Roads should be designed no wider than necessary to accommodate the immediate anticipated use.

(3) Design cut and fill slopes to minimize mass soil movement.

(4) Provide culverts, dips, water bars, and cross drainages to minimize road bed erosion.

(5) Design bridge and culvert installations using stream flow data, with a margin of safety proportional to the importance of the road and the protected resources.

(6) Provide drainage where surface and groundwater cause slope instability.

(7) Avoid diverting water from natural drainage ways. Dips, water bars, and cross drainage culverts should be placed above stream crossings so that water can be filtered through vegetative buffers before entering streams.

(8) Locate roads to fit the topography and minimize alterations to the natural features.

(9) Avoid marshes and wetlands.

(10) Minimize the number of stream crossings.

(11) Cross streams at right angles to the stream channel.

(12) A road may not be located in a Streamside Management Zone (SMZ) except where access is needed to a water crossing, or where there is no feasible alternative. A road in any SMZ must be designed and located to minimize adverse effects on fish habitat and water quality.

Construction

Once the road's location and design is staked out, road construction begins. Timber is out, logs and vegetation are removed and piled along the lower side of the right-of-way.

Most forest roads are built by excavating a road surface. Road design and layout on-the-ground show machine operators the proper cut slopes and indicate cut slope steepness. The bulldozer starts at the top of the cut slope, excavating and sidecasting material until the desired road grade and width is obtained. Material from cuts is often pushed in front of the blade to areas where fill is needed. Road fill is used to cover culverts and build up flat areas. Since fill must support traffic, it needs to be spread and compacted in layers to develop strength. The following practices are recommended:

(1) Construct roads when moisture and soil conditions are not likely to result in excessive erosion or soil movement.

(2) The boundaries of all SMZs shall be defined on the ground prior to the beginning of any earth-moving activity.

(3) Construct a road sufficient to carry the anticipated traffic load with reasonable safety and with minimum environmental impact.

(4) When using existing roads, reconstruct only to the extent necessary to provide adequate drainage and safety.

(5) Avoid construction during wet periods, when possible, to minimize unnecessary soil disturbance and compaction.

(6) Road grades should be kept at less than 10%, except where terrain requires short, steep grades.

(7) Minimize the number of stream crossings. Stream crossing construction should minimize disturbance of the area in which the crossing is being constructed.

(8) As slope increases, additional diversion ditches should be constructed to reduce the damages caused by soil erosion; ditches, adequate culverts, cross drains, etc., should be installed concurrent with construction.

(9) To control erosion, cut and fill slopes should conform to a design appropriate for the particular soil type and topography.

(10) Stumps, logs, and slash should be disposed of outside of the road prism; in no cases should they be covered with fill material and incorporated into road beds.

(11) Stabilize the side banks of a road during construction to aid in the control of erosion and road deterioration; this may require mesh or other stabilizing material in addition to planting and/or seeding and other structural measures.

(12) Water bars should be located to take advantage of existing wing ditches and cross drainage. Water bars should be constructed at an angle of 30 to 45 degrees to the road. Water bars should be periodically inspected and damage or breeches should be promptly corrected. Install water bars at recommended intervals to provide the drainage. Water bar spacing recommendations are as follows:

Grade of Road	Distance Between Water bars
2%	250 ft.
5%	135 ft.
10%	80 ft.
15%	60 ft.
20%	45 ft.
25%	40 ft.
30%	35 ft.
40%	30 ft.

Water bars may need to be spaced closer together depending on soil type and rainfall.

(13) Bridges and overflow culverts should be constructed to minimize changes in natural stream beds during high water.

(14) Culverts on perennial streams should be installed low enough to allow passage of aquatic life during low water.

Maintenance

Maintenance of active and inactive roads shall be sufficient to maintain a stable surface, keep the drainage system operating, and protect the quality of streams. The following are recommended:

(1) Maintenance should include cleaning dips and crossdrains, repairing ditches, marking culverts inlets to aid in location, and clearing debris from culverts.

(2) Keep culverts, flumes, and ditches functional before and during the rainy season to diminish danger of clogging and the possibility of washouts. This can be done by clearing away any sediment or vegetation that could cause a problem. Provide for practical and scheduled preventative maintenance programs for high risk sites that will address the problems associated with high intensity rainfall events.

(3) Conduct road surface maintenance as necessary to minimize erosion of the surface and subgrade.

(4) During operations, keep the road surface crowned or outsloped, and keep the downhill side of the road free from berms except those intentionally constructed for protection of fill.

(5) Avoid using roads during wet periods if such use would likely damage the road drainage features.

(6) Water bars should be inspected after major rain storms and damage or breeches should be promptly corrected.

Harvesting - Temporary Access Roads and Landings

(1) The location of temporary access roads (logging roads) should be planned before operations begin.

(2) Road construction should be kept to a minimum.

(3) Landings should be located to minimize the adverse impact of skidding on the natural drainage pattern.

(4) Logging roads and landings should be located on firm ground.

(5) Landings should be kept as small an area as possible.

(6) When operations are completed, provisions should be made to divert water run-off from the landings and roads.

2.0 Pre-Harvest Planning

Pre-harvest planning is the collection of information about the area to be harvested and the synthesis of that information into an effective environmental plan. This plan will consider the silvicultural prescription for the species and site, the best estimate of the time and method of harvest and any post-harvest site preparation and reforestation activities.

At this stage, it is assumed that all federal, state, and local government regulations regarding harvesting have been met.

An effective pre-harvest plan will take into consideration all aspects of the timber harvest which may lead to water quality degradation and plan for the implementation of BMPs which will minimize or avoid the adverse effects of the operation. The objective of pre-harvest planning from the perspective of non-point source pollution is to determine which BMPs are necessary to protect water quality and how those BMPs will be implemented. The following is recommended:

(1) A pre-harvest plan should include the following information:

A. Physical and administrative description

1. Property boundaries & administrative boundaries (zoning, etc.)
2. Topography
3. Location of streams and drainages
4. Location of SMZs and buffer strips
5. Forest types
6. Soil types
7. Areas of ecological and/or archaeological concerns

B. Management Activities

1. Design and construction techniques for all new roads, skid trails, and landings or modification of existing roads, skid trails and landings.
2. Felling and bucking techniques
3. Yarding systems and layout
4. Planned stream crossings
5. Disposal of waste materials (machine lubricants)
6. Post-harvest site preparation
7. Reforestation activities

(2) The use of topographic maps, road maps, aerial photos, forest type maps, and soil surveys in combination with field reconnaissance is essential to determine site conditions and plan operations.

(3) Field reconnaissance with a trained forester or one who is knowledgeable about the specific area is highly recommended.

(4) Preliminary planning should consider the maintenance of existing drainage patterns and the location of environmentally sensitive areas such as streams, wet areas, and high erosion hazard areas.

(5) The design of roads, skid trails, and landings shall be integrated to minimize their impact.

(6) The grade of logging roads and skid trails should be less than 10% when possible, with 3-5% being the norm. Long, straight, unbroken grades are to be avoided. Adequate surface drainage shall be provided.

(7) Time the harvesting activity for the season or moisture conditions when the least impact occurs.

(8) A final pre-harvest site review shall be conducted by management so that road alignments and other considerations can be visually checked prior to road construction. The reconnaissance plan shall be modified as necessary to make desirable adjustments based on the final site review.

2.1 Timber Harvesting

Standards and use

Timber harvesting is an integral part of most forest management programs. Harvesting operations cause a temporary disturbance in the forest as well as diminish water quality. However, it can be conducted in a manner where the impact to water quality is minimized and the re-establishment of vegetative cover is realized. Guidelines to help reduce the potential for nonpoint source pollution from harvesting trees are as follows:

Felling and Bucking

(1) Careful felling can minimize the impact of subsequent phases of the logging operation.

(2) Trees should not be felled into streams, except where no safe alternative exists. In the latter case, such trees should be removed promptly.

Skidding

(1) Skidding should be done so as to avoid disrupting natural drainage and to prevent excessive soil displacement.

(2) Stream channels or road ditches should not be used as skid trails.

(3) Skid trails on steep slopes should have occasional water bars.

(4) Servicing of equipment involving fuel, lubricants, or coolants should be performed in places where these materials cannot enter streams. Spent oil should be collected for proper disposal, never poured on the ground.

(5) Upon completion of logging, erosion-prone areas should be mulched or seeded.

Mechanical Site Preparation

(1) Avoid excessive soil compaction.

(2) Minimize erosion and the movement of sediment into waters.

(3) Prevent accumulation of debris in ponds, streams, or rivers.

(4) Windrows, disking, bedding, and planting with "furrow" type mechanical planters should follow contours.

(5) Avoid complete disking of steep slopes with extremely erodible soil.

(6) Plant trees on contour.

Disposal of Debris and Litter

(1) Logging debris in streams should be removed immediately.

(2) Debris from landings should not be pushed into drains, streams or Streamside Management Zones (SMZs)

(3) All trash associated with the logging operation should be promptly removed (not buried) and hauled to a legal disposal site.

3.0 Silvicultural Chemical Management

Description and Purpose

Pesticides are used on forest lands to facilitate meeting forest management objectives. The purpose of a pesticide application is to rid an area of undesirable vegetation or control insects or diseases to promote the establishment, survival, growth or maintenance of a desired species or condition.

Planning Considerations

Planning is an essential first step in reducing pest problems. A plan is needed by which the application of pesticides is utilized in an efficient manner that produces no adverse impacts on the environment. The maintenance of water quality is an important consideration in all aspects of pesticide operation planning.

Pesticide Selection

When the decision is made to use pesticides, choose products suitable for use on the target species and registered for the intended uses. Use only pesticides registered by the Environmental Protection Agency. Prior to using any pesticide, carefully read and follow all label directions.

When selecting pesticide options, more than effectiveness and cost should be evaluated. Consideration should be given to site factors, application conditions and techniques and products that can influence impacts to water quality.

Three main characteristics can greatly affect a pesticide potential to contaminate surface or ground water. They are solubility, absorption and breakdown rate.

1) Solubility

Solubility is the ability of a pesticide to dissolve in water. The greater the solubility, the greater the chance that the chemical will leach to ground water.

2) Absorption

Absorption is the inherent ability of a pesticide to bind with soil. Some pesticides stick very tightly to soil while others are easily dislodged. A greater absorption means a pesticide will remain longer in the soil and thus be less likely to leach down into the ground water before it has degraded. Absorption increases as soil organic matter increases.

3) Breakdown Rate

Breakdown rate or half-life is the time a pesticide takes to degrade or breakdown into other chemical forms. Pesticides that do not break down quickly can be hazardous if they move to ground water or surface water.

In a given situation, pesticides with the highest water solubilities, greatest persistence, lowest affinities for absorption to organic matter and other soil components, and highest application rates have the greatest potential for movement in surface water or to ground water. An alternative means of minimizing the potential movement of a pesticide is to select a non-broadcast application

technique for the same pesticide that reduces the amount of the chemical applied directly to the soil.

Procedures for Chemical Use

Proper pesticide management practices make efficient use of chemical while preventing contamination of surface water or ground water. Residues of pesticides used in forestry can affect water quality at several phases of the chemical use cycle. These phases are: 1) transportation, 2) storage, 3) mixing and loading, 4) application, and 5) cleanup and disposal. To minimize potential impacts on water quality, use of the following practices is encouraged.

A) Transportation

(1) Inspect all containers prior to loading and ensure all caps, plugs and bungs are tightened.

(2) Handle containers carefully when loading them onto vehicles.

(3) Secure containers properly to prevent shifting during transport.

(4) Check containers periodically enroute.

(5) Limit access to containers during transport to prevent tampering.

(6) Educate and inform the driver of the proper transportation precautions.

(7) Never transport pesticides unless arrangements have been made to receive and store them properly.

B) Storage

(1) Chemicals should be managed and stored in accordance with all applicable federal, state, or local regulations. These would include:

(a) The EPA container registration label, as printed on the label;

(b) Label instruction for use as provided by the manufacturer;

(c) Requirements or the use, application, and registration of pesticides;

(d) Requirements relating to the licensing of applicators.

(2) All containers should be labeled in accordance with applicable federal, state and local regulations.

(3) Apply pesticides under favorable weather conditions. Never apply a pesticide when there is a likelihood of significant drift.

(4) Always use pesticides in accordance with label instruction, and adhere to all Federal and State policies and regulations governing pesticide use.

E) Cleanup and Disposal

(1) Before disposal, containers should be rinsed as described in equipment cleanup.

(2) Cleanup should be in a location where chemicals will not enter any stream, pond, or where stream pollution might occur.

(3) Rinse empty pesticide containers and mixing apparatus as many times as needed. This flushing should be applied in spray form to the treated area, NOT into the ground near streams.

(4) Dispose of pesticide wastes and containers according to federal and state laws. Some pesticide wastes are specifically identified as hazardous wastes by law and must be handled and disposed of in accordance with hazardous waste regulations. For more information about proper management of waste pesticides, contact the Department of Health, Environmental Health Administration.

Other chemicals

Improper storage and handling of oil products and fuel can be a water quality hazard. Improper disposal of oil or fuel can contaminate ground water and seep into streams. The following are recommended:

(1) Locate facilities away from streams and be prepared to clean up spills.

(2) Know and comply with regulations governing the storage, handling, application (including licensing of applicators), and disposal of hazardous substances.

(3) Do not transport, handle, store, load, apply or dispose of any hazardous substance or fertilizer in such a manner as to pollute water supplies or cause damage or injury to land, including humans, desirable plants and animals.

(4) Do not store, mix, or rinse hazardous substances or fertilizers within the streamside management zone or where they might enter streams or waterways.

(5) Develop a contingency plan for hazardous substance spills, including cleanup procedures.

(6) Report all spills to the Department of Health, Environmental Health Administration.

4.0 Streamside Management Zone (SMZ)

The Special Management Zone (SMZ) is a specific area associated with a stream, lake, wetland or other waterbody that is designated and maintained during silviculture operations. The purpose of the SMZ is to protect water quality by reducing or eliminating forestry related ouputs, i.e. sediment, nutrients, logging debris, chemicals, and water temperature fluctuations that can adversely affect aquatic communities. SMZs provide shade, streambank stability and erosion control, as well as detritus and woody debris which benefit the aquatic ecosystem in general. In addition, the SMZ is designed to maintain certain forest attributes that will provide specific wildlife habitat values. Snags, den and cavity trees as well as mast producing trees, left in the SMZ, are necessary to meet habitat requirements for certain wildlife.

The SMZ has specific criteria, that defines operational restrictions and special management objectives. In addition, the SMZ has a specific width which is based on the size and type of waterbody involved.

A Streamside Management Zone (SMZ) is an area covered with vegetation or ground cover on both sides of perennial, intermittent streams and other bodies of open water, where extra precaution is used in carrying out forest management practices. The SMZ also provides shade and functions as a buffer when fertilizers, pesticides, etc. are applied to adjacent lands. For practical purposes, an SMZ must be wide enough to protect water quality and stream characteristics. Precaution is needed in carrying out forest management practices in order to protect bank edges and water quality. Determining the necessary width involves in part a judgement factor based on reliable local experience.

SMZs should be used where: 1) water quality is impaired and adjacent land use contributes to that degradation, 2) good water quality exists and protection against potential future impairment is desired, 3) streambank erosion is a concern, 4) wildlife habitat enhancement is desired, and/or 5) silviculture practices are to be implemented, and 6) the lower edge of cropland, grassland, or forest land is adjacent to permanent or intermittent streams, or border streams, rivers, ponds or intermittent or permanently flooded, open-water wetlands.

SMZ benefits include the following:

(1) Shade - Trees within the SMZs provide shade to maintain cool water temperatures which aid in the spawing of fish. Without trees and overhanging shrubs, stream temperatures would increase during the summer. Some fish species and aquatic organisms would then be unable to live in the streams. In the summer, water from shaded streams eventually flows into larger bodies of water and helps maintain its fish and aquatic life by keeping these waters cool all the way downstream.

(2) Food - Leaves and insects drop into streams from overhanging trees and shrubs. In fact, 90% of the food in the forested streams comes from bordering vegetation.

(3) Protection of Streambanks - Many streambanks are stabilized by streambank trees. They anchor banks and prevent erosion during periods of high water. Removing trees and shrubs and substituting shallow rooted grasses can lead to streambank collapse and stream sediment. Bank overhang is created by stream flows undercutting the stream bank and tree roots. Fish can rest, hide from predators, and feed in these protected areas.

(4) Flooding - Healthy SMZs stabilize floodplains. During times of high water, SMZs reduce the velocity of floodwaters. Their dense vegetation and deep humus slow down racing waters. Forest floodplains suffer less damage when SMZs are protected during harvesting activities.

(5) Recreation - The recreational activities that we enjoy in and around streams are many. This includes swimming, fishing, camping, hunting, and backpacking to name a few.

(6) Timber Production - For those who grow and harvest trees, the fact is that trees often grow best in SMZs. Trees respond to those deep, fertile, and moist soils. Logging activities should not be eliminated within SMZs but modified to insure that stream channels and banks are protected from disturbance. SMZs are not timber harvest "keep out" zones, but there are locations where timber harvesting activities must be modified to protect the many benefits mentioned above.

Recommendations

SMZs should be maintained along all perennial streams or where forest disturbances occur and surface runoff will carry sediment loads. SMZs should be maintained around streams, ponds, perennial flowing natural springs, and all springs and reservoirs serving as domestic water supplies. The following best management practices are recommended:

(1) The width of SMZs should be determined depending on the following conditions: slope of land adjacent to stream, soil erodibility, precipitation, knowledge of particular area, sensitivity of stream, etc. These factors can be obtained from soil maps, on-the-ground evaluation and measurements, weather data, etc.

(2) SMZs should be designed on a case-by-case basis. Most important is that SMZs be consistent with stream characteristics and wide enough to protect water quality.

Soil Type	Percent Slope	SMZ Width (each side)
Slightly erodible	0-5	35'
Slightly erodible	5-20	35-50'
Slightly erodible	20+	50-160'
Erodible	0-5	35-50'
Erodible	5-20	80' minimum
Erodible	20+	160' minimum

Table 1. Recommended Widths for Streamside Management Zone

[NOTE: Please contact your local Natural Resources Conservation Service office to determine the erodibility factor of the soil before determining the proper width of the SMZ.]

(3) On relatively flat terrain (0-5%) on slightly erodible soils, the width of an SMZ should be at least 35 feet wide on each side of a stream.

(4) On relative flat terrain (0-5%) on erodible soils, the SMZ width should range between 35 to 50 feet on each side of a stream.

(5) On slightly erodible soils with slopes ranging between 5 and 20 percent, the SMZ width should range between 35 to 50 feet wide on each side of a stream.

(6) On erodible soils with slopes ranging between 5 and 20 percent, the SMZ width should range between 50 to 160 feet on each side of a stream.

(7) On slightly erodible soils with slopes exceeding 20 percent, the SMZ width should be at least 80 feet on each side of a stream.

(8) On erodible soils with slopes exceeding 20 percent, the SMZ width should be a minimum of 160 feet on each side of a stream.

(9) Partial harvesting is acceptable. A minimum of 50% of the original crown cover or 50 square feet of basal area per acre, evenly distributed, should be retained in the SMZ. This may be adjusted to meet on-site conditions.

(10) Clearcutting is always prohibited within the SMZ.

(11) Designate SMZs to provide stream shading, soil stabilization, sediment and water filtering effects, and wildlife habitat.

(12) Strive to protect the forest floor and understory vegetation from unnecessary damage. Do not remove (harvest) trees from banks, beds or slopes if it will destablilize the soil. Trees on the south and west banks provide the most critical shading of water.

(13) Access roads should cross perennial or intermittent streams at or near a right angle.

(14) Drainage structures such as ditches, cross drain culverts, water bars, rolling dips, and broad-based dips should be used on all roads prior to their entrance into an SMZ to intercept and properly discharge runoff waters.

(15) SMZs may be desirable on intermittent streams for large drainage areas where wildlife is a major landowner concern or for other reasons.

5.0 Fencing

(1) Fencing out livestock, pigs, and other animals in certain areas will help to prevent water quality degradation of streams, protect threatened and endangered plants, reduce soil compaction and maintain soil productivity. Fencing is applicable where desired forest reproduction, soil hydrologic values, existing vegetation, aesthetic values, and recreation are prevented or damaged by these animals.

(2) Pastures should be fenced separately from woodlands. Consider maintenance as well as ease of construction when planning a fence location. By taking advantage of natural barriers such as cliffs, the cost of animal exclusion can be reduced. Also consider use of fences to protect vegetation that provides wildlife food and cover.

(3) Fences should be permanent stock fences built in accordance with good construction principles and workmanship.

6.0 Wildfire Damage Control and Reclamation/Prescribed Burn

The prevention, control, and extinguishment of all wildfires on grass, brush, and watershed lands and the implementation of a prescribed fire program is a desirable goal. Where wildfires do occur, the first and foremost concern is to control the fire and limit the damage. Fire suppression activities can add to the problem of water quality protection.

The loss of vegetative cover, destruction of soil-holding feature of root masses, the exposure of bare mineral soil, is a combination that makes the area burned a highly erodible one. The effects of suppression efforts and equipment operations necessary to control and stop the fire can magnify the erosion problem.

The following are best management practices for wildfire control and reclamation:

(1) The first and foremost concern in wildfire control is to prevent harm or damage to people and property. Fireline best management practices should incorporate minimum impact strategies, which meet land and resource management objectives;

(2) Areas with bare mineral soils should be revegetated and areas where vegetative cover has been killed or severely degraded should be regenerated with plant species appropriate for the soil conditions;

(3) First priority for revegetation/reforestation should be given to banks of surface water bodies so that the SMZ is reestablished;

(4) Firelines should be stabilized and, if necessary, revegetated. Erodible areas altered by suppression equipment activities should be repaired and revegetated as necessary;

(5) Access road surfaces should be repaired and stabilized as necessary.

(6) Whenever possible, avoid using fire suppression chemicals over watercourses and prevent their runoff into watercourses. Do not clean application equipment in watercourses or locations that drain into watercourses.

(7) Provide advance planning and training for firefighters that considers water quality impacts when fighting wildfires. This can include increasing awareness so direct application of fire suppression chemicals to waterbodies is avoided and firelines are appropriately placed.

(8) Include rehabilitative practices as part of suppression and post-suppression tactics and strategies to mitigate non-point source pollution.

6.1 Fireline Construction and Maintenance

Fireline construction and maintenance is an essential part of forest and other land management activities. It deals with site preparation burning, prescribed burning, and wildfire defense and control. A number of control practices can be implemented during fireline construction to prevent unnecessary erosion. Periodic inspection and proper maintenance can prevent potential erosion on established firelanes. The following are best management practices for fireline construction and maintenance:

(1) Firelines should be constructed on the perimeter of the burn area and along the boundary of the Streamside Management Zone. The purpose of protecting the Streamside Management Zone from fire is to safeguard the filtering effects of the litter and organic matter;

(2) Firelines should follow the guidelines established for logging trails and skid trails with respect to waterbars and wing ditches, and should be only as wide and as deep needed to permit safe prescribed burns or fire suppression needs;

(3) Firelines which would cross a drainage should be turned parallel to the stream or have a wing ditch or other structure allowing runoff in the line to be dispersed rather than channeled directly into the stream.

(4) All firelines should be assessed after the fire is controlled for appropriate stabilization, and if necessary, proper rehabilitation should be done while equipment and people are in place.

6.2 Prescribed Burn

(1) Intense prescribed fire for site preparation shall be conducted only if it achieves desired results with minimum impacts to water quality.

(2) Burning on steep slopes or highly erodible soils should be conducted when they are absolutely necessary and should follow carefully planned prescriptions.

(3) Carefully plan burning to adhere to time of year, weather, topography, and fuel conditions that will help achieve the desired results and minimize impacts on water quality. With proper planning, prescribed fires should not cause excessive sedimentation due to the combined effect of removal of canopy species and the loss of soil-binding ability of the subcanopy and herbaceous vegetation roots, in streamside vegetation, small ephemeral drainages, or on very steep slopes.

(4) Site preparation burning creates the potential for soil movement. Burning in the SMZ reduces the filtering capacity of the litter. All efforts should be made to plan burns to minimize impacts on the SMZ.

(5) All bladed firelines, for prescribed fire and wildfire activities, should be built so as to minimize erosion. If necessary, the firelines should be stabilized with water bars and/or other appropriate techniques to control excessive sedimentation or erosion of the fireline. Include any erosion control practices in the construction of firelines.

7.0 Reforestation

Reforestation refers to those operations undertaken to establish a new forest. Site preparation, for the purpose of forest regeneration, is a basic silvicultural tool where for competing vegetation and

reduction of logging debris are necessary. Common site preparation techniques include, manual, mechanical, fire, and herbicides.

Regeneration includes hand and machine planting and direct seeding. Since hand planting and direct seeding pose no water quality problems, BMPs are not necessary. Some mineral soil exposure does occur with machine planting and BMPs are offered.

1) Sites should receive the minimum preparation necessary to successfully control competing vegetation and establish a desirable timber stand. In general, the more intensive the treatment, the more concern for water quality.

2) When working on slopes, mechanical operations such as ripping, shearing, etc., should follow contours.

3) Hand planting, direct seeding or natural regeneration should be used on protected areas adjacent to streams or on slopes too steep to machine plant.

APPENDICES

1. Definition of Terms
2. Road Construction Applications
3. Streamside Management Zone
4. Available Assistance
5. Suggested Readings

definition of terms

DEFINITION of TERMS:

Best Management Practices -- effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of silvicultural activities. These practices are developed to achieve a balance between water quality protection and the production of wood crops within natural and economic limitations.

Bucking -- to saw felled trees into predetermined lengths.

Clearcutting -- the removal of all standing trees within a designated area.

Cross drain -- a cross ditch used to move water from one side of the road to the other side to prevent accumulation of runoff without the need of a culvert or bridge.

Culvert -- a conduit through which surface water can flow under roads.

Diversion ditch - a ditch built across the top of a slope to divert surface water from that slope.

Felling -- the process of severing trees from stumps.

Firebreaks -- naturally occurring or man-made barriers preventing the spread of fire.

Fireline construction -- the construction of a barrier used to prevent the spread of fire.

Intermittent streams -- streams that provide water flow continuously during some seasons of the year but little or no flow during the remainder of the year.

Landing -- an area in the field where logs are collected.

Non-point source -- a source of water pollution which are induced by natural processes, including precipitation, seepage, percolation, and runoff; and not traceable to any discrete or identifiable source.

Perennial streams -- streams which provides water flow at all times except during extreme drought.

Pesticides -- any herbicide, insecticide, or rodenticide, but does not include non-toxic repellents or other chemicals.

Pre-commercial thinning - the removal of selected trees within an established forest destined for commercial use.

Prescribed burning -- the controlled application of fire as a management tool in forest management.

Reforestation -- the successful reestablishment of tree species following harvest.

Silvicultural practices -- all forest management practices, including the establishment, composition, constitution, and growth of forests.

Site preparation -- the removal of unwanted vegetation and other material prior to reforestation.

Skid trails -- routes over which logs are moved to a landing or road.

Streamside Management Zone -- an area on each side of the banks and above the head of intermittent streams, perennial streams, and other drains or bodies of water where extra precaution in carrying out best management practices is needed to protect bank edges and water quality.

Waterbar -- a cross drainage diversion ditch and/or hump in a trail or road for the purpose of diverting surface water runoff into roadside vegetation, duff, ditch, or dispersion area to minimize the volume and velocity which can cause soil movement and erosion.

Wetlands -- geographic areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wing ditch -- a water turnout or diversion ditch constructed to move and disperse water away from the road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduce on slopes.

Yarding -- the method of log transport from the harvest area to the storage area.

BROAD BASED DIPS

Definition:

A dip and reverse slope in a truck road surface with an outslope in the dip for natural cross drainage.

Purpose:

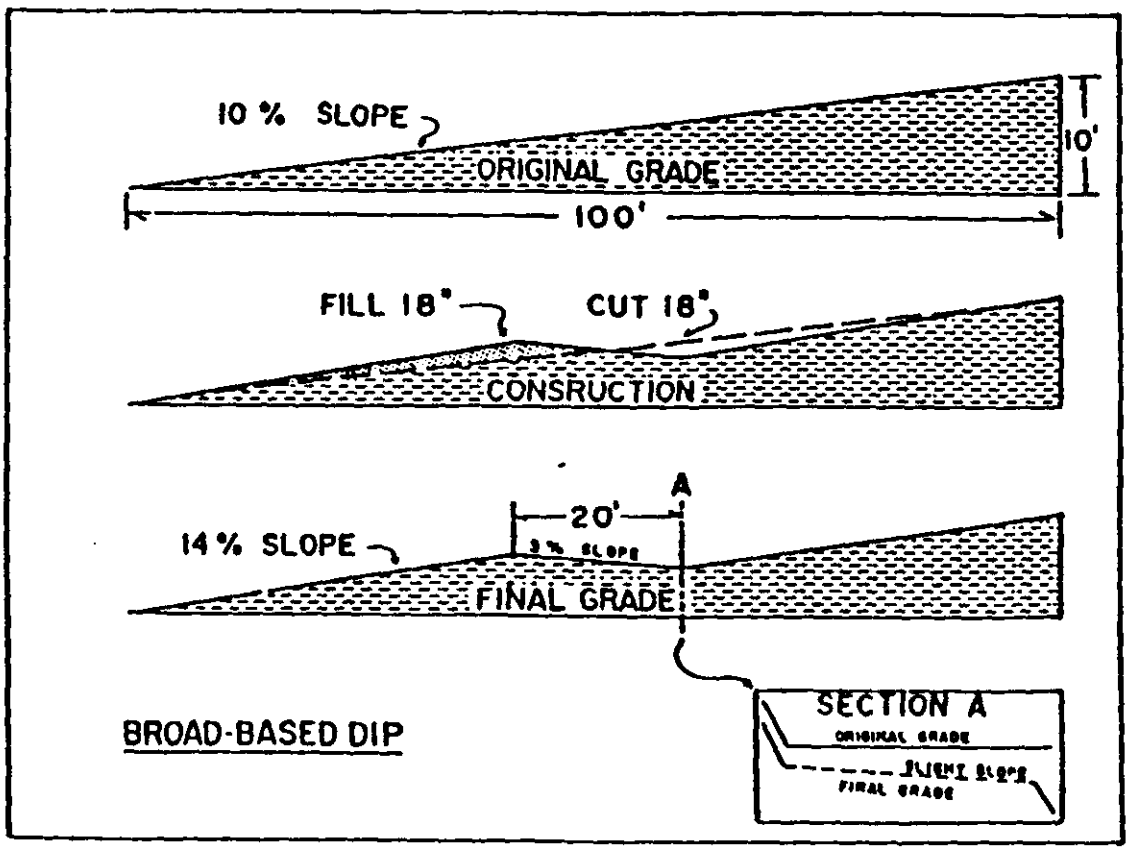
To provide cross drainage on insloped truck roads to prevent build-up of excessive surface runoff and subsequent erosion.

Conditions Where Practice Applies:

Use on truck roads and heavily used skid trails having a gradient of 10% or less. May be substituted for other cross drainage structures where no intermittent or permanent streams are present.

Guidelines:

* Proper construction requires an experienced bulldozer operator.
* Installed after the basic roadbed has been constructed and before major hauling use.



- On grades steeper than 8%, surface dips with stone (approx. 3" diameter) or gravel.
- Use dips on approaches to steep declines in heavily used skid trails.
- Discharge area should be protected with stone, grass sod, heavy litter cover or slash and logs to reduce the velocity and filter the water.

SPACING FOR BROAD BASED DIPS

Road Grade (percent)	Spacing Between Dips (feet)
2	300
4	200
6	165
8	150
10	140
12	130

WATER BARS

Definition:

An earthen or reinforced berm constructed across a truck road or skid trail.

Purpose:

To intercept and divert water from side ditches and truck road or skid trail surfaces, therefore minimizing erosion by decreasing the slope length of surface water flow.

Conditions Where Practice Applies:

Utilized on any sloping truck road or skid trail where surface water runoff may cause erosion.

Guidelines:

* Start placement of water bars at the farthest skid trail and work back to the log landing and then to the truck road.
* Install water bars with a skidder blade, dozer blade, or by hand.
* Install water bars at the top of any sloping road or trail and at proper spacing along steep sections.

* Water bars may be shallow or deep depending on the need.

* Soil should be left along the lower side of the water bar.

* Should be constructed at a 30° - 35° angle downslope from a line perpendicular to the direction of the truck road or skid trail.

* Should drain at a 3% outslope onto undisturbed litter or vegetation.

* The uphill end of the water bar should extend beyond the side ditch line of the road or trail to fully intercept any water flow.

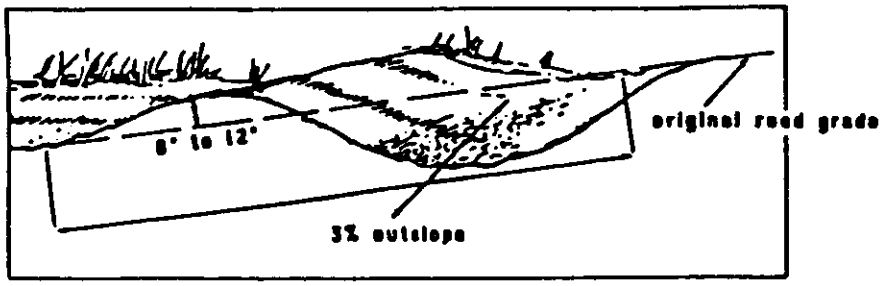
* The downhill end of the water bar should be fully open and extended far enough beyond the edge of the road or trail to disperse runoff water onto undisturbed forest floor.

* Place rocks, slash, or logs to disperse water coming from a water bar.

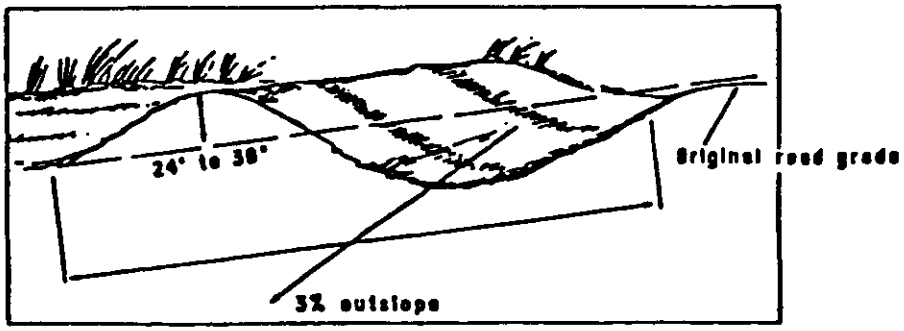
* If the road or trail is to be kept open after the harvesting operation, the following guidelines should be used in order to preserve effective water bars.

  - Reinforce the water bars
  - Keep travel to a minimum
  - Use only in dry weather
  - Make frequent inspections
  - Maintain as needed

SHALLOW WATER BAR



DEEP WATER BAR



SPACING FOR WATER BARS

Road/Trail Grade (percent)	Spacing Between Water Bars (feet)
2	250
5	135
10	80
15	60
20	45
30	35

CROSS DRAINAGE CULVERTS

Definition:

Corrugated pipe, well casing, dredge pipe, or other suitable material placed under a truck haul road or major skid road to transmit ditch runoff and seeps from a drainage area of less than 10 acres.

Purpose:

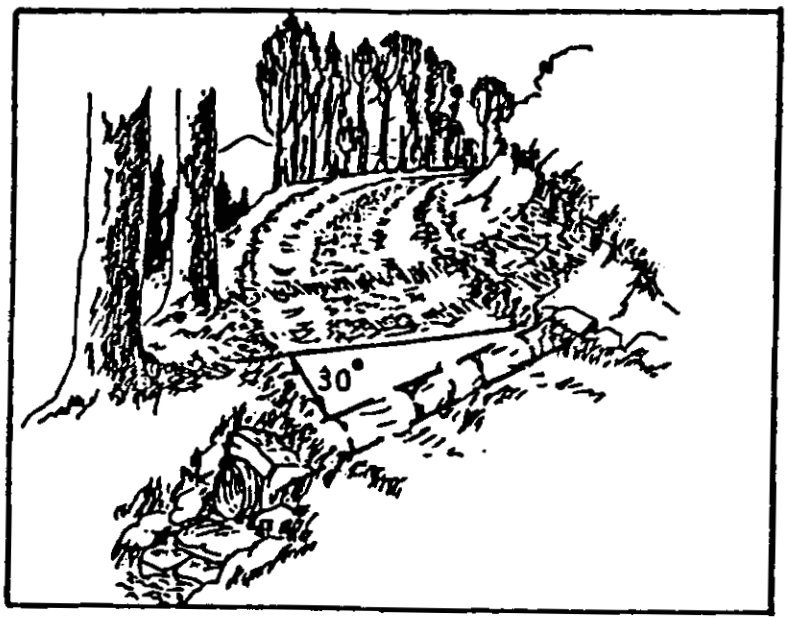
To collect and transmit water flows from side ditches and seeps, under truck haul roads and major skid trails safely without eroding a drainage system or road surface.

Conditions Where Practice Applies:

For any size operation where cross drainage of storm water is required temporarily or permanently.

Guidelines:

* This is the most expensive method of road cross drainage and should be used where heavy road use is anticipated during and after the harvesting operation.



* When sizing culverts for temporary roads, allow for periods of high flow, such as spring runoff or cloudbursts.

* The minimum size culvert to be installed is 12 inch diameter and 20 feet in length.

- When constructing roads on sidehill locations, ditch uphill side of the roadway to intercept surface runoff.

- Allow inlet end of culvert to extend into side ditch so that it intercepts water flowing in the ditch. Construct a berm across the side ditch to assist in diverting water into the culvert.

- Allow outlet end of culvert to extend beyond any fill and empty onto an apron of rock, gravel or logs.

- Space culverts according to road grade:

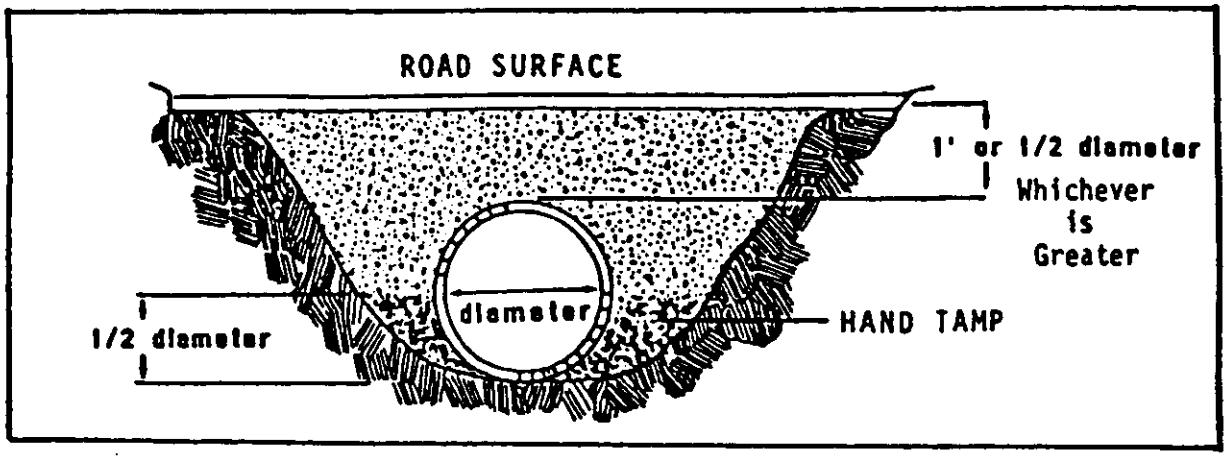
On gentle slopes (1-2%)	300 feet
On moderate slopes (3-10%)	150 feet
On steep slopes (10%+)	100 feet or less

- Culverts should be installed at a 30-35 degree angle downgrade.

- Culverts should be sloped at least 5 inches for every 10 feet of length to permit self-cleaning.

- When harvesting operation has been completed, the road should be stabilized by installing water bars and removing all pipe culverts from truck roads which will not be maintained.

- Culverts, when not maintained, are very likely to become blocked with rocks, ice or other debris. Runoff water can become rerouted over and around the culvert and may wash out sections of road into brooks, streams, ponds or wetlands. It is important to clean culverts regularly. Check after every storm.



- Culvert size selection should be based on the size of the drainage area of a forested watershed and should be able to handle the largest flows.

- Estimating drainage area by taking measurements on a USGS topographic map, using contour lines to define the drainage limits. The Soil Conservation Service can assist you with determination of drainage area.

OPEN TOP CULVERTS

Definition:

A wooden culvert placed across truck haul roads to convey surface runoff and side ditch flows across to downslope side.

Purpose:

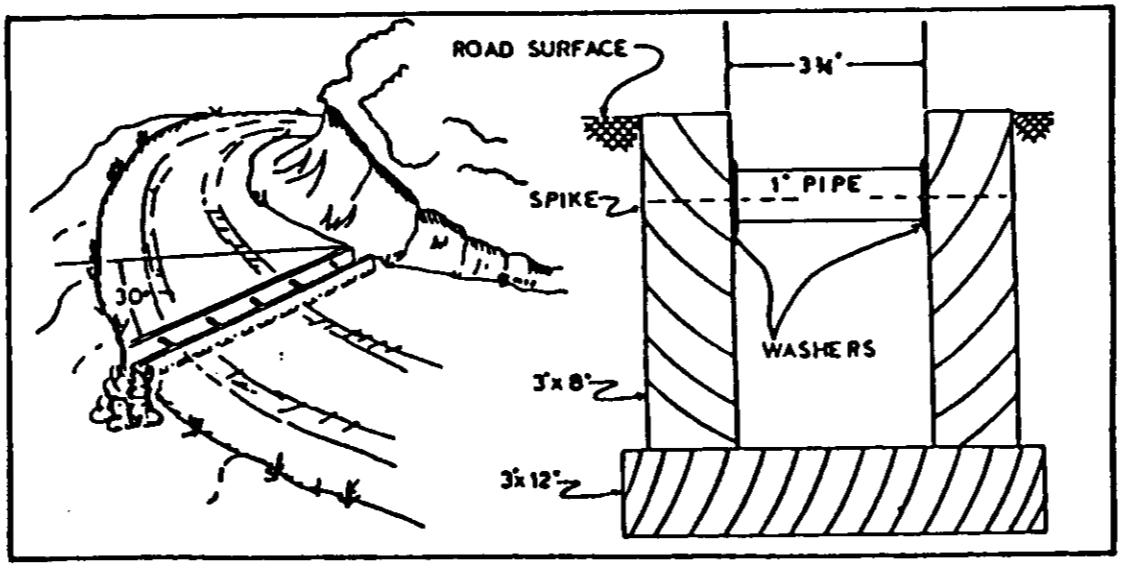
To collect and direct road surface storm runoff and upslope side ditch flows across road without eroding drainage system or road surfaces.

Conditions Where Practice Applies:

This is a temporary drainage structure for on-going harvesting operations. Property built and maintained, it can be used for cross drainage on roads of smaller operations as a substitute for a pipe culvert. This practice should not be used for handling intermittent or live streams or skid trail cross drainage.

Guidelines:

* Can be constructed of cull logs or from sawn lumber. If made of durable wood or treated material, these culverts will give many years of service.



- To be installed flush with the road surface and skewed at an angle not less than 30 degrees downgrade.
- Allow the inlet end to extend into the cut slope or side ditch so that it intercepts water.
- Allow outlet end to extend beyond any fill and empty onto an apron of rock, gravel or logs.
- Open top culverts must be cleaned regularly to remove sediments, gravel, and logging debris to allow normal function of structure at all times.

SPACING FOR OPEN TOP CULVERTS

Road Grade (percent)	Spacing Between Culverts (feet)
2	300
4	200
6	165
8	150
10	140
12	130

road construction applications

OUTSLOPING

Definition:

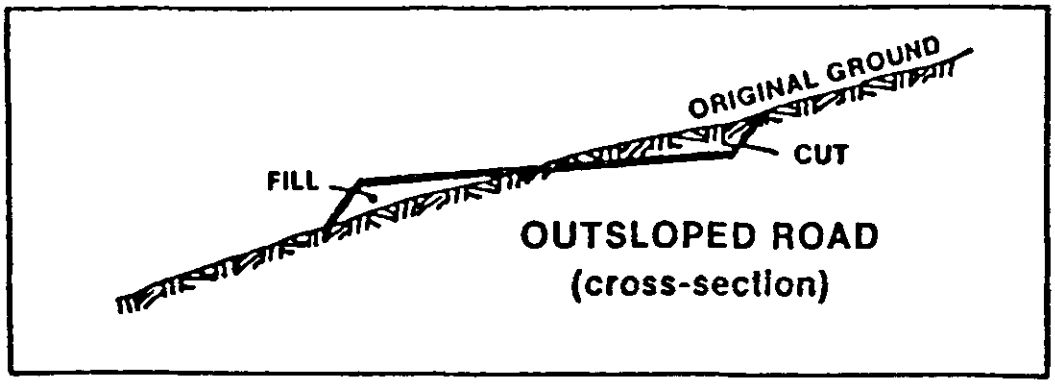
A section of road is sloped slightly (1-3%) from the cut bank to the outside edge of the road bed.

Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted on to the forest floor.

Condition Where Practice Applies:

Used when the area is entirely rock, or when water can be diverted on to undisturbed forest floor.



INSLOPING

Definition:

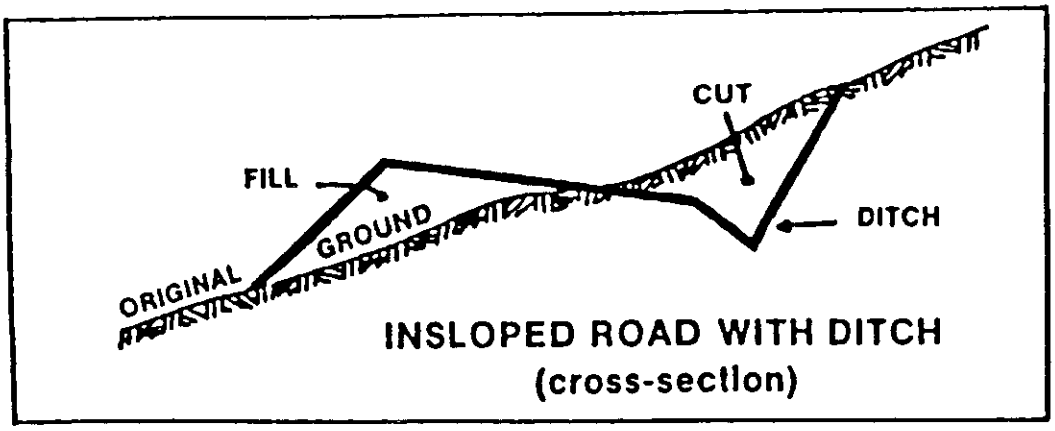
A section of road is sloped slightly (1-3%) toward the cut bank.

Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly to the inside ditch which will carry the water into a culvert.

Condition Where Practice Applies:

Used when the soils are easily saturated or highly erodible. This will limit the amount of ditch water which will flow on to unstable fills.



INSLOPED ROAD WITH DITCH
(cross-section)

CROWNING

Definition:

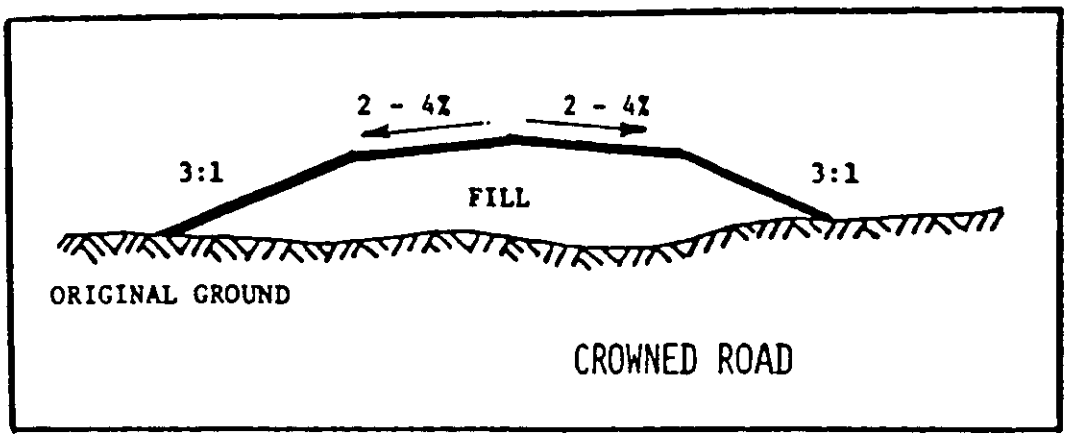
A section of road is sloped slightly (2-4%) from the center line of the road to the outside edges of the roadbed.

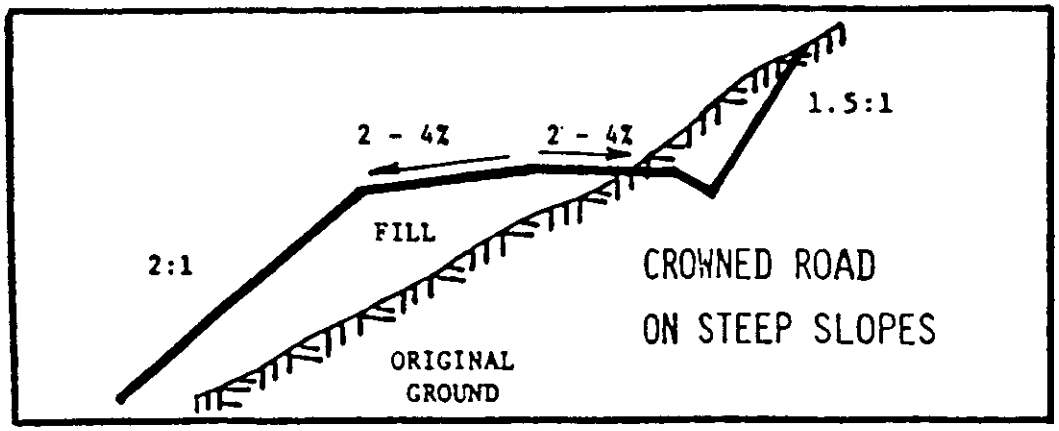
Purpose:

Effective way of limiting erosion because water is removed from the road surface quickly and diverted directly onto the forest floor or into a ditch which will carry the water into a culvert.

Conditions Where Practice Applies:

Used when soils are easily saturated or highly erodible when adjacent areas are relatively level with roadbed or on steep side hills.





streamside management zone

STREAMSIDE MANAGEMENT ZONE

Streamside Management Zones (SMZs) should be maintained along all perennial streams or where forest disturbances occur and surface runoff will carry sediment loads. SMZs should be maintained around streams, ponds, perennial flowing natural springs, and all springs and reservoirs serving as domestic water supplies.

The width of SMZs should be varied, depending on the following conditions: slope of land adjacent to stream, soil erodibility, precipitation, knowledge of particular area, sensitivity of stream, etc. These factors can be obtained from soil maps, on-the-ground evaluation and measurements, weather data, etc.

SMZs should be designed on a case-by-case basis. Most important is that SMZs be consistent with stream characteristics and wide enough to protect water quality.

The following is offered as a guideline:

Soil Type	Percent Slope	SMZ Width (each side)
Slightly erodible	0-5	35'
Slightly erodible	5-20	35-50'
Slightly erodible	20+	50-160'
Erodible	0-5	35-50'
Erodible	5-20	80' minimum
Erodible	20+	160' minimum

[NOTE: Please contact your local Natural Resources Conservation Service office to determine the erodibility factor of the soil before determining the proper width of the SMZ.]

available assistance

Available Assistance

Department of Land & Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813
Telephone: (808) 587-0166 Facsimile: (808) 587-0160

Hawaii Branch

P.O. Box 4849
Hilo, HI 96720-0849
Telephone: (808) 974-4221
Facsimile: (808) 974-4226

Maui Branch

54 High Street
Wailuku, Hi 96793
Telephone: (808) 984-8100
Facsimile: (808) 984-8111

Oahu Branch

2135 Makiki Heights Drive
Honolulu, HI 96822
Telephone: (808) 973-9778
Facsimile: (808) 973-9781

Kauai Branch

3060 Eiwa Street, Rm. 306
Lihue, HI 96766-1875
Telephone: (808) 274-3433
Facsimile: (808) 274-3438

Natural Resources Conservation Service
Prince Kuhio Federal Bldg., Rm 4-118
Honolulu, HI 96850
Telephone: (808) 541-2600

Hawaii District Offices

Hilo Office
154 Waianuenue Avenue
Hilo, HI 96720
Telephone: (808) 961-5502

Kealakekua Office
P.O. Box 636
Kealakekua, HI 96750
Telephone: (808) 322-2484

Kamuela Office
P.O. Box 1089
Kamuela, HI 96743
Telephone: (808) 885-6602

Pahala Office
P.O. Box 807
Pahala, HI 96777
Telephone: (808) 928-6185

Natural Resources Conservation Service, cont'd.

Maui District Offices

Wailuku Office
70 S. High Street
Wailuku, HI 96793
Telephone: (808) 2444-3729

Molokai Office
P.O. Box 376
Kaunakakai, HI 96748
Telephone: (808) 567-6530

Kauai District Office

Lihue Office
4334 Rice Street, Rm. 104
Lihue, HI 96766
Telephone: (808) 245-6513

Consulting Foresters

Contact the Division of Forestry and Wildlife at (808) 587-0166 for the latest list.

NOTES

Suggested Readings

1. "Logging Roads and Skid Trails, A Guide for Soil Protection and Timber Access," Indiana Department of Natural Resources - Division of Forestry, 21 pp.

2. Dellberg, Robert A., "Road Building for Small Private Roads," Mendocino County Resource Conservation District, Ukiah, CA., July 1992, 73 pp.

3. Walbridge, T.A. Jr., "The Direct Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1990, 70 pp.

4. Walbridge, T.A. Jr., "The Paper Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1990, 75 pp.

5. Walbridge, T.A. Jr., "Field Tables for the Direct Location of Forest Roads," Virginia Polytechnic and State University, Blacksburg, VA., 1991, 15 pp.

6. Wenger, Karl F., "Forestry Handbook, Second Edition," Society of American Foresters, 1984, 1,335 pp.

7. "Erosion and Sediment Control Guide for Hawaii," Soil Conservation Service, 1981, 178 pp.

A TIMBER INVENTORY OF THE

WAIAKEA TIMBER MANAGEMENT AREA

Michael Constantinides

Ronald J. Cannarella

Honolulu, Hawaii
May, 1999

Supported by:

The USDA Forest Service Economic Recovery Program
The Hawaii Forestry and Communities Initiative
The Division of Forestry and Wildlife

Executive summary:

In 1997, the first comprehensive inventory of timber resources in the Waiakea Timber Management Area (WTMA) was conducted. Primary survey objectives included producing accurate forest type maps, estimating wood volume, and providing training for field crew members in timber inventory methodology.

Mapping efforts revealed that the WTMA was comprised of 228 timber stands, 28 forest types, and occupies 12,043 acres. Sampling was conducted on a systematic grid of fixed radius plots over the entire landscape. The grid was intensified in high volume *Flindersia brayleyana* stands to provide stronger estimates for this species of special commercial interest.

The sum of merchantable volume in all forest types exceeded 16,300,000 cubic feet, or approximately 81,500,000 board feet assuming a conversion factor of five board feet per cubic foot. The survey intensity and resulting volume and value analyses of this study were designed to provide guidelines for long-term forest management, and were not intended to be the sole basis for conducting timber sales.

Various eucalyptus species and Queensland maple appear to be well suited to the growing conditions found in the WTMA. Mean annual increment (MAI) values for these species ranged between 150-500 ft^3 $acre^{-1}$ $year^{-1}$. *Toona ciliata* and *Fraxinus uhdei* are not well adapted to site conditions within the WTMA, with mean annual increments typically less than 25 ft^3 $acre^{-1}$ $year^{-1}$.

Introduction:

From June to October, 1997, the Hawaii Forestry and Communities Initiative (HFCI) timber survey crew conducted an inventory of timber resources located within the Waiakea Timber Management Area (WTMA). The primary objectives of the inventory were to provide:

1. Accurate forest type maps.
2. Volume estimates of commercial timber resources.
3. Training for the HFCI survey crew in timber inventory methodology.

The WTMA is located along Stainback Highway, on the northeast slopes of Mauna Loa. Elevations within the tract range from approximately 380-3200 feet. Rainfall exceeds 200 inches per annum at lower elevations, and gradually declines with increasing elevation. A majority of the WTMA is situated on relatively recent lava flows (less than 1,500 years old), and surface soils are typically rocky with only a few inches of mineral soil. Surface soils can be broadly categorized as aa lava, pahoehoe lava, or mineral. The latter occurred in areas of older and more weathered lava flows, areas of ash accumulation from a past eruption of Puu Makaala, or depressions with accumulation of mineral sized soil particles.

Originally comprised of wet ohia (*Metrosideros polymorpha*) - hapuu (*Cibotium* spp.) forests, most areas within the WTMA were cleared by bulldozer in the mid-1960's and converted to plantations of commercial non-native hardwood species. Most hardwoods were planted using a 10 x 10 foot spacing with the exception of some low-elevation eucalyptus stands that were planted at 8 x 8 foot spacing. Primary planting efforts occurred from 1960-1980, after which harvesting of some *E. saligna* occurred. The latter areas were re-planted with *E. grandis*.

Survey methodology:

Planting maps, harvest maps, satellite imagery and aerial photographs were used to develop initial stand boundaries for the WTMA. During field inventory work, the survey crew verified and updated these boundaries, while concurrently assigning forest types to each stand based on primary commercial species present, age, and stand composition.

Sampling was based on a systematic grid with one point every five acres. Using a random start, sample plots were established at every ninth grid point over the entire landscape. Within *Flindersia brayleyana* stands, sample plots were established at every grid point. Once the initial survey was completed, all timber stands were post-stratified by type, and all plot data were aggregated by forest type for subsequent volume analyses. Additional grid points were randomly selected and sampled to increase the plot sample size in forest types that had inadequate plot representation in the standard grid system.

Circular sample plots were 0.20 acres in size, with a fixed radius of 52.66 feet. All trees larger than 5" diameter at breast height (DBH) were measured as "main plot" trees. Each plot tree was numbered and measured for DBH. Total height was recorded for every fifth tree of each species encountered on the plot. Regeneration data were recorded by tallying all tree stems in a DBH range of 2-5" within a nested 0.10 acre (26.33 feet in radius) "sub-plot."

Three primary overstory, understory, and groundcover species at or near each plot point were recorded in order of decreasing abundance. These data did not represent actual stem counts. All tree species encountered were included in volume analyses, though some may currently be considered non-merchantable (Appendix A). Other descriptive data collected included slope, aspect, surface soil type, and weather conditions.

Survey data were analyzed using Forestry Projection System software version 5.3a (Forest Biometrics, 1998). Gross wood volume calculations represented volume from tree base to tree tip. Merchantable wood volume calculations were based on 16 foot log sections, a minimum top diameter of four inches, a stump height of one foot, and a minimum DBH of eight inches. No defect deductions were applied to volume analyses in this study. Volume calculations were based on data from all cruised stands within each forest type. These data were subsequently used to predict volume in non-cruised stands of the same type.

Three local taper profiles were available for volume analyses of species encountered during this survey, necessitating the use of taper profiles from alternate species and regions (Appendix B).

Survey results:

The post stratified WTMA survey map contained 228 timber stands totaling 12,043 acres (Figure 1). Total merchantable wood volume within the WTMA exceeded 16,300,000 cubic feet (Table 1) in 1997. All mapped stands were stratified into 28 unique forest types based on dominant overstory tree species, age and stand structure, allowing type-level volume summaries (Table 2). Additional detail for type-level volume data are presented in Appendix C. Approximately 51% of total merchantable volume occurred on only 20% of the total acreage in the WTMA (forest type codes of "33" or higher). These stands contained a high proportion of total volume due to relatively high tree stocking and large tree size. The remaining 49% of total merchantable volume occurred on 80% of the total acreage in the WTMA (forest type codes of "22" or lower). The latter forest types included stands that had poor survival or growth, were poorly stocked, were recently planted, or were cut over. If the entire inventory of trees within the WTMA were harvested at once and cut into sixteen foot logs, total merchantable wood in log diameter classes of 4-8", 8-12", and 12+" would equal 7,163,586, 5,473,901, 3,681,865 cubic feet, respectively (44%, 34%, and 23% of total merchantable volume, respectively).

Table 1. Total merchantable wood volume summary for WTMA timber resources. Values in parentheses represent nearest whole percentages of area and volume totals.

Species	Total Acres	Total merchantable volume (ft^3)
Eucalyptus robusta	227 (2)	1,007,433 (6)
E. saligna & E. grandis	3,749 (31)	8,180,306 (50)
E. deglupta & E. pilularis	54 (0)	88,711 (1)
Flindersia brayleyana	1,485 (12)	2,557,756 (16)
Toona ciliata	3,500 (29)	2,682,282 (16)
Fraxinus uhdei	2,060 (17)	1,128,586 (7)
Cryptomeria japonica	102 (1)	30,798 (0)
Alnus nepalensis	24 (0)	110,855 (1)
Metrosideros polymorpha	205 (2)	167,113 (1)
Acacia koa	272 (2)	327,086 (2)
Experimental Hardwoods	28 (0)	38,427 (0)
Out or Non-stocked	17 (0)	0 (0)
Block Roads	320 (3)	0 (0)
Total	12,043	16,319,353

Differentiation between *Eucalyptus saligna* and *E. grandis* proved to be very difficult during the field survey – particularly for trees younger than 15 years of age. Many *E. saligna* stands were harvested and re-planted to *E. grandis* in the mid-1980's. Numerous trees that were sampled and identified as *E. saligna* in these stands were undoubtedly *E. grandis*. Taper profiles for these two species are very similar, and we expect volume differences to be minor.

Figure 1. Timber stands represented by primary overstory species in the WTMA.

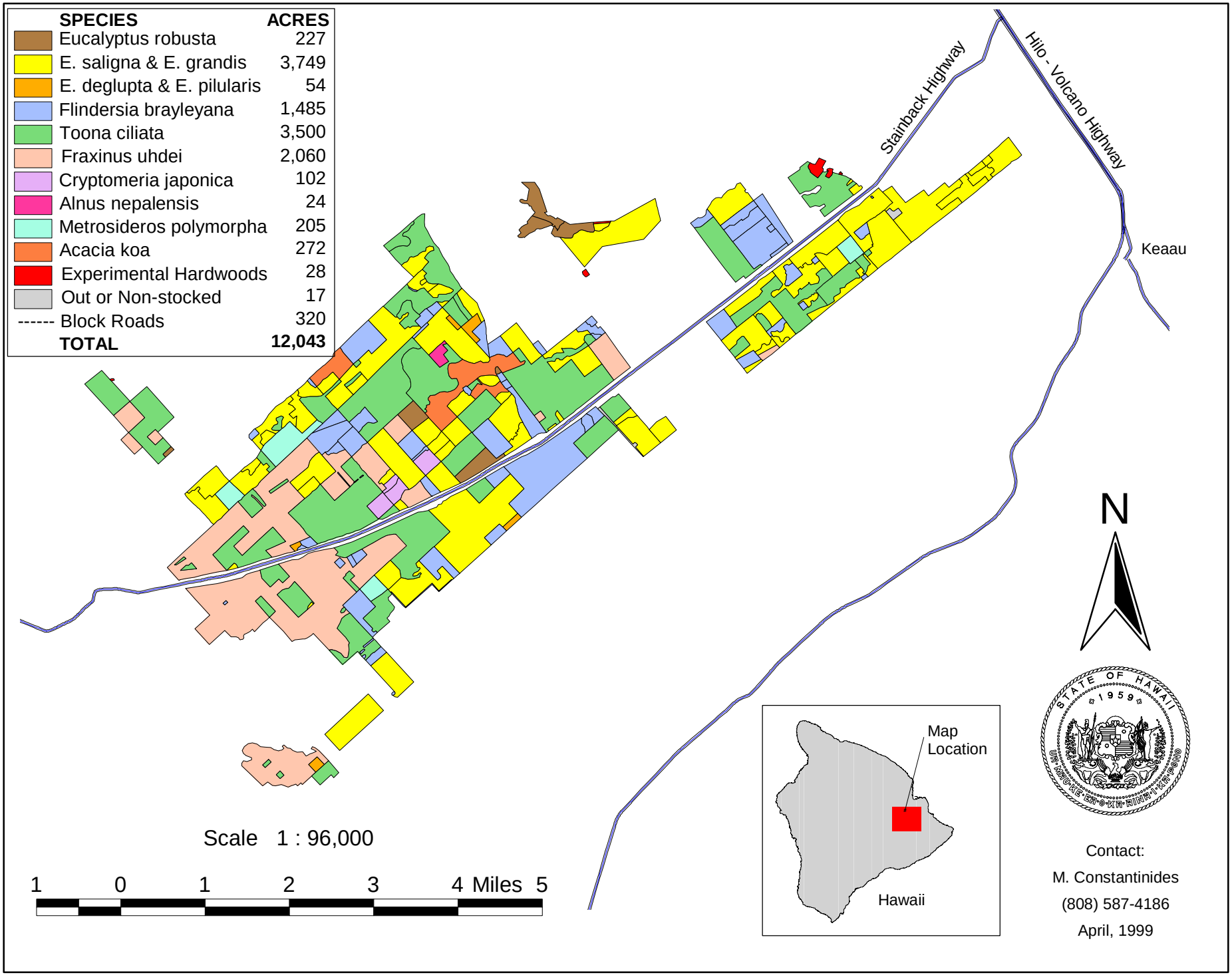


Table 2. Descriptive statistics for timber types in the WTMA. Age data represent original planting date, while stocking and DBH data represent all tree species with a minimum DBH of 2 inches. Maximum DBH data represent planted, non-native trees only.

Species & Type	Description	Net Acres	Age in Years	Stocking Trees ac^{-1}	DBH Range	Mean DBH	--Mean ft^3 ac^{-1}-- Gross	Merch	Total merchantable volume (ft^3) by log minimum diameter class 4-8"	8-12"	> 12"	Row Sub-Totals
Flindersia brayleyana												
FB00	Recent plantings / sapling stands	242	1-15	256	2-17	6	742	481	91,682	14,418	10,306	**116,407**
FB11	Low volume pole and saw timber	715	28-35	161	2-23	8	1,095	901	282,010	236,022	125,904	**643,936**
FB22	Low to moderate volume pole and saw timber	114	28-31	221	2-30	10	2,782	2,442	95,683	96,576	85,164	**277,424**
FB33	Moderate volume pole and saw timber	171	32	208	2-27	11	3,808	3,447	170,624	238,173	181,978	**590,775**
FB44	High volume pole and saw timber	120	32	255	2-28	12	5,649	5,214	203,486	265,708	158,616	**627,810**
FB55	Similar to FB33 with 20% volume as Toona ciliata	123	29	153	2-29	11	2,716	2,460	86,411	112,601	102,392	**301,404**
Sub-Total FB:		**1,485**							**929,896**	**963,499**	**664,361**	**2,557,756**
Eucalyptus saligna and grandis												
ES00	Recent plantings / sapling stands	113	5-8	314	2-10	5	478	206	13,613	3,145	5,898	**22,655**
ES11	Cut over, or low volume pole and saw timber	730	12-30	192	2-28	7	1,141	913	307,493	197,181	161,797	**666,470**
ES22	Low to moderate volume pole and saw timber	1447	11-31	280	2-26	7	2,119	1,653	1,313,800	853,728	224,350	**2,391,877**
ES33	Moderate volume pole and saw timber	1057	29	279	2-31	8	3,498	3,105	1,289,546	1,270,558	729,895	**3,289,999**
ES44	High volume pole and saw timber	185	14	241	2-19	11	6,243	5,699	443,557	473,387	136,282	**1,053,226**
ES55	Moderate volume saw timber	218	28	117	2-29	12	3,710	3,476	153,420	238,481	364,177	**756,078**
Sub-Total ES:		**3,749**							**3,521,429**	**3,036,479**	**1,622,397**	**8,180,306**
Eucalyptus robusta												
ER22	Low to moderate volume pole and saw timber	44	30	50	8-31	18	2,663	2,564	15,781	27,897	68,374	**112,051**
ER33	Moderate volume pole and saw timber	87	31-53	163	2-42	11	3,536	3,305	45,406	63,642	179,507	**288,556**
ER55	Moderate volume saw timber	57	53	208	2-40	12	4,814	4,475	49,946	59,546	146,017	**255,509**
ER66	High volume saw timber	39	59	219	2-37	16	9,541	9,078	65,106	81,882	204,329	**351,317**
Sub-Total ER:		**227**							**176,240**	**232,967**	**598,226**	**1,007,433**
Eucalyptus deglupta and pilularis												
ED11	Cut over, or low volume pole and saw timber	20	29	88	2-9	6	354	184	1,507	755	1,489	**3,752**
ED22	Low to moderate volume pole and saw timber	34	29	156	2-17	10	2,825	2,499	23,020	29,717	32,221	**84,959**
Sub-Total ED:		**54**							**24,527**	**30,473**	**33,711**	**88,711**
Toona ciliata												
TC11	Low volume pole and saw timber	3,178	30-35	263	2-24	6	873	595	1,088,854	487,061	314,593	**1,890,508**
TC22	Low to moderate volume pole and saw timber	69	30	199	2-15	9	1,986	1,698	73,634	43,879	0	**117,513**
TC33	Moderate volume pole and saw timber	253	30-35	239	2-20	9	3,023	2,667	309,814	255,219	109,229	**674,262**
Sub-Total TC:		**3,500**							**1,472,301**	**786,159**	**423,822**	**2,682,282**

Table 2. Continued.

Species & Type	Description	Net Acres	Age in Years	Stocking Trees ac^{-1}	DBH Range	Mean DBH	--Mean ft^3 ac^{-1}-- Gross	Merch	Total merchantable volume (ft^3) by log minimum diameter class 4-8"	8-12"	> 12"	Row Sub-Totals
Other species												
FU11	Low volume tropical ash pole and saw timber	2,060	34	348	2-18	5	902	548	855,304	250,770	22,512	**1,128,586**
AN33	Moderate volume Nepal alder pole and saw timber	24	30	154	2-27	14	4,956	4,677	30,245	41,110	39,500	**110,855**
CJ00	Recent Sugi plantings / sapling stands	102	7-10	395	2-14	5	618	303	17,333	4,039	9,426	**30,798**
AK11	Low volume koa pole and saw timber	272	NA	Native species			1,296	1,204	63,272	70,620	193,194	**327,086**
MP22	Low volume ohia pole and saw timber	205	NA	Native species			978	817	58,435	45,139	63,538	**167,113**
XH33	Moderate volume experimental hardwoods	28	38	Experimental species			1,512	1,387	14,603	12,646	11,178	**38,427**
Sub-Total other species:		**2,689**							**1,039,192**	**424,324**	**339,348**	**1,802,864**

Total forested acreage: **11,704**

Merchantable volume summary:
Cubic foot totals by log diameter and timber type class.

Type Class	Acres	----Log minimum diameter---- 4-8"	8-12"	> 12"	Total
00	456	122,629	21,602	25,630	169,860
11	6,975	2,598,440	1,242,408	819,490	4,660,338
22	1,912	1,580,353	1,096,936	473,647	3,150,937
33	1,620	1,860,237	1,881,348	1,251,287	4,992,872
44	305	647,043	739,095	294,897	1,681,036
55	397	289,777	410,628	612,586	1,312,992
66	39	65,106	81,882	204,329	351,317
Total	11,704	7,163,586	5,473,901	3,681,865	16,319,352

Volume results expressed in units of mean cubic feet per acre were derived from statistical sampling, and are therefore estimates. Standard error (SE) analysis provides one tool for assessing the strength of the field survey data. Because sampling intensity was proportional to area, volume analyses for larger forest types were based on a larger number of sample plots. In forest types with codes of "33" or more, standard error values rarely exceeded 10 percent of the mean, except in smaller types (Table 3). In forest types with codes of "22" or less, standard error values commonly exceeded 10 percent of the mean due to factors such as a small number of sample plots, or relatively heterogeneous stand conditions. Confidence intervals offer a second approach for analyzing cruise precision (Table 3). The reported confidence intervals represent ranges of gross volume per acre that are 80% likely to contain the true mean volume per acre for each forest type.

While stands were assigned to forest types based on the dominant overstory species, type level volume data also included components of secondary species. Most forest types had three or fewer principal species components (Table 4). *Toona ciliata* was a common secondary overstory species in both *Flindersia brayleyana* and *Eucalyptus saligna* stands, while ohia was evenly distributed throughout the entire WTMA (Figure 2). Though sparse in distribution, the remaining *Acacia koa* were concentrated near the north end of Flume Road.

Relatively undisturbed blocks of *Metrosideros polymorpha* and *Acacia koa* forest exist in approximately 4% of the total area of the WTMA (Figure 1). Within the remaining non-native timber plantations, large ohia and koa trees were left standing during initial land clearing operations, some of which remain to this day. As a result of this practice, ohia and to a lesser extent koa, were observed as secondary overstory species at 17% and 3% of all sampled points, respectively.

Other tree species observed and measured in minor quantities during the survey included olapa (*Cheirodendron* spp.), loulu palms (*Pritchardia* spp.), iron wood (*Casuarina equisetifolia*), blackwood acacia (*Acacia melanoxylon*), silk oak (*Grevillia robusta*), gunpowder tree (*Trema orientalis*), paperbark (*Melaleuca quinquenervia*) and African tulip tree (*Spathodea campanulata*). Detailed volume and distribution analyses were not conducted for these species due to their scattered occurrence.

Relative abundance data for understory species revealed that *Cibotium* spp. and *Psidium* spp. dominate the forest understory throughout the WTMA. Combined, these two species account for 86% of primary understory species (Figure 3), and 70% of secondary understory species (data not shown) observed at all sample plots. *Psidium cattleianum* is the most common and aggressive species of guava present in the WTMA. *Psidium* spp. appears to be encroaching from lower elevation, and from the South. In a vast majority of cases, where *Psidium* spp. was the primary understory species, *Cibotium* spp. was the secondary understory species, and vice versa. Excluding *Cibotium* spp., native tree and shrub species were recorded as primary and secondary understory species on 3%, and 16 % of sample plots, respectively.

Psidium spp. occurred as the primary groundcover species almost exclusively in well-stocked and mature stands of timber, revealing a relatively strong shade tolerance for this shrub

Table 3. Cruise precision analyses for the WTMA timber inventory. Volume data are presented in gross cubic feet.

Type	Acres	Sample Plots	Mean	SE	% SE	----80 % CI---- Low	High
			-----ft^3 ac^{-1}-----			-----ft^3 ac^{-1}-----	
FB00	242	7	742	294	40	319	1,164
FB11	715	13	1,095	154	14	886	1,304
FB22	114	20	2,782	194	7	2,525	3,040
FB33	171	26	3,808	284	7	3,434	4,182
FB44	120	24	5,649	326	6	5,219	6,080
FB55	123	26	2,716	178	7	2,482	2,951
ES00	113	2	478	19	4	420	535
ES11	730	17	1,141	128	11	970	1,313
ES22	1,447	41	2,119	105	5	1,982	2,255
ES33	1,057	26	3,498	281	8	3,128	3,868
ES44	185	4	6,243	681	11	5,129	7,358
ES55	218	6	3,710	383	10	3,145	4,275
ER22	44	1	2,663	NA	NA	NA	NA
ER33	87	8	3,536	687	19	2,564	4,507
ER55	57	7	4,814	352	7	4,307	5,321
ER66	39	6	9,541	508	5	8,791	10,290
ED11	20	3	354	89	25	185	522
ED22	34	3	2,825	1,370	48	241	5,410
TC11	3,178	71	873	50	6	808	938
TC22	69	1	1,986	NA	NA	NA	NA
TC33	253	6	3,023	447	15	2,363	3,683
FU11	2,060	47	902	37	4	853	950
AN33	24	3	4,956	287	6	4,415	5,497
CJ00	102	3	618	238	39	169	1,067
AK11	272	6	1,296	259	20	914	1,678
MP22	205	4	978	252	26	564	1,391
XH33	28	1	1,512	NA	NA	NA	NA
XX00	17	0	NA	NA	NA	NA	NA
Roads	320	0	NA	NA	NA	NA	NA
Total	**12,042**	**382**					

SE = standard error; % SE = standard error / mean volume per acre * 100
80 % CI = 80 percent confidence interval

FB = Flindersia brayleyana; ES = Eucalyptus saligna & E. grandis; ER = E. robusta
ED = E. deglupta; TC = Toona ciliata; FU = Fraxinus uhdei; AN = Alnus nepalensis
CJ = Cryptomeria japonica; AK = Acacia koa; MP = Metrosideros polymporpha
XH = experimental hardwoods; XX = open or cleared area; NA = not applicable

Table 4. Component merchantable volume for timber types in the WTMA.

		--mean ft^3 ac^{-1}--			----------Component merchantable volume per acre by species* (ft^3 ac^{-1})----------													
Type	**Acres**	**Gross**	**Merch**	**% Merch**	**FB**	**TC**	**MP**	**ES**	**ER**	**ED**	**AK**	**FU**	**TO**	**EM**	**CJ**	**AN**	**MQ**	**OTH**
FB00	242	742	481	65		359	56				17	12					26	11
FB11	715	1,095	901	82	592	83	100				63	59						4
FB22	114	2,782	2,442	88	1,922	100	225		7		10	178						
FB33	171	3,808	3,447	91	3,056	21	235				8	124						2
FB44	120	5,649	5,214	92	5,058	63	94											
FB55	123	2,716	2,460	91	1,756	427	229				46						2	
ES00	113	478	206	43		34	118	54										
ES11	730	1,141	913	80		35	81	729			68							
ES22	1,447	2,119	1,653	78		24	18	1,538	22	2	1	11	38					
ES33	1,057	3,498	3,105	89		146	20	2,810				40	80					7
ES44	185	6,243	5,699	91				5,629					71					
ES55	218	3,710	3,476	94		36	92	3,349										
ER22	44	2,663	2,564	96		1,155			1,410									
ER33	87	3,536	3,305	93			666	1,537	1,015			53					28	5
ER55	57	4,814	4,475	93			118	862	3,041			31		74			349	
ER66	39	9,541	9,078	95				369	8,709									
ED11	20	354	184	52			124			53								7
ED22	34	2,825	2,499	88			469			1,885	144							
TC11	3,178	873	595	68		300	228	5	1		45	10						7
TC22	69	1,986	1,698	86		1,698												
TC33	253	3,023	2,667	88		2,105	10				552							
FU11	2,060	902	548	61		29	28					487						3
AN33	24	4,956	4,677	94			61				193					4,424		
CJ00	102	618	303	49			150					132			24			
AK11	272	1,296	1,204	93		28	725				452							
MP22	205	978	817	84			811											5
XH33	28	1,512	1,387	92			263											1,124
XX00	17	NA	NA	NA														
Roads	320	NA	NA	NA														

*FB = Flindersia brayleyana; ES = Eucalyptus saligna & E. grandis; ER = E. robusta; ED = E. deglupta; TC = Toona ciliata
FU = Fraxinus uhdei; AN = Alnus nepalensis; CJ = Cryptomeria japonica; AK = Acacia koa; MP = Metrosideros polymporpha
TO = Trema orientalis; EM = E. microcorys; MQ = Melaleuca quinquenervia
XH = experimental hardwoods; XX = open or cleared area; NA = not applicable

Figure 2. Secondary overstory species at sample plot locations in the WTMA.

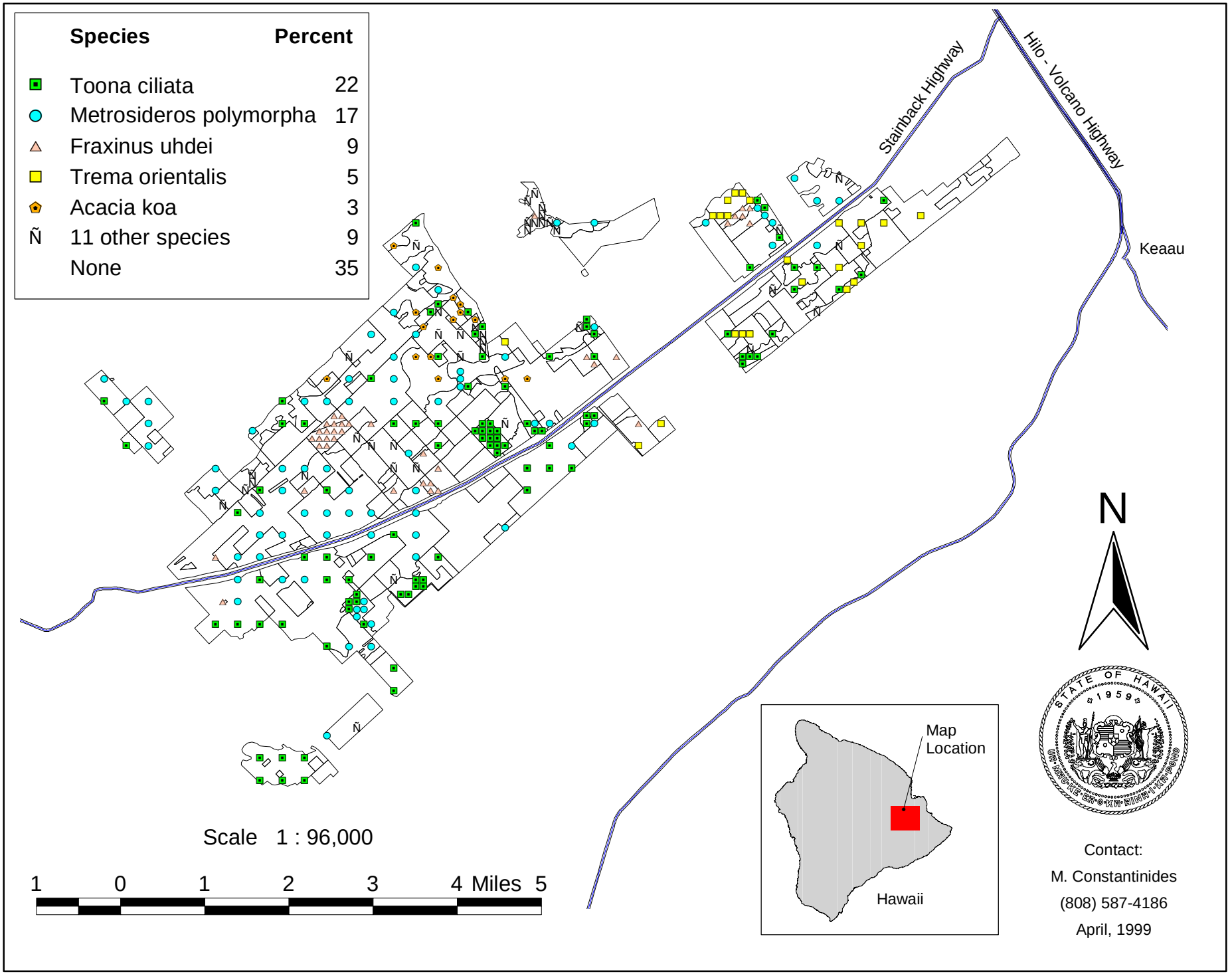
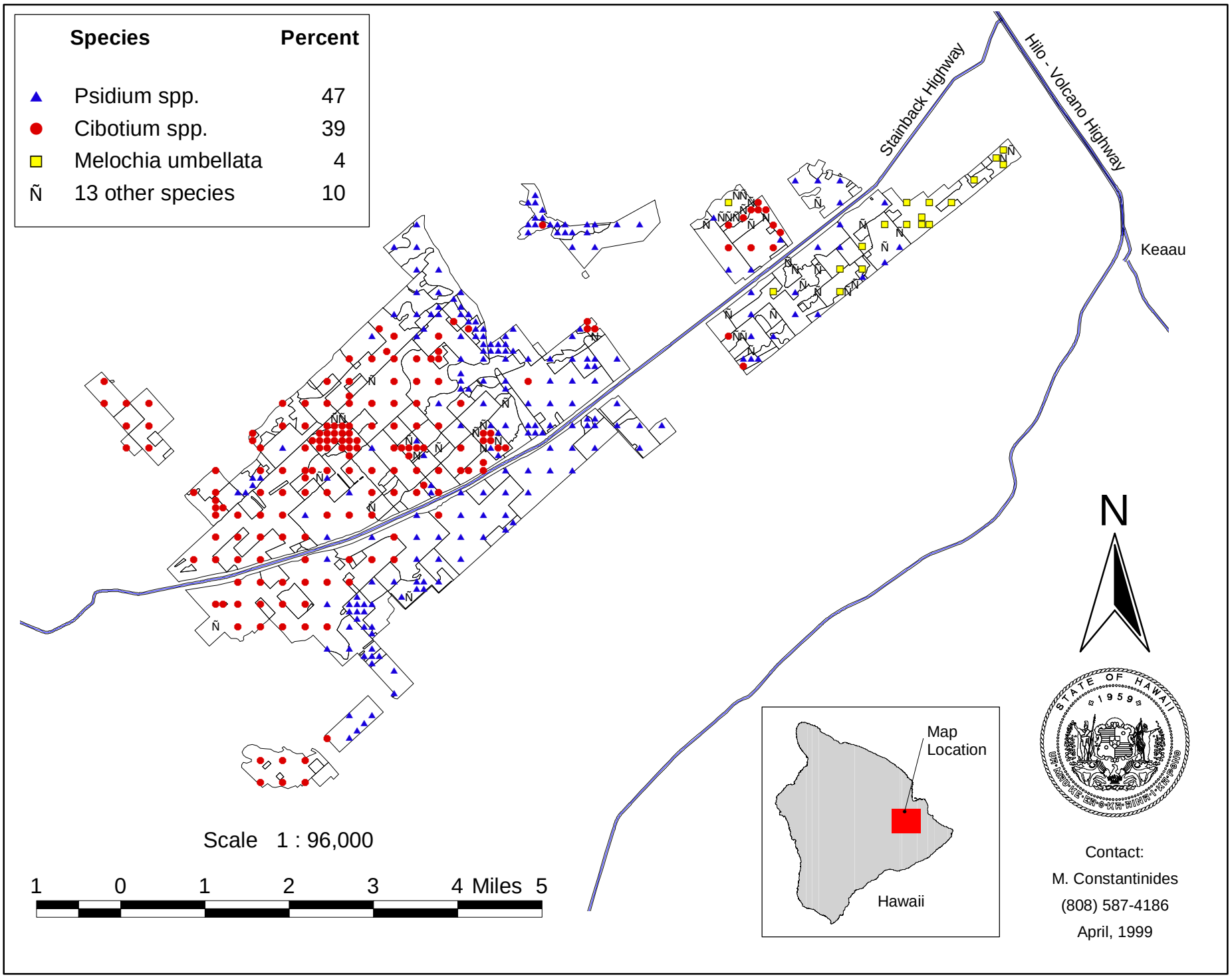


Figure 3. Primary understory species at sample plot locations in the WTMA.



species (Figure 4). In most other areas, *Dicranopteris linearis* dominated the groundcover layer, with the exception of an apparent outbreak of *Setaria palmifolia* in the north-central zone of the WTMA. Excluding *Dicranopteris linearis.*, native tree and shrub species were recorded as primary and secondary understory species on 3%, and 11 % of sample plots, respectively.

The low-elevation zone of the WTMA provided an exception to the understory and groundcover trends discussed above. The lower sites appeared to be a zone of concentration for *Trema orientalis* in the overstory (Figure 2), *Melochia umbellata* in the understory (Figure 3), and *Melastoma* spp. and *Nephrolepis multiflora* in the groundcover layer (Figure 4).

Discussion and planning implications:

The commercial timber plantings within the WTMA exhibited a wide range of growth potential both within, and among species. Site adaptation, surface soil conditions, and site preparation appeared to be the primary factors that influenced stand growth potential. Current within-species productivity differences can not be attributed to varying stand management or maintenance, since little has been implemented historically in the WTMA. However, intensive stand management in future rotations may significantly increase the productivity and yield of timber stands in the WTMA.

In order to compare productivity of different species, representative stands within the most important commercial forest types were selected for mean annual increment (MAI) analyses (Table 5). Among the original and secondary hardwood species planted, the eucalypts were best adapted to site conditions within the WTMA. *E. saligna* and *E. grandis* stands commonly had MAI values ranging from 250 –500 ft^3 ac^{-1} yr^{-1}. Surface soils appeared to be the primary factor influencing within-species differences in MAI. For example, though they had similar ages, stand 10010 was located on relatively deep mineral soil, stand 10200 had mixed aa-mineral soils and included a depression (zone of mineral soil accumulation), and stand 11110 had relatively shallow and rocky surface soils. Stands 10892 and 11380 were older, and were probably in a condition where mortality and residual growth did not differ greatly. Again, we attribute the differences between MAI in the latter two stands to surface soils conditions – 11380 had relatively deep mineral surface soils, while 10892 had primarily aa.

Relatively low MAI values for *E. robusta* may be misleading since most of these stands are the oldest within the WTMA, and had stagnated. Based on visual observations, young *E. robusta* trees often had similar size and vigor as adjacent *E. grandis*. Two stands of *E. microcorys* and *E. pilularis* appeared to be vigorous as well. *E. deglupta* had a relatively moderate MAI value in stand 10430 (Table 5), but scattered individuals at other locations within the WTMA appeared to be fast growing and vigorous.

Queensland maple (*Flindersia brayleyana*) is the most promising non-eucalyptus hardwood from the original WTMA plantings. With the exception of shallow pahoehoe sites, this

Figure 4. Primary groundcover species at sample plot locations in the WTMA.

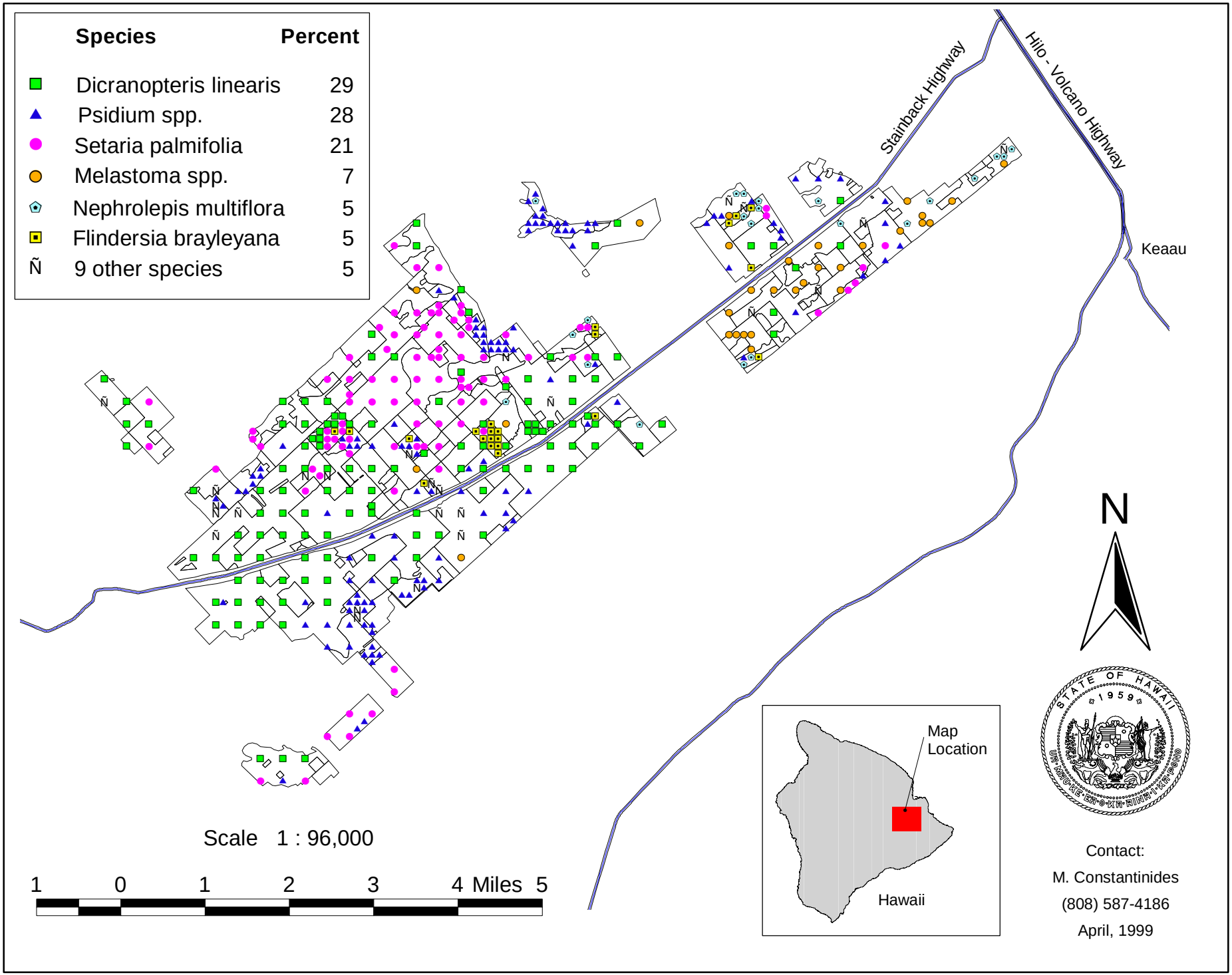


Table 5. Mean annual increment (MAI) analyses for selected stands in the WTMA based on 1997 data. All figures in each species section represent trees of that species only that have a miniumum DBH of two inches.

Species & Type	Stand ID	Net Acres	Plots	Age (Yr)	Trees Per Acre	Maximum DBH	Median DBH	Basal Area (ft^2)	Gross volume ($ft^3\ ac^{-1}$)	MAI ($ft^3\ ac^{-1}\ yr^{-1}$)
Flindersia brayleyana										
FB11	10710	22	4	32	144	17	7	54	1,145	36
FB11	11050	308	7	30	42	18	11	27	563	19
FB22	10680	16	4	31	80	27	12	84	2,194	71
FB33	10711	64	12	32	143	23	11	105	2,935	92
FB33	11331	58	10	32	102	27	14	121	3,662	114
FB44	10581	37	8	31	230	28	10	166	5,085	164
Eucalyptus saligna and E. grandis										
ES22	11110	381	9	10	206	17	7	71	2,665	267
ES33	10200	84	7	11	147	20	10	89	4,574	416
ES33	10892	61	5	27	119	23	10	82	2,896	107
ES44	10010	185	6	14	266	19	10	166	7,090	506
ES55	11380	118	6	29	122	28	11	103	4,552	157
Eucalyptus robusta										
ER33	10610	53	3	31	283	26	4	89	2,068	67
ER55	8138	57	7	53	134	40	6	119	3,245	61
ER66	8134	39	6	59	217	37	11	283	9,163	155
Eucalyptus deglupta										
ED22	10430	23	3	29	125	17	9	66	2,845	98
Toona ciliata										
TC11	10340	390	7	35	137	20	7	45	775	22
TC22	10070	69	1	30	180	15	8	87	1,966	66
TC33	10560	186	4	30	213	20	7	83	2,203	73
Fraxinus uhdei										
FU11	11200	915	19	34	167	17	6	42	690	20
Alnus nepalensis										
AN33	10463	24	3	30	152	27	13	164	4,643	155

species always exhibited vigorous growth once established. However, maple may be more difficult to establish than the eucalypts. Almost without exception, type codes FB33, FB44, and FB55 were comprised of stands where surface soils at sample plots were recorded as aa. This indicates that maple was either intentionally planted on aa sites, or that a unique scarification method was applied to surface soils prior to planting. Many FB11 stands are represented by low stocking and MAI values (e.g. stand 11050, Table 5), suggesting problems with seedling establishment or early weed competition. One area was planted across a surface soil change (Stands 10710 and 10711) from shallow pahoehoe to aa, and the latter stand had MAI that was nearly triple that of the former. Maple is probably the most shade tolerant hardwood planted within the WTMA, and natural regeneration was often prolific under dense canopies. Thinning and uneven-age management of this species merit future research.

The single stand of *Alnus nepalensis* within the WTMA had an MAI value similar to that for the best maple stands. However, this stand appeared to be located on a site having surface soils of above average productivity. Any future attempt to plant *Alnus nepalensis* as a commercial species in the WTM A should be preceded by additional site suitability tests.

Toona ciliata and *Fraxinus uhdei* plantings essentially failed on a large scale. *T. ciliata* showed moderate growth potential only on the best sites (e.g. stand 10560, Table 5). These species otherwise exhibited poor growth, and are not suited to site conditions within the WTMA. *Cryptomeria japonica* trees were too young to evaluate at this time, but field observations indicated that survival and growth rates for 7-10 year old stands of this species have been reasonable. These stands will likely require 35 or more years to reach merchantable size.

Tree DBH ranges and mean DBH values were relatively similar among forest types of the same species (Table 2), suggesting that type differences were directly proportional to stocking differences. What are not apparent in these data are differences in DBH distribution. For example, Queensland maple types FB33 and FB44 had similar DBH ranges and mean DBH values, most trees within FB33 had DBH near the mean value of 11 inches, while FB44 had a relatively even distribution of tree DBH ranging in size from 8-28 inches. FB44 therefore had higher volume per acre due to higher stocking and larger volume contribution per tree from larger diameter classes.

Qualitative data collection for the relative abundance of primary and secondary species in the above ground forest strata indicated that the WTMA is dominated by non-native timbers, underlain by invasive non-native weed species. If current commercial timber resources are harvested, control of these weed species will probably require significant resources during planting and establishment of future timber plantations. Overstory ohia and koa trees that remain within non-native timber plantations are generally senescent, contain considerable defect, and have poor form. Excluding *Cibotium* spp. and *Dicranopteris linearis*, the presence of native tree and shrub species in understory and groundcover layers was negligible.

Total wood volume estimates within the WTMA exceeded 16,300,000 merchantable cubic feet, or approximately 81,500,000 merchantable board feet. Forest types coded "22" or lower could be considered to represent pre- or non-commercial timber acreage as of 1997 due to their low volume or heterogeneous composition. Well-stocked stands in these forest types could have significant commercial value in future years, while others will have salvage potential at best unless they are replaced. Forest types coded "33" or higher contained a majority of timber resources with current commercial value, where total merchantable volume exceeded 8,300,000 cubic feet, or approximately 41,500,000 merchantable board feet.

The WTMA represents a readily accessible timber resource due to its close proximity to Hilo and an extremely well laid out road network. Though several block roads have become overgrown with weeds, they could be easily cleared, and would be operable 365 days per year. Within the tract, slopes typically range between 5-10%, which would not limit operation of mechanized equipment. One exception would small areas having relatively deep mineral surface soils that may become inaccessible when saturated. The close proximity of virtually all stands to Stainback Highway would facilitate harvesting and transportation of logs, replanting, and stand management efforts.

Analysis of survey precision indicated that reported timber volumes were robust – particularly in forest types representing the greatest current commercial value (type codes "33" or higher). The volume data in this report are not intended to be the sole basis for negotiation of timber sale contracts, but rather a guideline to long term timber management planning within the WTMA. Additional inventory data, or careful scaling of timber removed from harvest sites are highly recommended for all harvest contracts.

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Appendix A. Botanical species tallied during the WTMA survey.

TREE SPECIES

Latin genus and species	Common name
Acacia koa	Koa
Acacia melanoxylon	Blackwood
Alnus nepalensis	Nepal alder
Casuarina equisetifolia	Ironwood
Cheirodendron trigynum	Olapa
Cryptomeria japonica	Sugi
Eucalyptus deglupta	Mindanao gum
Eucalyptus grandis	Rose gum
Eucalyptus microcorys	Tallow-wood
Eucalyptus pilularis	Black butt
Eucalyptus robusta	Swamp mahogany
Eucalyptus saligna	Sydney blue gum
Flindersia brayleyana	Queensland maple
Fraxinus uhdei	Tropical ash
Grevillia robusta	Silk oak
Melaleuca quinquenervia	Paper bark
Metrosideros polymorpha	Ohia
Pritchardia spp.	Loulu
Spathodea campanulata	African tulip tree
Toona ciliata	Australian red cedar
Trema orientalis	Gunpowder tree

UNDERSTORY AND GROUNDCOVER SPECIES

Latin genus and species	Common name
Cheirodendron trigynum	Olapa
Cibotium spp.	Tree ferns
Dicranopteris linearis	Uluhe fern
Melastoma spp.	Melastoma family
Melochia umbellata	Melochia
Nephrolepis multiflora	Sword fern
Psidium spp.	Guavas
Setaria palmifolia	Palm grass
Zanthoxylum dipetalum	Kawau

Appendix B. Species assignments by taper profile class for volume analyses.

Species analyzed using *Flindersia brayleyana* taper profile:

1. *Acacia koa*
2. *Acacia melanoxylon*
3. *Alnus nepalensis*
4. *Casuarina equisetifolia*
5. *Cheirodendron trigynum*
6. *Flindersia brayleyana*
7. *Fraxinus Uhdei*
8. *Grevillia robusta*
9. *Metrosideros polymorpha*
10. *Pritchardia* spp.
11. *Toona ciliata*
12. *Trema orientalis*
13. *Spathodea campanulata*
14. *Zanthoxylum dipetalum*

Species analyzed using *Eucalyptus saligna* taper profile:

1. *Eucalyptus microcorys* (bark thickness coefficients 1.5 times those of *E. saligna*)
2. *E. robusta* (bark thickness coefficients 2.0 times those of *E. saligna*)
3. *E. saligna*
4. *Melaleuca quinquenervia* (bark thickness coefficients 2.0 times those of *E. saligna*)

Species analyzed using *Eucalyptus grandis* taper profile:

1. *Eucalyptus deglupta*
2. *E. grandis*

Species analyzed using a West-coast *Thuja plicata* (Western red cedar) taper profile:

1. *Cryptomeria japonica*

Appendix C. Stand tables by forest type.

Guidelines for interpreting stand table data:

1. Stand tables summarize sample plot analyses by presenting one inch DBH classes. Statistics provided for each DBH class include trees per acre, basal area per acre (ft^2), average tree height (feet), and cubic foot volume per acre. Gross cubic volume represents the tree bole from tree base to tree tip. Merchantable wood volume calculations were based on 16 foot log sections, a minimum top diameter of four inches, a stump height of one foot, and a minimum DBH of eight inches.

2. For each forest type, statistics are first presented by tree species. The last row of each species section gives a species summary (species codes typically use the first initial from both genus and species names). The species summary shows average DBH, total trees per acre, total basal area per acre, and total volume per acre.

3. After all species for a particular forest type have been listed, two final rows provide type level summary statistics. The first row represents all trees with a DBH of two inches or larger. The second row represents only trees with a minimum DBH of eight inches. Type level summaries show average DBH, total trees per acre, total basal area per acre, and total volume per acre. Type level volume totals may differ slightly from those reported in Tables 2-4 due to rounding errors.

Forest type FB00: Recent *Flindersia brayleyana* plantings / sapling stands.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus saligna			
	4	29	2.9	0	2	0
ES summary:	4		2.9	0	3	0
			Melaleuca quinquenervia			
	17	90	0.7	1	26	25
MQ summary:	17		0.7	1	27	26
			Flindersia brayleyana			
	2	22	6.4	0	1	0
	4	46	2.9	0	3	0
	6	61	1.6	0	6	0
FB summary:	3		10.9	1	12	0
			Toona ciliata			
	2	19	51.4	1	9	0
	4	29	60	5	58	0
	6	39	17.2	3	49	0
	7	37	8.6	2	32	0
	8	40	12.3	4	65	55
	9	44	5	2	36	31
	10	54	7.4	4	78	71
	11	52	7.9	5	99	90
	12	44	3.6	3	46	42
	13	51	1.4	1	24	22
	14	53	0.7	1	14	13
	16	55	0.7	1	19	18
TC summary:	6		176.3	34	534	346

Appendix C (continued).

Forest type FB00 (continued):

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Fraxinus uhdei			
	11	17	0.7	0	4	3
	15	27	0.7	1	9	8
FU summary:	13		1.4	1	14	12
			Metrosideros polymorpha			
	2	18	20	0	3	0
	4	34	17.1	1	18	0
	6	43	4.3	1	13	0
	7	44	0.7	0	3	0
	11	58	0.7	0	9	8
	26	59	0.7	3	50	48
MP summary:	5		43.6	6	99	56
			Acacia koa			
	2	24	11.4	0	2	0
	9	73	0.7	0	8	7
	10	76	0.7	0	10	9
AK summary:	4		12.9	1	21	17
			Acacia melanoxylon			
	13	49	0.7	1	12	11
AM summary:	13		0.7	1	12	11
			Trema orientalis			
	4	21	5.7	0	4	0
	6	33	1.6	0	3	0
TO summary:	4		7.3	1	8	0
			-- Type Level Summary --			
All trees:	5.7		256	46	730	468
Merch trees:	10.8		44	29		

Forest type FB11: Low volume *Flindersia brayleyana* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Fraxinus uhdei			
	2	14	4.6	0	0	0
	4	25	6.2	1	5	0
	6	34	3.1	1	7	0
	7	36	1.5	0	5	0
	8	45	0.8	0	4	3
	9	40	2.3	1	15	13
	10	47	0.4	0	3	3
	11	50	1.2	1	13	12
	12	52	0.8	1	11	10
	14	59	0.8	1	17	16
FU summary:	7		21.5	5	86	60

Appendix C (continued).

Forest type FB11 (continued):

	DBH (in)	Average Height (ft)	Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Flindersia brayleyana			
	2	28	7.7	0	1	0
	4	41	13.8	1	16	0
	6	50	2.7	1	9	0
	7	56	5.4	1	29	0
	8	53	4.6	2	31	26
	9	68	2.3	1	24	21
	10	58	3.1	2	35	31
	11	58	4.2	3	57	53
	12	59	5.4	4	89	82
	13	58	2.7	2	51	47
	14	65	1.5	2	37	35
	15	66	2.7	3	75	71
	16	67	0.8	1	24	23
	17	82	2.3	4	99	95
	18	67	0.8	1	31	29
	20	82	0.4	1	22	21
	22	82	0.4	1	27	26
	23	70	0.4	1	25	24
FB summary:	10		61.2	31	690	592
			Toona ciliata			
	2	13	13.8	0	2	0
	4	26	9.2	1	8	0
	6	50	2.7	1	9	0
	7	35	2.7	1	10	0
	8	38	1.5	1	8	7
	9	50	0.8	0	5	5
	10	58	0.4	0	4	3
	11	57	0.4	0	5	4
	12	74	0.8	1	15	14
	14	66	0.4	0	9	8
	15	77	0.4	0	13	12
	16	72	0.4	1	12	11
	17	75	0.4	1	16	15
TC summary:	6		33.8	6	120	83
			Metrosideros polymorpha			
	2	8	23.1	1	4	0
	4	22	12.3	1	10	0
	6	34	1.9	0	4	0
	7	40	0.8	0	3	0
	8	50	0.4	0	2	2
	9	48	0.4	0	3	2
	12	63	0.4	0	6	6
	17	67	0.4	1	13	13
	18	65	1.2	2	45	43
	19	70	0.4	1	17	17
	20	71	0.4	1	20	19
MP summary:	6		41.5	7	132	104
			Spathodea campanulata			
	9	68	0.4	0	4	3
SC summary:	9		0.4	0	4	4

Appendix C (continued).

Forest type FB11 (continued):

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Acacia koa			
	8	81	0.4	0	3	3
	9	83	0.4	0	4	4
	10	84	0.4	0	6	5
	11	86	0.8	1	14	13
	13	88	0.8	1	21	20
	16	91	0.4	1	16	15
AK summary:	12		3.1	2	67	63
			-- Type Level Summary --			
All trees:	7.7		161	52	1099	905
Merch trees:	12.5		50	43		

Forest type FB22: Low to moderate volume *Flindersia brayleyana* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Acacia koa			
	11	69	0.3	0	3	3
	13	78	0.3	0	6	6
AK summary:	12		0.5	0	11	10
			Flindersia brayleyana			
	2	15	9	0	1	0
	4	37	7	1	7	0
	6	60	5.3	1	21	0
	7	56	6	2	32	0
	8	61	4	1	30	26
	9	65	7.2	3	73	65
	10	79	8.4	5	124	113
	11	66	6.5	4	98	91
	12	76	7.8	6	160	150
	13	69	4.8	4	107	100
	14	85	5.9	6	182	173
	15	91	3	4	112	107
	16	84	4.3	6	169	161
	17	89	3.1	5	146	140
	18	82	2.9	5	141	135
	19	84	2.8	5	151	145
	20	82	1.3	3	74	71
	21	98	1.8	4	134	129
	22	75	0.8	2	49	47
	23	80	1.3	4	94	90
	24	89	0.3	1	22	21
	25	80	0.3	1	22	21
	26	90	0.3	1	26	25
	27	90	0.6	2	71	68
	30	92	0.3	1	35	34
FB summary:	12		94.5	78	2093	1924

Appendix C (continued).

Forest type FB22 (continued):

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	2	18	5	0	0	0
	4	32	4	0	4	0
	6	42	3.8	1	11	0
	7	52	1.8	0	8	0
	8	60	1.3	0	9	0
	9	59	2	1	18	16
	10	47	0.3	0	2	2
	11	59	0.8	1	10	9
	12	39	0.8	1	8	7
	13	85	1	1	27	26
	14	81	0.8	1	21	20
	15	80	0.3	0	7	7
	17	77	0.3	0	10	9
TC summary:	7		21.8	7	143	100
			Fraxinus uhdei			
	2	9	12	0	1	0
	4	20	12	1	9	0
	6	31	7.7	2	18	0
	7	43	11.9	3	50	0
	8	51	7.5	3	48	41
	9	50	5.5	2	45	39
	10	49	3.5	2	34	30
	11	63	2	1	29	27
	12	76	1.8	1	35	33
	13	68	0.3	0	5	5
FU summary:	7		64.1	16	279	178
			Metrosideros polymorpha			
	2	12	26	1	3	0
	4	28	6	1	5	0
	6	40	0.8	0	2	0
	8	57	0.7	0	4	4
	9	53	0.9	0	7	6
	10	56	1	1	10	9
	11	51	0.9	1	11	10
	12	65	0.3	0	4	4
	13	63	0.3	0	5	4
	14	66	0.8	1	18	17
	15	86	0.8	1	26	25
	16	69	0.5	1	16	15
	18	72	0.3	0	10	10
	22	77	0.3	1	16	15
	25	78	0.5	2	43	41
	30	85	0.5	2	65	63
MP summary:	7		40.3	11	254	230
			Eucalyptus robusta			
	16	75	0.3	0	7	7
ER summary:	16		0.3	0	7	7
			-- Type Level Summary --			
All trees:	9.6		221	112	2787	2449
Merch trees:	13.4		102	99		

Appendix C (continued).

Forest type FB33: Moderate volume *Flindersia brayleyana* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Flindersia brayleyana			
	2	17	5.4	0	0	0
	4	41	6.9	1	8	0
	6	52	4.7	1	17	0
	7	66	7.9	2	48	0
	8	70	5.7	2	48	41
	9	74	10.3	5	117	105
	10	79	7.9	4	117	108
	11	86	8.5	6	166	155
	12	75	8.3	7	170	159
	13	82	10.7	10	276	261
	14	86	9.4	10	295	281
	15	81	8.2	10	276	263
	16	94	7.5	10	328	315
	17	90	7.5	12	355	341
	18	93	4.1	7	222	213
	19	105	3.1	6	208	201
	20	90	4.2	9	275	265
	21	90	1.4	3	99	96
	22	94	0.8	2	62	60
	23	87	0.6	2	47	45
	24	88	0.2	1	17	16
	25	96	0.6	2	60	58
	26	97	0.4	1	43	42
	27	98	0.2	1	23	22
FB summary:	13		124.4	130	3289	3056
			Toona ciliata			
	2	7	1.5	0	0	0
	4	22	3.1	0	2	0
	6	51	0.8	0	2	0
	7	41	1	0	3	0
	8	59	1.3	0	9	8
	9	46	0.4	0	2	2
	11	72	0.4	0	6	5
	12	76	0.2	0	3	3
TC summary:	6		8.7	2	33	21
			Fraxinus uhdei			
	2	14	5.4	0	0	0
	4	26	22.3	2	20	0
	6	41	10.3	2	30	0
	7	43	8.3	2	35	0
	8	41	5.4	2	29	24
	9	49	3.3	1	26	23
	10	59	2	1	22	20
	11	58	1	1	14	13
	12	62	0.2	0	3	3
	13	80	0.2	0	4	4
	14	68	0.4	0	9	9
	17	77	0.6	1	23	22
FU summary:	6		59.3	12	221	121

Appendix C (continued).

Forest type FB33: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Metrosideros polymorpha			
	2	5	6.9	0	0	0
	4	13	1.5	0	0	0
	6	72	0.8	0	4	0
	7	33	0.2	0	0	0
	8	50	1.2	0	7	0
	9	62	1	0	9	8
	10	50	0.6	0	5	5
	11	56	0.2	0	2	2
	12	61	0.2	0	3	3
	14	45	0.2	0	3	2
	15	79	0.6	1	19	18
	16	31	0.4	1	6	5
	18	82	0.2	0	9	8
	19	84	0.2	0	10	10
	20	65	0.4	1	18	17
	21	89	0.4	1	27	26
	22	91	0.2	1	15	14
	24	95	0.2	1	18	17
	26	70	0.2	1	15	14
	28	48	0.2	1	13	12
	30	78	0.2	1	23	22
	31	105	0.2	1	31	30
MP summary:	11		16	10	246	222
			Acacia koa			
	15	95	0.2	0	7	7
AK summary:	15		0.2	0	8	8
			Pritchardia spp.			
	9	29	0.2	0	1	0
	11	37	0.2	0	1	1
PR summary:	10		0.4	0	3	2
			-- Type Level Summary --			
All trees:	11		208	139	3800	3429
Merch trees:	13.9		120	127		

Forest type FB44: High volume *Flindersia brayleyana* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Acacia koa			
	8	65	1	0	7	0
AK summary:	8		1	0	8	0

Appendix C (continued).

Forest type FB44: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Flindersia brayleyana			
	2	12	23.3	1	3	0
	4	35	21.7	2	23	0
	6	57	8.6	2	33	0
	7	51	13.3	4	65	0
	8	75	12.3	4	112	97
	9	77	12.7	6	150	135
	10	83	15.2	8	236	216
	11	86	15	10	291	271
	12	87	16.3	13	379	357
	13	85	15.5	14	413	391
	14	87	16.5	18	517	493
	15	91	17.2	21	646	617
	16	87	14.8	21	605	580
	17	89	8.5	13	398	382
	18	90	9.6	17	511	492
	19	84	5.6	11	306	294
	20	98	3.9	8	271	261
	21	94	1.9	5	141	136
	22	98	1.4	4	117	114
	23	102	0.4	1	39	38
	24	103	1	3	107	104
	25	104	0.2	1	23	22
	27	92	0.2	1	24	23
	28	106	0.2	1	29	28
FB summary:	12		235.1	187	5452	5060
			Toona ciliata			
	4	23	1.7	0	1	0
	6	44	1.5	0	4	0
	7	59	2.3	1	13	0
	8	70	0.8	0	7	6
	9	70	2.3	1	25	22
	10	54	1.3	1	13	12
	11	73	0.2	0	3	3
	12	59	0.2	0	3	3
	13	80	0.4	0	10	9
	16	60	0.2	0	6	5
TC summary:	8		10.9	4	88	63
			Metrosideros polymorpha			
	2	5	5.8	0	0	0
	4	6	0.8	0	1	0
	16	80	0.2	0	7	7
	17	54	0.2	0	5	5
	18	57	0.2	0	7	7
	20	63	0.2	0	9	9
	25	85	0.2	1	19	18
	28	51	0.2	1	14	13
	35	77	0.2	1	33	31
MP summary:	10		8.1	4	100	94
			-- Type Level Summary --			
All trees:	11.9		255	196	5648	5217
Merch trees:	14		175	187		

Appendix C (continued).

Forest type FB55: Similar to FB33 *Flindersia brayleyana* with 20% volume as Toona ciliata.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Melaleuca quinquenervia			
	9	65	0.3	0	2	2
MQ summary:	9		0.3	0	2	2
			Flindersia brayleyana			
	2	21	1.5	0	0	0
	4	43	4.6	0	5	0
	6	60	0.4	0	1	0
	7	62	1.5	0	9	0
	8	64	1.9	1	15	13
	9	61	2.5	1	24	21
	10	57	1.5	1	17	15
	11	71	4.1	3	67	62
	12	67	4	3	72	68
	13	76	4	4	97	92
	14	83	5.8	6	173	165
	15	84	5.9	7	205	196
	16	82	5	7	194	185
	17	85	3.5	5	157	151
	18	81	3.1	5	148	142
	19	86	3.4	7	191	184
	20	78	1.8	4	103	99
	21	85	1.3	3	90	87
	22	100	0.6	2	49	47
	23	84	1	3	76	73
	24	80	1.1	3	88	85
	26	87	0.2	1	19	19
	27	88	0.2	1	23	22
	29	89	0.2	1	24	23
FB summary:	15		59.2	69	1860	1756
			Toona ciliata			
	2	6	5.4	0	1	0
	4	20	18.5	2	14	0
	6	36	8.7	2	23	0
	7	42	9.5	3	40	0
	8	47	8.2	3	49	41
	9	52	6.2	3	51	45
	10	63	6.8	4	82	74
	11	56	3.2	2	42	38
	12	71	3.4	3	65	61
	13	70	1.2	1	25	24
	14	72	0.8	1	20	19
	15	76	1	1	31	29
	16	84	0.4	1	15	14
	17	79	0.8	1	32	30
	19	83	0.2	0	11	11
	20	80	0.4	1	22	21
	21	85	0.2	0	12	12
TC summary:	8		74.7	27	543	427

Appendix C (continued).

Forest type FB55: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Metrosideros polymorpha			
	2	5	6.2	0	0	0
	4	13	5.4	0	3	0
	7	17	0.2	0	0	0
	9	75	0.8	0	8	7
	22	69	0.4	1	23	22
	25	42	0.2	1	9	8
	28	55	0.3	1	23	22
	30	67	0.3	2	32	30
	31	68	0.2	1	21	20
	35	72	0.2	1	28	27
	36	73	0.6	4	91	87
MP summary:	12		14.7	12	244	228
			Acacia koa			
	7	72	0.6	0	3	0
	8	70	1.2	0	9	0
	9	68	0.2	0	1	1
	10	60	0.4	0	4	4
	11	75	1	1	16	15
	12	57	0.8	1	12	11
	14	61	0.4	0	9	8
	15	60	0.2	0	5	4
AK summary:	10		4.6	3	63	46
			-- Type Level Summary --			
All trees:	11.5		153	110	2712	2459
Merch trees:	14.4		89	102		

Forest type ES00: Recent *Eucalyptus saligna* plantings / sapling stands.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus saligna			
	2	12	70	2	10	0
	4	29	30	3	28	0
	6	41	7.5	1	22	0
	7	45	7.5	2	33	0
	8	49	10	3	63	53
ES summary:	4		125	11	158	54
			Toona ciliata			
	2	8	20	0	3	0
	4	17	20	2	15	0
	6	25	17.5	4	37	0
	7	30	12.5	3	41	0
	8	27	5	2	21	18
	10	33	2.5	1	17	15
TC summary:	5		77.5	12	138	34

Appendix C (continued).

Forest type ES00: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Metrosideros polymorpha			
	2	16	30	1	4	0
	4	23	10	1	8	0
	6	28	5	1	11	0
	12	35	2.5	2	26	23
	19	42	2.5	5	73	68
MP summary:	6		50	9	125	92
			Casuarina equisetifolia			
	8	43	2.5	1	12	0
CE summary:	8		2.5	1	13	0
			Trema orientalis			
	2	8	50	1	9	0
	4	17	10	1	7	0
TO summary:	2		60	2	17	0
			-- Type Level Summary --			
All trees:	4.6		315	36	450	180
Merch trees:	10.6		22	14		

Forest type ES11: Cut over, or low volume *Eucalyptus saligna* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Eucalyptus saligna			
	2	8	41.2	1	6	0
	4	30	21.2	2	20	0
	6	50	11.2	2	39	0
	7	60	9.4	3	53	0
	8	76	7.1	2	65	56
	9	74	6.8	3	77	69
	10	80	2.9	2	44	41
	11	87	5	3	99	93
	12	89	2.4	2	56	53
	13	94	2.6	2	79	75
	14	100	2.1	2	74	71
	15	108	1.2	1	52	50
	18	109	0.3	1	18	18
	19	111	0.3	1	21	20
	22	117	0.3	1	29	28
	23	119	0.6	2	65	63
	28	102	0.6	3	81	79
ES summary:	7		115	32	889	724
			Eucalyptus robusta			
	7	61	0.3	0	1	0
	7	60	0.9	0	4	0
	8	66	0.3	0	1	0
ER summary:	7		1.5	0	7	0

Appendix C (continued).

Forest type ES11: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	2	18	1.2	0	0	0
	4	31	3.5	0	3	0
	6	38	1.8	0	4	0
	7	50	1.2	0	5	0
	8	44	0.6	0	3	2
	10	53	0.3	0	3	2
	11	57	1.2	1	15	14
	12	59	0.6	0	9	8
	14	63	0.3	0	6	6
TC summary:	7		10.6	3	52	35
			Fraxinus uhdei			
	2	6	23.5	1	0	0
	4	20	7.1	1	5	0
	6	42	0.9	0	2	0
FU summary:	3		31.5	1	8	0
			Metrosideros polymorpha			
	2	10	14.1	0	2	0
	4	24	2.4	0	2	0
	6	33	0.9	0	2	0
	7	34	0.6	0	2	0
	9	42	0.3	0	2	1
	11	46	0.6	0	6	5
	12	52	0.3	0	4	3
	13	49	0.3	0	4	4
	15	51	0.3	0	6	6
	18	54	0.3	1	9	9
	19	47	0.3	1	9	8
	20	58	0.6	1	25	23
	21	56	0.3	1	13	12
MP summary:	7		21.2	5	91	77
			Acacia koa			
	7	40	0.3	0	1	0
	8	48	0.9	0	5	4
	9	50	1.5	1	11	10
	10	49	0.9	0	8	7
	11	56	0.6	0	8	7
	14	74	0.3	0	8	8
	16	84	0.3	0	11	10
	19	98	0.3	1	18	18
	27	45	0.3	1	17	16
AK summary:	12		5.3	4	91	83
			Trema orientalis			
	2	8	2.4	0	0	0
	4	30	4.7	0	4	0
TO:	3		7.1	0	5	0
			-- Type Level Summary --			
All trees:	6.7		192	47	1143	919
Merch trees:	12.2		43	35		

Appendix C (continued).

Forest type ES22: Low to moderate volume *Eucalyptus saligna* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus grandis			
	6	78	0.1	0	0	0
	8	99	0.1	0	1	1
	10	115	0.2	0	6	5
	11	108	0.2	0	7	6
	12	111	0.1	0	4	4
	13	114	0.4	0	15	15
	14	107	0.4	0	16	16
	16	122	0.4	1	24	24
EG summary:	13		2	2	78	74
			Eucalyptus saligna			
	2	13	41.5	1	6	0
	4	41	41.2	4	50	0
	6	68	18.6	4	84	0
	7	75	16.1	4	111	0
	8	91	14.3	5	156	136
	9	84	11.1	5	144	130
	10	90	11	6	187	173
	11	92	9.5	6	199	186
	12	93	6.4	5	161	152
	13	105	4.8	4	159	152
	14	108	5.3	6	207	198
	15	95	2.6	3	102	98
	16	112	1.2	2	63	61
	17	67	0.6	1	22	21
	18	116	0.1	0	8	8
	19	102	0.5	1	32	31
	20	120	0.4	1	33	32
	21	121	0.1	0	11	11
	22	123	0.1	0	12	12
	24	125	0.1	0	15	15
	26	120	0.1	0	17	16
ES summary:	8		185.9	59	1790	1440
			Deglupta Eucalyptus			
	6	42	0.4	0	1	0
	7	45	0.5	0	2	0
	10	62	0.1	0	1	1
ED summary:	7		1	0	6	2
			Eucalyptus robusta			
	2	8	2	0	0	0
	4	29	4.9	0	3	0
	6	55	1.5	0	4	0
	7	60	1.8	0	8	0
	8	71	1.1	0	7	6
	9	69	0.7	0	6	5
	10	78	0.2	0	2	2
	11	75	0.4	0	5	4
	12	87	0.1	0	2	2
ER summary:	6		12.7	2	41	21

Appendix C (continued).

Forest type ES22: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Fraxinus uhdei			
	2	5	1.5	0	0	0
	4	10	0.5	0	0	0
	6	21	0.2	0	0	0
	7	27	0.4	0	1	0
	9	39	0.2	0	1	1
	11	41	0.1	0	1	1
	12	59	0.4	0	5	5
	14	63	0.1	0	2	2
FU summary:	7		3.4	1	13	11
			Acacia koa			
	4	19	0.5	0	0	0
	7	38	0.1	0	0	0
	8	60	0.1	0	0	0
AK summary:	5		0.7	0	2	1
			Toona ciliata			
	2	22	7.1	0	1	0
	4	35	12.7	1	13	0
	5	59	0.1	0	0	0
	6	48	3.3	1	11	0
	7	44	1.6	0	7	0
	8	57	0.9	0	6	5
	9	75	0.2	0	2	2
	10	48	0.2	0	2	2
	12	53	0.1	0	1	1
	16	72	0.4	1	13	12
TC summary:	5		26.7	4	61	24
			Metrosideros polymorpha			
	2	5	12.9	0	0	0
	4	9	2.9	0	1	0
	6	41	0.2	0	0	0
	7	26	0.1	0	0	0
	11	49	0.1	0	1	1
	12	44	0.4	0	4	4
	20	57	0.1	0	5	4
	26	52	0.1	0	7	7
MP summary:	4		17	2	22	18
			Trema orientalis			
	2	52	12.7	0	4	0
	4	59	8.8	1	14	0
	6	66	3	1	13	0
	7	62	1.9	1	11	0
	8	69	1.6	1	13	11
	9	60	0.8	0	7	7
	10	85	0.8	0	12	11
	11	69	0.1	0	1	1
	12	69	0.4	0	6	6
TO summary:	5		30.1	4	87	38

Appendix C (continued).

Forest type ES22: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Spathodea campanulata			
	4	41	1	0	1	0
SC summary:	4		1	0	1	0
			-- Type Level Summary --			
All trees:	6.9		280	74	2100	1629
Merch trees:	11.1		80	54		

Forest type ES33: Moderate volume *Eucalyptus saligna* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Eucalyptus saligna			
	2	11	10.8	0	1	0
	4	38	25.4	2	29	0
	6	61	9.6	2	39	0
	7	71	11.5	3	76	0
	8	84	6.8	2	69	60
	9	87	11.8	5	158	143
	10	104	11.3	6	219	203
	11	109	7.4	5	182	172
	12	110	9.3	7	274	261
	13	121	7.3	7	275	263
	14	115	8.1	9	335	323
	15	122	5.9	7	296	286
	16	112	5.5	8	286	277
	17	126	3.2	5	210	204
	18	105	2.4	4	151	146
	19	120	0.6	1	49	48
	20	129	1.3	3	124	121
	21	97	1	2	74	72
	22	135	1	3	110	108
	23	135	0.2	1	24	23
	24	136	0.2	1	26	25
	25	138	0.2	1	28	28
	31	145	0.2	1	45	44
ES summary:	11		141	85	3093	2814
			Fraxinus uhdei			
	2	5	17.7	0	0	0
	4	12	7.7	1	4	0
	6	40	0.4	0	1	0
	7	17	1.3	0	3	0
	8	66	1	0	7	0
	9	53	0.6	0	5	4
	10	64	0.6	0	7	6
	11	45	0.6	0	6	5
	14	86	0.2	0	5	5
	15	92	0.2	0	7	7
	16	96	0.2	0	8	7
FU summary:	5		30.4	3	57	37

Appendix C (continued).

Forest type ES33: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	2	14	13.1	0	2	0
	4	30	8.5	1	8	0
	6	49	2.9	1	10	0
	7	49	1.7	0	8	0
	8	52	2.8	1	18	15
	9	63	1.2	1	11	10
	10	90	1.3	1	22	20
	11	100	0.4	0	8	8
	12	67	0.6	0	10	9
	13	76	1	1	23	21
	14	105	1	1	36	34
	15	92	0.4	0	14	13
	18	103	0.2	0	11	11
TC summary:	6		34.9	8	186	146
			Metrosideros polymorpha			
	2	11	22.3	0	3	0
	4	25	6.2	1	5	0
	6	30	0.2	0	0	0
	8	41	0.2	0	1	0
	10	45	0.2	0	1	1
	21	60	0.2	0	9	8
	22	47	0.2	1	9	8
MP summary:	4		29.4	3	31	20
			Trema orientalis			
	2	6	13.8	0	4	0
	4	20	9.2	1	7	0
	6	35	2.8	1	7	0
	7	46	1.8	0	8	0
	8	56	2.5	1	17	14
	9	47	0.2	0	1	1
	10	67	1.2	1	15	13
	11	82	0.8	1	15	14
	12	60	0.2	0	3	2
	13	77	0.2	0	4	4
	15	83	0.2	0	6	6
	17	82	0.2	0	8	8
	18	92	0.3	0	14	13
TO summary:	6		33.4	6	114	80
			Spathodea campanulata			
	2	28	0.8	0	0	0
	6	56	0.6	0	2	0
	8	67	0.4	0	3	2
	9	68	0.2	0	2	1
	11	70	0.2	0	3	2
SC summary:	6		2.1	0	11	7

Appendix C (continued).

Forest type ES33: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Casuarina equisetifolia			
	2	11	6.2	0	0	0
	4	38	1.5	0	1	0
CE summary:	3		7.7	0	3	0
			-- Type Level Summary --			
All trees:	8.3		279	105	3494	3106
Merch trees:	12.7		102	90		

Forest type ES44: High volume *Eucalyptus saligna* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Eucalyptus saligna			
	4	56	25	2	39	0
	6	75	13.5	3	71	0
	7	95	14.8	4	131	0
	8	109	18.3	7	245	216
	9	105	21.5	10	352	321
	10	123	20.3	11	469	437
	11	117	19	13	495	467
	12	122	27	21	872	831
	13	136	16.5	15	691	664
	14	133	17.3	18	798	769
	15	140	17.3	21	993	961
	16	141	5.5	8	364	354
	18	155	5.5	10	503	491
	19	148	1.3	2	116	113
ES summary:	11		222.5	145	6146	5629
			Trema orientalis			
	2	31	10	0	2	0
	6	60	2.5	1	10	0
	7	65	1.3	0	6	0
	10	77	3.8	2	55	51
	11	79	1.3	1	21	19
TO summary:	6		18.8	4	97	71
			-- Type Level Summary --			
All trees:	10.6		241	149	6243	5699
Merch trees:	12.1		174	139		

Appendix C (continued).

Forest type ES55: Moderate volume *Eucalyptus saligna* saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus saligna			
	2	14	10	0	1	0
	4	46	6.7	1	9	0
	6	75	6.7	1	33	0
	7	85	4.2	1	32	0
	8	95	5	2	56	49
	9	103	5	2	77	70
	10	109	0.8	0	16	15
	11	115	5	3	129	121
	12	113	10	8	301	287
	13	134	2.5	2	103	99
	14	129	1.7	2	77	74
	15	145	6.7	8	392	380
	16	149	2.5	3	171	167
	17	110	3.3	5	193	187
	18	145	3.3	6	279	272
	19	150	3.3	7	320	312
	20	147	0.8	2	86	84
	22	151	1.7	4	213	208
	26	179	3.3	12	688	676
	28	168	0.8	4	186	182
	29	135	0.8	4	161	157
ES summary:	13		84.2	78	3533	3349
			Toona ciliata			
	4	46	6.7	1	8	0
	6	57	2.5	0	9	0
	7	63	2.5	1	14	0
	8	65	0.8	0	6	0
	12	76	0.8	1	16	15
	13	80	0.8	1	21	19
TC summary:	7		14.2	3	77	36
			Metrosideros polymorpha			
	2	12	16.7	0	2	0
	14	48	0.8	1	15	13
	18	60	0.8	1	29	27
	24	60	0.8	3	53	50
MP summary:	7		19.2	5	100	92
			-- Type Level Summary --			
All trees:	11.6		117	87	3710	3476
Merch trees:	15.6		60	81		

Appendix C (continued).

Forest type ER22: Low to moderate volume *Eucalyptus robusta* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus robusta			
	14	105	5	5	153	146
	23	119	5	14	449	436
	31	126	5	26	827	807
ER summary:	24		15	46	1431	1390
			Toona ciliata			
	8	65	5	2	41	35
	9	67	5	2	53	47
	11	72	5	3	87	80
	14	75	5	6	145	137
	19	79	5	10	255	244
	20	81	5	11	304	292
	21	82	5	12	313	300
TC summary:	15		35	46	1200	1140
			-- Type Level Summary --			
All trees:	18.3		50	92	2631	2531
Merch trees:	18.3		49	92		

Forest type ER33: Moderate volume *Eucalyptus robusta* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus robusta			
	2	35	52.5	1	11	0
	4	53	17.5	2	21	0
	6	81	3.8	1	15	0
	7	71	7.5	2	39	0
	8	69	2.5	1	17	13
	9	71	5.6	2	49	43
	10	109	2.5	1	40	37
	11	45	5	3	44	40
	12	105	1.3	1	28	26
	13	90	2.5	2	57	54
	14	77	3.1	3	72	68
	15	92	2.5	3	78	74
	16	94	2.5	3	90	86
	17	96	1.3	2	51	49
	18	98	0.6	1	29	28
	20	144	0.6	1	51	50
	21	102	2.5	6	164	158
	22	104	0.6	2	45	43
	24	106	0.6	2	54	52
	26	108	0.6	2	64	62
	36	117	0.6	4	126	122
ER summary:	9		116.3	47	1155	1015

Appendix C (continued).

Forest type ER33: (continued).

	DBH (in)	Average Height (ft)	Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Eucalyptus saligna			
	4	26	2.5	0	2	0
	8	69	0.6	0	5	4
	9	84	0.6	0	8	7
	10	85	0.6	0	10	9
	12	98	0.6	0	16	15
	13	93	0.6	1	18	17
	15	113	0.6	1	29	28
	17	141	2.5	4	183	178
	18	125	0.6	1	45	44
	20	153	0.6	1	67	66
	22	136	0.6	2	72	70
	23	138	2.5	7	320	313
	24	140	0.6	2	88	86
	25	114	0.6	2	78	76
	26	153	1.3	5	222	217
	28	148	0.6	3	123	121
	42	164	0.6	6	286	280
ES summary:	20		16.9	36	1578	1537
			Melaleuca quinquenervia			
	24	57	0.6	2	29	28
MQ summary:	24		0.6	2	30	28
			Fraxinus uhdei			
	2	24	7.5	0	1	0
	4	35	10	1	10	0
	6	42	1.3	0	3	0
	8	48	0.6	0	3	3
	9	62	0.6	0	6	5
	11	54	0.6	0	7	7
	14	47	0.6	1	11	10
	19	64	0.6	1	26	25
FU summary:	6		21.9	4	73	52
			Metrosideros polymorpha			
	7	10	0.6	0	1	0
	15	41	0.6	1	11	10
	18	49	0.6	1	19	17
	20	60	0.6	1	28	26
	21	100	0.6	2	49	47
	22	44	1.3	3	50	47
	25	77	0.6	2	53	51
	28	95	0.6	3	80	77
	54	125	0.6	10	334	325
MP summary:	26		6.3	23	628	604
			Spathodea campanulata			
	7	47	0.6	0	2	0
	9	65	0.6	0	6	5
SC summary:	8		1.3	0	9	5
			-- Type Level Summary --			
All trees:	11.2		163	112	3472	3241
Merch trees:	18		59	105		

Appendix C (continued).

Forest type ER55: Moderate volume *Eucalyptus robusta* saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus saligna			
	6	91	0.7	0	4	0
	9	85	2.1	1	27	25
	10	130	0.7	0	17	15
	12	107	1.4	1	40	38
	15	111	0.7	1	32	31
	17	93	0.7	1	35	34
	20	134	0.7	2	68	66
	23	120	0.7	2	80	78
	26	121	1.4	5	204	198
	32	125	0.7	4	154	150
	39	128	0.7	6	227	222
ES summary:	20		10.7	23	893	862
			Eucalyptus robusta			
	2	11	28.6	1	3	0
	4	34	28.6	2	24	0
	6	61	10	2	32	0
	7	52	5.7	2	22	0
	8	76	5	2	36	30
	9	95	6.4	3	74	65
	10	79	2.1	1	26	23
	11	88	6.4	4	104	96
	12	77	5	4	85	79
	13	90	1.4	1	33	31
	14	126	5.7	6	208	199
	15	92	1.4	2	44	42
	16	75	2.9	4	83	79
	17	100	1.4	2	61	59
	18	97	4.3	8	199	192
	20	120	2.1	5	148	144
	21	107	1.4	3	98	94
	22	108	2.1	6	162	157
	23	110	0.7	2	59	57
	24	111	0.7	2	65	63
	25	115	2.9	10	291	283
	26	113	1.4	5	153	149
	27	100	1.4	6	146	142
	29	116	2.1	10	288	281
	30	116	0.7	4	103	100
	32	118	0.7	4	117	114
	33	110	1.4	8	231	225
	34	140	0.7	5	154	151
	40	120	0.7	6	180	176
ER summary:	13		134.3	119	3246	3041
			Fraxinus uhdei			
	13	36	0.7	1	9	8
	14	39	0.7	1	11	10
	15	42	0.7	1	12	11
FU summary:	14		2.1	2	34	31

Appendix C (continued).

Forest type ER55: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Alnus nepalensis			
	7	50	1.4	0	6	0
AN summary:	7		1.4	0	7	0
			Eucalyptus microcorys			
	2	30	2.9	0	0	0
	4	54	2.9	0	3	0
	6	66	0.7	0	2	0
	7	65	0.7	0	3	0
	8	74	0.7	0	5	4
	9	76	0.7	0	7	6
	10	90	1.4	1	21	20
	21	84	0.7	2	43	41
EM summary:	8		10.7	4	90	74
			Melaleuca quinquenervia			
	2	52	2.9	0	0	0
	6	64	0.7	0	2	0
	8	75	2.1	1	15	0
	9	67	2.9	1	25	21
	11	69	0.7	0	9	9
	12	55	0.7	1	9	8
	14	71	1.4	2	31	29
	15	65	1.4	2	33	31
	16	90	1.4	2	51	49
	17	67	2.1	3	65	62
	18	73	0.7	1	26	25
	20	74	0.7	2	30	29
	21	74	0.7	2	36	34
	25	80	0.7	2	50	48
MQ summary:	14		19.3	19	388	349
			Metrosideros polymorpha			
	2	18	2.9	0	0	0
	4	29	17.1	1	16	0
	6	37	1.4	0	3	0
	7	43	2.9	1	12	0
	8	45	2.9	1	16	14
	9	46	0.7	0	5	4
	13	55	0.7	1	12	11
	20	52	0.7	2	27	26
	24	83	0.7	2	60	58
MP summary:	7		30	9	157	115
			-- Type Level Summary --			
All trees:	12.4		208	176	4814	4472
Merch trees:	17.7		96	165		

Appendix C (continued).

Forest type ER66: High volume *Eucalyptus robusta* saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Eucalyptus saligna			
	12	125	0.8	1	27	26
	20	153	0.8	2	90	88
	33	173	0.8	5	259	254
ES summary:	23		2.5	7	377	369
			Eucalyptus robusta			
	2	22	3.3	0	0	0
	4	42	26.7	2	26	0
	6	65	14.2	3	48	0
	7	68	15.8	4	79	0
	8	71	8.3	3	58	47
	9	88	16.7	7	180	157
	10	68	11.7	6	124	111
	11	88	13.3	9	217	200
	12	91	11.7	9	232	217
	13	95	7.5	7	182	172
	14	101	9.2	10	272	259
	15	107	7.5	9	268	257
	16	136	3.3	5	169	163
	17	125	10	16	528	510
	18	116	6.7	12	365	353
	19	119	3.3	7	207	201
	20	130	6.7	15	500	486
	21	125	4.2	10	329	320
	22	128	3.3	9	294	286
	23	138	5.8	17	603	588
	24	117	2.5	8	240	233
	25	125	5	17	550	535
	26	134	5	18	633	618
	27	140	0.8	3	117	115
	28	142	2.5	11	384	375
	29	135	1.7	8	259	253
	30	148	3.3	16	606	593
	31	149	0.8	4	161	157
	32	151	1.7	9	346	338
	34	154	0.8	5	197	193
	36	150	1.7	12	426	418
	37	184	1.7	12	546	536
ER summary:	15		216.7	283	9163	8709
			-- Type Level Summary --			
All trees:	15.6		219	291	9541	9078
Merch trees:	18		159	281		

Appendix C (continued).

Forest type ED11: Cut over, or low volume Eucalyptus deglupta pole and saw timber.

	DBH (in)	Average Height (ft)	Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Eucalyptus deglupta			
	2	11	20	0	3	0
	4	30	33.3	3	34	0
	6	45	13.3	3	51	0
	7	51	11.7	3	69	0
	8	54	1.7	1	14	13
	9	58	3.3	2	40	37
ED summary:	5		83.3	11	214	51
			Metrosideros polymorpha			
	18	66	1.7	3	66	63
	20	52	1.7	4	65	61
MP summary:	19		3.3	7	132	124
			Pritchardia spp.			
	9	29	1.7	1	8	6
PR summary:	9		1.7	1	8	7
			-- Type Level Summary --			
All trees:	6.2		88	19	354	182
Merch trees:	13.2		9	9		

Forest type ED22: Low to moderate volume Eucalyptus deglupta pole and saw timber.

	DBH (in)	Average Height (ft)	Number of Trees	Basal Area	--Volume (ft^3)-- Gross	Merch
			Eucalyptus deglupta			
	2	15	13.3	0	2	0
	4	34	33.3	3	37	0
	6	52	16.7	3	73	0
	7	82	6.7	2	60	0
	8	70	5	2	51	46
	9	62	15	7	176	161
	10	71	13.3	7	217	203
	11	113	3.3	2	101	96
	12	97	3.3	3	104	100
	13	104	5	5	194	187
	14	110	5	5	236	228
	15	115	3.3	4	189	183
	16	122	8.3	12	564	549
	17	126	1.7	3	130	127
ED summary:	9		133.3	57	2141	1885
			Acacia koa			
	6	46	3.3	1	10	0
	7	77	5	1	35	0
	8	63	1.7	1	13	11
	10	75	1.7	1	23	21
	13	92	1.7	2	47	45
	17	75	1.7	3	66	63
AK summary:	10		15	8	198	142

Appendix C (continued).

Forest type ED22: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Metrosideros polymorpha			
	4	5	6.7	1	0	0
	42	105	1.7	16	485	469
MP summary:	19		8.3	17	485	469
			-- Type Level Summary --			
All trees:	9.8		156	82	2825	2497
Merch trees:	13.5		71	71		

Forest type TC11: Low volume *Toona ciliata* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3): Gross	Merch
			Toona ciliata			
	2	8	25.4	1	4	0
	4	23	33.8	3	28	0
	6	34	15.5	3	39	0
	7	42	15.3	4	64	0
	8	46	9.5	3	57	48
	9	45	8.1	4	60	52
	10	46	4.3	2	40	36
	11	59	3.7	2	51	47
	12	55	2.2	2	33	30
	13	57	1.1	1	19	18
	14	57	0.7	1	15	14
	15	65	0.3	0	7	7
	16	66	0.2	0	6	6
	17	67	0.4	1	12	12
	18	60	0.1	0	5	4
	19	66	0.2	0	9	9
	20	57	0.1	0	3	2
	23	69	0.1	0	4	4
	24	70	0.1	0	5	4
TC summary:	7		121	28	470	301
			Eucalyptus saligna			
	2	14	0.3	0	0	0
	6	49	0.1	0	0	0
	7	51	0.1	0	0	0
	8	58	0.1	0	0	0
	10	65	0.1	0	0	0
	12	70	0.1	0	1	1
	14	74	0.1	0	1	1
ES summary:	8		0.8	0	6	4
			Eucalyptus robusta			
	4	27	0.3	0	0	0
	10	58	0.1	0	0	0
ER summary:	6		0.4	0	1	1

Appendix C (continued).

Forest type TC11: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Melaleuca quinquenervia			
	9	70	0.1	0	0	0
MQ summary:	9		0.1	0	1	0
			Fraxinus uhdei			
	2	24	1.1	0	0	0
	4	34	1.4	0	1	0
	6	38	0.2	0	0	0
	7	46	0.1	0	0	0
	8	46	0.1	0	0	0
	9	48	0.1	0	0	0
	10	49	0.1	0	1	0
	13	54	0.1	0	1	1
	16	53	0.1	0	2	2
	22	65	0.1	0	4	3
FU summary:	6		3.4	1	13	10
			Metrosideros polymorpha			
	2	7	76.7	2	16	0
	4	21	36.6	3	29	0
	6	37	5.2	1	13	0
	7	43	2.3	1	10	0
	8	51	1.8	1	11	10
	9	53	3.5	2	29	25
	10	56	0.9	1	10	9
	11	46	0.8	1	8	8
	12	53	0.7	1	10	9
	13	57	1	1	18	16
	14	74	0.8	1	21	20
	15	56	0.4	0	8	8
	16	67	0.4	1	13	12
	17	63	0.4	1	12	11
	18	75	0.3	0	12	12
	19	63	0.2	0	8	8
	20	73	0.2	0	11	10
	21	70	0.1	0	4	3
	22	75	0.2	1	13	13
	24	43	0.2	1	9	9
	25	66	0.1	0	5	4
	26	55	0.1	0	4	4
	28	25	0.1	0	3	2
	29	75	0.1	1	15	15
	33	57	0.1	0	7	7
MP summary:	5		132.9	19	311	225
			Casuarina equisetifolia			
	9	48	0.1	0	0	0
	12	58	0.1	0	1	1
	13	60	0.1	0	2	2
	14	63	0.1	0	1	1
CE summary:	12		0.4	0	6	6

Appendix C (continued).

Forest type TC11: (continued).

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Acacia koa			
	4	18	0.8	0	0	0
	6	67	0.4	0	1	0
	7	41	0.2	0	0	0
	8	52	0.4	0	2	1
	9	45	0.4	0	2	2
	10	60	0.4	0	4	3
	11	53	0.1	0	0	0
	12	55	0.1	0	1	1
	13	75	0.3	0	6	6
	14	61	0.2	0	4	4
	15	63	0.4	0	9	8
	17	65	0.1	0	2	2
	18	15	0.3	0	4	3
	19	70	0.1	0	3	3
AK summary:	11		3.9	2	46	39
			Spathodea campanulata			
	6	45	0.1	0	0	0
SC summary:	6		0.1	0	0	0
			Pritchardia spp.			
	6	24	0.1	0	0	0
	7	56	0.1	0	0	0
	8	29	0.2	0	0	0
	10	42	0.1	0	0	0
PR summary:	8		0.4	0	2	1
			Cheirodendron trigynum			
	4	20	0.3	0	0	0
	6	34	0.1	0	0	0
CH summary:	5		0.4	0	1	0
			-- Type Level Summary --			
All trees:	5.9		263	50	856	587
Merch trees:	11.3		47	33		

Appendix C (continued).

Forest type TC22: Low to moderate volume *Toona ciliata* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	2	16	20	0	3	0
	6	43	5	1	15	0
	7	50	20	5	97	0
	8	51	30	10	193	165
	9	58	30	13	274	243
	10	61	25	14	294	266
	11	66	15	10	228	211
	12	73	15	12	299	279
	13	73	5	5	116	109
	14	76	10	11	279	264
	15	79	5	6	165	157
TC summary:	9		180	87	1966	1698
			Metrosideros polymorpha			
	4	31	20	2	19	0
MP summary:	4		20	2	20	0
			-- Type Level Summary --			
All trees:	9		199	89	1986	1698
Merch trees:	10.5		134	80		

Appendix C (continued).

Forest type TC33: Moderate volume *Toona ciliata* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	2	7	40	1	9	0
	4	23	40	3	33	0
	6	42	14.2	3	43	0
	7	47	14.2	4	65	0
	8	66	16.7	6	134	116
	9	68	18.3	8	194	173
	10	75	12.5	7	177	162
	11	96	11.7	8	251	234
	12	98	10	8	260	246
	13	79	8.3	8	208	197
	14	63	5	5	117	110
	15	91	3.3	4	126	120
	16	85	6.7	9	266	255
	17	97	2.5	4	127	122
	18	97	2.5	4	142	137
	19	102	0.8	2	55	53
	20	70	3.3	7	171	163
TC summary:	9		210	91	2388	2094
			Metrosideros polymorpha			
	2	5	3.3	0	0	0
	11	59	0.8	1	11	10
MP summary:	5		4.2	1	11	10
			Acacia koa			
	7	90	3.3	1	27	0
	8	37	1.7	1	8	6
	9	77	1.7	1	19	17
	10	72	4.2	2	56	51
	11	74	2.5	2	42	39
	12	56	1.7	1	26	24
	13	77	0.8	1	20	19
	14	86	5.8	6	182	173
	15	80	0.8	1	27	26
	16	81	0.8	1	32	30
	18	84	0.8	1	41	39
	21	87	0.8	2	57	55
AK summary:	12		25	20	542	485
			-- Type Level Summary --			
All trees:	9.3		239	112	2941	2589
Merch trees:	12.1		124	100		

Appendix C (continued).

Forest type FU11: Low volume *Fraxinus uhdei* pole and saw timber.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Fraxinus uhdei			
	2	7	32.8	1	7	0
	4	20	39.6	3	31	0
	6	34	25.5	5	66	0
	7	40	20.4	5	82	0
	8	46	16.6	6	99	84
	9	46	13	6	98	86
	10	47	7.8	4	73	66
	11	52	6.2	4	76	69
	12	58	3	2	48	44
	13	60	2.1	2	40	37
	14	63	1.4	1	32	30
	15	60	1.1	1	27	26
	16	67	0.5	1	17	16
	17	68	0.2	0	7	7
	18	70	0.2	0	8	8
FU summary:	7		170.3	43	718	479
			Toona ciliata			
	2	7	13.6	0	3	0
	4	19	9.8	1	7	0
	6	34	4.6	1	11	0
	7	43	2.5	1	10	0
	8	36	1.7	1	8	7
	9	48	0.6	0	4	4
	10	34	0.3	0	2	2
	11	54	0.2	0	2	2
	12	54	0.3	0	4	4
	13	59	0.1	0	2	1
	15	64	0.1	0	2	2
	16	66	0.1	0	3	3
TC summary:	5		34	5	65	28
			Metrosideros polymorpha			
	2	33	98.7	2	25	0
	4	36	38.7	3	43	0
	6	39	3.5	1	10	0
	7	40	1.1	0	4	0
	8	39	0.2	0	1	0
	9	32	0.1	0	0	0
	10	50	0.2	0	2	1
	11	12	0.2	0	1	0
	13	40	0.1	0	1	1
	14	37	0.1	0	1	1
	15	55	0.1	0	2	2
	16	60	0.3	0	9	8
	18	41	0.1	0	2	2
	19	35	0.1	0	2	2
	20	61	0.1	0	4	4
MP summary:	3		143.8	9	114	28

Appendix C (continued).

Forest type FU11: (continued).

	Average DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Acacia melanoxylon			
	8	49	0.1	0	0	0
	9	48	0.1	0	0	0
	10	51	0.1	0	1	0
AM summary:	9		0.3	0	3	2
			Pritchardia spp.			
	8	21	0.1	0	0	0
	9	25	0.2	0	1	0
PR summary:	9		0.3	0	1	1
			-- Type Level Summary --			
All trees:	5.4		348	56	901	539
Merch trees:	10.1		57	32		

Forest type AN33: Moderate volume *Nepal alder* pole and saw timber.

	Average DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Metrosideros polymorpha			
	17	72	1.7	3	64	61
MP summary:	17		1.7	3	64	61
			Acacia koa			
	30	80	1.7	8	200	192
AK summary:	30		1.7	8	201	193
			Alnus nepalensis			
	6	52	1.7	0	6	0
	7	39	8.3	2	33	0
	8	55	10	4	69	59
	9	54	11.7	5	103	91
	10	60	11.7	6	139	126
	11	145	11.7	8	371	349
	12	75	15	12	314	295
	13	95	18.3	17	545	518
	14	47	13.3	15	253	234
	15	65	10	12	278	262
	16	83	8.3	12	341	326
	17	97	5	8	250	241
	18	97	8.3	15	472	455
	19	100	5	10	322	311
	20	111	1.7	4	132	128
	21	64	3.3	8	170	162
	22	85	3.3	9	245	236
	24	113	3.3	11	385	374
	27	119	1.7	7	254	247
AN summary:	14		151.7	163	4691	4424
			-- Type Level Summary --			
All trees:	14.4		154	175	4956	4677
Merch trees:	14.8		144	172		

Appendix C (continued).

Forest type CJ00: Recent *Cryptomeria japonica* plantings / sapling stands.

	DBH (in)	Average Height (ft)	Values per acre: Number of Trees	Basal Area	Volume (ft^3) Gross	Volume (ft^3) Merch
			Toona ciliata			
	7	28	1.7	1	6	0
TC summary:	7		1.7	1	6	0
			Fraxinus uhdei			
	6	31	8.3	2	20	0
	7	29	3.3	1	10	0
	8	43	6.7	2	37	31
	9	19	10	4	41	33
	10	25	3.3	2	19	16
	11	24	3.3	2	23	20
	13	23	1.7	2	16	13
	14	23	1.7	2	18	15
FU summary:	9		38.3	17	188	132
			Metrosideros polymorpha			
	14	47	1.7	2	31	29
	23	76	1.7	5	125	120
MP summary:	19		3.3	7	157	150
			Cryptomeria japonica			
	2	24	206.7	5	38	0
	4	31	113.3	10	105	0
	6	36	18.3	4	57	0
	7	37	10	3	42	0
	9	37	1.7	1	11	10
	10	43	1.7	1	15	14
CJ summary:	3		351.7	22	271	24
			-- Type Level Summary --			
All trees:	4.6		395	46	621	305
Merch trees:	11.2		33	23		

APPENDIX C. SUMMARY OF GAME AND NON-GAME WILDLIFE SPECIES PRESENT IN THE WTMA

Game Species	**Mammal**	Feral Pig (Sus scrofa)
	Birds	Kalij Pheasant (Lophura leucomelana)
		Wild Turkey (Meleagris gallopavo)
		Spotted Dove (Streptopelia chinensis)
		Zebra Dove (Geopella striata)
		Japanese Quail (Coturnix japonica)
Non-Game Species	**Introduced Mammals**	Feral Dog (Canis familiaris)
		Feral Cat (Felis catus)
		Mongoose (Herpestes auropunctatus)
		Rat (Rattus spp.)
	Native mammal	Bat (Lasiurus cinereus semotus)
	Native Birds	Akepa (Loxops coccineus)
		Akiapolaau (Hemignathus munroi)
		Amakihi (Hemignathus virens)
		Apapane (Himatione sanguinea)
		Elepaio (Chasiempis sandwichensis)
		Iiwi (Vestiaria coccinea)
		I'o (Buteo solitarius)
		Omao (Myadestes obscurus)
		O'u (Psittirostra psittacea)
		Pueo (Asio flammeus)
	Introduced Birds	Barn Owl (Tyto alba)
		Common Mynah (Acridotheres tristis)
		House Finch (Carpodacus mexicanus)
		House Sparrow (Passer domesticus)
		Japanese White Eye (Zosterops japonicus)
		Melodious Laughing Thrush (Garrulax canorus)
		Northern Cardinal (Cardinalis cardinalis)
		Red-Billed Leiothrix (Leiothrix lutea)

Appendix D: Species Lists

Scientific name	Common name	Hawaiian name
Native Plant Species		
Acacia koa		Koa
Adenophorus tamariscinus		Wahini noho mauna
Alyxia stellata		Maile
Antidesma platyphyllum		Hame
Astelia menziesiana		Paʻiniu
Broussaisia arguta		Kanawao
Cheirodendron trigynum		ʻŌlapa
Coprosma pubens		Pilo
Cibotium glaucum		Hāpuʻu
Cibotium menziesii		Hāpuʻu
Clermontia parviflora		
Cyanea pilosa		
Cyrtandra giffardii		Haʻiwale
Cyrtandra paludosa		Moa
Cyrtandra platyphylla		ʻIlihia
Dicranopteris linearis		Uluhe
Diplazium sandwichianum		Hōʻiʻo
Diplopterygium pinnatum		
Dryopteris sandwicensis		
Elaphoglossum crassifolium		
Elaphoglossum paleaceum		
Freycinetia arborea		ʻIeʻie
Ilex anomala		Kāwaʻu
Kadua affinis		Manono
Melicope spp.		Alani
Metrosideros polymorpha		ʻŌhiʻa lehua
Myrsine lessertiana		Kōlea lau nui

Myrsine sandwicensis		Kōlea lau liʻi
Peperomia hypoleuca		ʻAlaʻala wai nui
Peperomia latifolia		ʻAlaʻala wai nui
Perrottetia sandwicensis		Olomea
Phyllostegia vestita		
Pipturus albidus		Māmaki
Pisonia brunoniana		Pāpala kēpau
Pritchardia beccariana	Fan palm	Loulu
Psilotum nudum		Moa
Psychotria spp.		Kōpiko
Sadleria spp.		ʻAmaʻu
Smilax melastomifolia		Hoi kuahiwi
Stenogyne calaminthoides		
Vaccinium calycinum		ʻŌhelo
Zanthoxylum kauaense		Aʻe
Intentionally Planted Timber Species		
Eucalyptus deglupta	Indonesian gum	
Eucalyptus grandis	Grand eucalyptus	
Eucalyptus microcorys	Australian tallowwood	
Eucalyptus pilularis	Blackbutt eucalyptus	
Eucalyptus robusta	Swamp mahogany	
Eucalyptus saligna	Sydney bluegum	
Flindersia brayleyana	Queensland maple	
Fraxinus uhdei	Tropical ash	
Toona ciliata	Australian toon; Australian red cedar	
Cryptomeria japonica	Sugi pine	
Alnus nepalensis	Nepal alder	
Non-Native Plant Species		
Acacia melanoxylon	Blackwood acacia	
Ageratina adenophora	Maui pamakani	
Angiopteris evecta	Mulesfoot fern	
Archontophoenix alexandrae	King palm	

Buddleja asiatica	Dog tail	
Casuarina equisetifolia	Ironwood	
Cecropia obtusifolia	Trumpet tree	
Clidemia hirta	Koster's curse	
Cyathea cooperi	Australian tree fern	
Grevillea robusta	Silk oak	
Hedychium coronarium	White ginger	
Hedychium flavescens	Yellow ginger	
Hedychium gardnerianum	Kahili ginger	
Melaleuca quinquenervia	Paperbark	
Melastoma candidum	Asian melastome	
Melochia umbellata		
Miconia calvescens	Miconia	
Nephrolepis brownii		
Paederia foetida	Maile pilau	
Passiflora edulis	Passionfruit	
Passiflora ligularis	Sweet granadilla	
Passiflora mollissima	Banana poka	
Plantago major	Common plantain	
Pluchea symphytifolia	Sourbush	
Psidium cattleianum	Strawberry guava	
Rubus ellipticus	Himalayan blackberry	
Rubus rosifolius	Thimbleberry	
Setaria palmifolia	Palm grass	
Spathodea campanulata	African tulip	
Tibouchina herbacea	Glorybush	
Tibouchina longifolia	Glorybush	
Trema orientalis	Gunpowder tree	
Native Wildlife		
Lasiurus cinereus semotus	Hawaiian hoary bat	ʻōpeʻapeʻa
Hemignathus virens		ʻAmakihi
Himatione sanguinea		ʻapapane
Chasiempis sandwichensis		ʻelepaio

sandwichensis		
Buteo solitarius	Hawaiian hawk	ʻio
Myadestes obscurus		ʻōmaʻo
Asio flammeus sandwichensis		pueo
Drosophila mulli	Hawaiian picture wing fly	
Non-Native Game Wildlife		
Sus scrofa	Feral pig	
Capra hircus	Feral goat	
Ovis aries	Mouflon sheep	
Lophura leucomelana	Kalij pheasant	
Meleagris gallopavo	Wild turkey	
Streptopelia chinensis	Spotted dove	
Geopelia striata	Zebra dove	
Coturnix japonica	Japanese quail	
Non-Native Non-Game Wildlife		
Canis lupus familiaris	Feral dog	
Felis catus	Feral cat	
Herpestes javanicus auropunctatus	Mongoose	
Rattus spp.	Rat	
Acridotheres tristis	Common myna	
Cardinalis cardinalis	Northern cardinal	
Carpodacus mexicanus	House finch	
Garrulax canorus	Melodius laughing thrush	
Leiothrix lutea	Red-billed leiothrix	
Passer domesticus	House sparrow	
Tyto alba	Barn owl	
Zosterops japonicus	Japanese white-eye	

Appendix E: He Moʻolelo ʻĀina: A Cultural Study of the Puʻu Makaʻala Natural Area Reserve (Kumu Pono Associates)

HE MOʻOLELO ʻĀINA:

A CULTURAL STUDY OF THE PUʻU MAKAʻALA NATURAL AREA RESERVE DISTRICTS OF HILO AND PUNA, ISLAND OF HAWAIʻI

View to Puʻu Makaʻala and Mauna Loa (Photo Courtesy of DLNR-NARS)

"Birds eye" View of the Hāpuʻu and Scattered ʻŌhiʻa Forest of Puʻu Makaʻala (Photo Courtesy of DLNR-NARS)

ʻŌhāhā (Cyanea longipedunculata) of Puʻu Makaʻala (William Mull 1975; Photo Courtesy of DLNR-NARS)

Julie Leialoha Describing Puʻu Makaʻala NAR to NARS Commission Members and Educators (Photo Courtesy of DLNR-NARS)

Kumu Pono Associates LLC

Historical & Archival Documentary Research · Oral History Interview Studies · Researching and Preparing Studies from Hawaiian Language Documents · Māhele ʻĀina, Boundary Commission, & Land History Records · Integrated Cultural Resources Management Planning · Preservation & Interpretive Program Development

HE MOʻOLELO ʻĀINA:
A CULTURAL STUDY OF THE PUʻU MAKAʻALA NATURAL AREA RESERVE DISTRICTS OF HILO AND PUNA, ISLAND OF HAWAIʻI

PREPARED BY

Kepā Maly • Cultural Historian - Resources Specialist
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MAY 31, 2004

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EXECUTIVE SUMMARY

At the request of Ms. Lisa Hadway, Natural Area Specialist for the State of Hawai'i Department of Land and Natural Resources–Division of Forestry and Wildlife (DLNR-DOFAW), *Kumu Pono Associates LLC*, conducted a detailed study of historical and archival literature documenting the natural and cultural landscape and history of land use in the vicinity of the Pu'u Maka'ala Natural Area Reserve, and adjoining lands of Waiākea, in the District of Hilo, and 'Ōla'a, in the District of Puna. The documentation also includes detailed oral testimonies—describing the lands, traditional and customary practices, and historical land use—from native residents of lands in the 'Ōla'a, Waiākea-Humu'ula, and Keauhou vicinity, collected in the 1870s to 1890s. The documentation cited herein is the product of years of research, and includes specific research conducted for the study between October 2003 to April 2004. The research was conducted in private and public collections, and that documentation, cited herein, includes written narratives that cover the period from antiquity to the 1980s.

The archival-historical resources were located in the collections of the Hawai'i State Archives, Land Management Division, Survey Division, Bureau of Conveyances and the Natural Areas Reserve System offices; the Hawaiian Historical Society; the University of Hawai'i-Hilo Mo'okini Library; private family collections; and in the collection of *Kumu Pono Associates LLC*. The documentation includes rich narratives translated from native Hawaiian accounts; descriptions of lands that make up the Puna, Hilo and Eastern Ka'ū mountain lands, recorded in historic surveys; a history of land tenure from 1848 to the present; records documenting the establishment of the 'Ōla'a and Waiākea Forest Reserves, and the subsequent designation of the Pu'u Maka'ala Natural Area Reserve.

The Natural Area Reserve takes it's name from Pu'u Maka'ala, literally, Stay-alert Hill—named by State Forester, Ralph Daelher in the early 1960s[1]—the summit of which is situated a little more than 3,600 feet above sea level. While the name of the *pu'u* is of recent origin, no older name identifiable with the hill was located while conducting this research. Many *pu'u* on the upland slopes of the Hilo and Puna Districts are named, and it is likely that in traditional times this hill too had a name or names, depending on the area it was viewed from.

The native traditions and historical accounts associated with the neighboring lands of the upper Hilo-Puna forests span many centuries, from Hawaiian antiquity to the later period following western contact. The narratives describe customs and practices of the native people who resided on these lands, walked the trails, and who were sustained by the wealth of the forest lands.

Among the most detailed descriptions of the Hilo-Puna forest lands, including documentation of traditional and customary rights, are those found in the Kingdom collections, documenting the history of land tenure, and defining the boundaries of *ahupua'a* of Waiākea and 'Ōla'a. Detailed oral testimonies from elder native tenants were taken in court proceedings of the mid to late 1800s document the occurrence of traditional and customary practices, and nature of the resources within a given *ahupua'a*. In those records, we learn of the traditional knowledge and occurrence of native practices in the lands which today are a part of, and adjoin the Pu'u Maka'ala Natural Area Reserve.

We find in native traditions and beliefs, that Hawaiians shared spiritual and familial relationships with the natural resources around them. Each aspect of nature from the stars in the heavens, to the winds, clouds, rains, growth of the forests and life therein, and everything on the land and in the ocean, was believed to be alive. Indeed, every form of nature was a body-form of some god or lesser deity. As an example, in this context, and in association with lands which are now included in a part of the landscape of the Pu'u Maka'ala Natural Area Reserve, we find that Kū-ka-'ōhi'a-Laka, is a defied guardian of the *'ōhi'a* growth of 'Ōla'a; *Ua-kuahine*, is the body form of a goddess of the rains in 'Ōla'a; and *Kū-lili-ka-ua* is the god of the thick mists that envelop the forests of the upper Puna,

[1] pers comm., Ralph Daelher, former State Forester (June 9, 2004).

Waiākea, and Keauhou lands. Indeed, tradition also tells us that the gods and goddesses of these forest lands were very protective of them. In olden times, travel through them was accompanied by prayer, and care. Traditions tell us that many a careless traveler, or collector of resources, found themselves lost in a maze of overgrowth and dense mists as a result of disrespectful and careless actions.

In the Hawaiian mind, care for each aspect of nature, the *kino lau* (myriad body-forms) of the elder life forms, was a way of life. This concept is still expressed by Hawaiian *kūpuna* (elders) through the present day, and passed on in many native families. Also, in this cultural context, anything which damages the native nature of the land, forests, ocean, and *kino lau* therein, damages the integrity of the whole. Thus caring for, and protecting the land and ocean resources, is a way of life.

In the traditional context above referenced, we find that the forests and mountain landscape—the native species, and the intangible components therein—are a part of a sacred Hawaiian landscape. Thus, the landscape itself is a highly valued cultural property. It's protection, and the continued exercise of traditional and customary practices, in a traditional and customary manner, are mandated by native custom, and State and Federal Laws (as those establishing the Waiākea and ʻŌlaʻa Forest Reserves and Puʻu Makaʻala Natural Area Reserve; and the Endangered Species Act).

In this discussion, protection does not mean the exclusion, or extinguishing of traditional and customary practices, it simply means that such practices are done in a manner consistent with cultural subsistence, where each form of native life is treasured and protected. *Kūpuna* express this thought in the words, *"Hoʻohana aku, a hoʻōla aku!"* (Use it, and let it live!).

In the early 1900s, the Hilo and ʻŌlaʻa forest lands were determined to be of significance, and worthy of protection. In between 1905 to 1928, the lands of the ʻŌlaʻa and Waiākea Forest Reserves, and the neighboring Kīlauea Forest Reserve were dedicated to the public interest as unique natural resources. As a part of on-going ranching operations, and the mission of the newly formed forestry programs, hunting for pigs, and in earlier times, for wild cattle, has been practiced on lands of the Puʻu Makaʻala NAR. Such hunting interests remain of importance to community members and long-term management goals of the Natural Area Reserve System program.

In 1981, the Puʻu Makaʻala Natural Area Reserve, containing approximately 12,106 acres was dedicated as one of the extraordinary ecological systems of the Natural Area Reserve program of the State of Hawaiʻi.

māua nō me ka haʻahaʻa — Kepā a me Onaona Maly

"Aʻohe hana nui, ke alu ʻia!
(It is no great task when done together by all!)

CONTENTS

ILLUSTRATIONS

INTRODUCTION

Background

As part of a state-wide program designed to protect, restore, and further the public benefit of significant Hawaiian natural resources making up three existing Natural Area Reserves, and one proposed reserve, all on the island of Hawai'i, Ms. Lisa Hadway, Natural Area Specialist for the State of Hawai'i Department of Land and Natural Resources–Division of Forestry and Wildlife (DLNR-DOFAW), requested that *Kumu Pono Associates LLC* [2], conduct detailed historical-archival research that would describe the traditional-cultural and historical setting of lands within existing, or proposed Natural Area Reserves on the Island of Hawai'i. This component of the study discusses several *ahupua'a* [3] that contribute to the land area of the Pu'u Maka'ala Natural Area Reserve situated in the forest lands of the Hilo and Puna Districts on the Island of Hawai'i (*Figure 1*).

The Pu'u Maka'ala Natural Area Reserve (NAR) is situated on lands within the upper Waiākea *ahupua'a* of the Hilo District, and the *kalana* (sub-district) of 'Ōla'a within the District of Puna. The Pu'u Maka'ala NAR adjoins the Kīlauea Forest Reserve (in the District of Ka'ū), the Waiākea Forest Reserve (in the District of Hilo), and the 'Ōla'a Forest Reserve (in the District of Puna), which were established by Governor's Proclamations in 1928, 1923, and 1918, respectively. The Pu'u Maka'ala NAR was proposed in the 1970s, and authorized by Governor's Executive Order No. 3102, on November 16th, 1981. The NAR contains 12,106 acres, and takes it's name from a *pu'u* (hill) which in the early 1960s was given the name "*Maka'ala*" (literally: Stay alert, be Vigilant; interpretively Lookout Hill[4]). Unfortunately, it does not appear that a traditional name for this *pu'u* was recorded in historical survey records. While several traditional and historical accounts name localities in the Waiākea-'Ōla'a uplands, they do not give the precise location of those localities, so it is not possible to know if any of those names refer to this particular feature.

In the narratives written to support the proposed establishment of the Pu'u Maka'ala NAR in the1970s, the lands and resources of the area were described with the following narratives:

> The area received its name from Puu Makaala, a cinder cone rising over 200 feet in the center of the proposed 2,612 acre tract on the slopes of Mauna Loa, Hawaii. It presently forms portions of the state-owned Waiakea and Olaa Forest Reserves and can be located on U.S.G.S Map No. N1390, Puu Makaala Quadrangle… It extends across an elevational gradient from 3,200-3,700 feet. It contains no streams. The heavy forest covering is believed to have never been disturbed by logging, grazing or other uses. The soil is very organic, with black muck that extends to a depth of several feet or more until lava rock is reached. There has been some disturbance by feral pigs…
>
> Most of the area is an *'ōhi'a* rainforest ecosystem. There is a rich assortment of native plants (some 48 species) and associated native insects, from flies and butterflies to crawling forms. It is also a habitat for at least nine native birds, of which three are endangered species. Another ecosystem present, but located only in the far southwest section, is the *koa-'ōhi'a* rain forest. The Kulani Project addition contains a significant amount of this type of ecosystem.

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[2] *Kumu Pono Associates LLC*: Kepā Maly, Cultural Historian-Resource Specialist and Onaona Maly, Researcher.

[3] *Ahupua'a* is a traditional term used to describe an ancient Hawaiian land unit (extending from sea to mountain lands), and remains the primary land unit of the modern land classification system.

[4] See notes regarding naming of Pu'u Maka'ala in ca. 1962, from telephone interview with retired Forester, Ralph Daehler, at end of study.

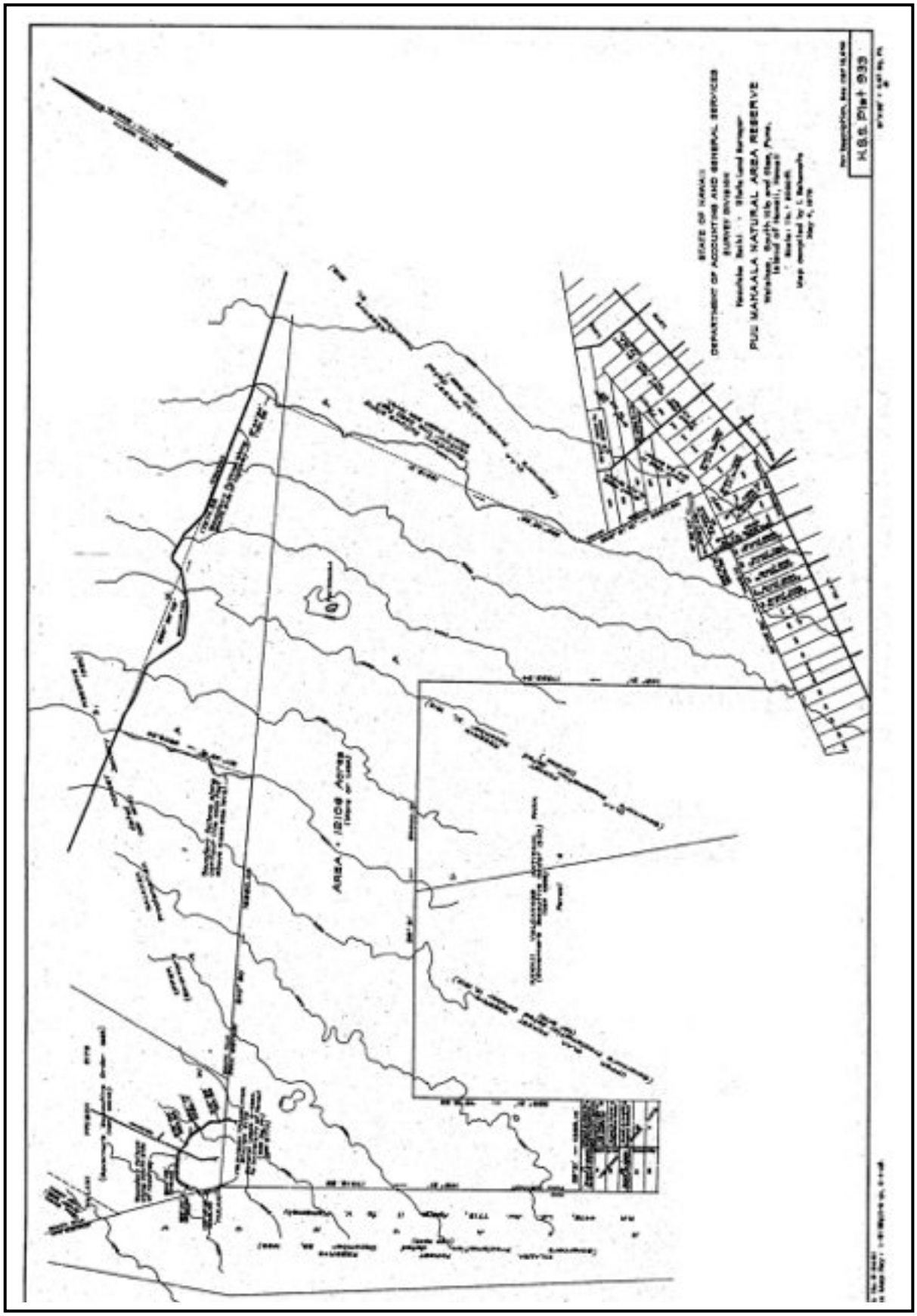


Figure 1. Pu‘u Maka‘ala Natural Area Reserve, and Neighboring Lands of Waiākea, ‘Ōla‘a, and Keauhou, Island of Hawai‘i (1979)

> Indicative of the dense and mature forest cover, the substrate consists of deep soils of "brown forest" and "humic" latosols. There is an average annual rainfall of 100-150 inches. The mature forest growth is a contrasting ecosystem to the developing forest condition preserved by the 640 acre Waiakea 1942 Lava Flow Natural Area Reserve about two miles away… [Pu'u Maka'ala NAR Folder, Natural Area Reserves Office]

This study seeks to provide readers with access to primary documentation on native traditions, customs, and practices associated with the Waiākea-'Ōla'a forest lands; and to provide readers with a historical overview of the land and activities of people in the region from the early 1900s through the present-day. Such information will be helpful in planning phases and discussions of the Hilo-Puna community and agencies, as efforts to protect the unique natural and cultural landscape of the forest lands are undertaken. While a great deal of information has been compiled, and is presented in the following sections of this study, we acknowledge that additional information will likely be found through further research. The goal here, is to bring a significant collection of documentation into one study that will help all interested parties plan actions to ensure the well-being of the land for present and future generations.

Historical and Archival Research

The historical and archival research conducted for this study were performed in a manner consistent with Federal and State laws and guidelines for such studies. Among the pertinent laws and guidelines are the National Historic Preservation Act (NHPA) of 1966, as amended in 1992 (36 CFR Part 800); the Advisory Council on Historic Preservation's "*Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review*" (ACHP 1985); National Register Bulletin 38, "*Guidelines for Evaluating and Documenting Traditional Cultural Properties*" (Parker and King 1990); the Hawai'i State Historic Preservation Statue (Chapter 6E), which affords protection to historic sites, including traditional cultural properties of on-going cultural significance; the criteria, standards, and guidelines of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) for the evaluation and documentation of cultural sites and practices, Title 13 Sub-Title 13:275-284 (October 21, 2002); and the November 1997 guidelines for cultural impact assessment studies, adopted by the Office of Environmental Quality Control (which also facilitate the standardized approach to compliance with Act 50 amending HRS Chapter 343; April 26, 2000).

While conducting the research, primary references included, but were not limited to—land use records, including an extensive review of Hawaiian Land Commission Award (L.C.A.) records from the *Māhele 'Āina* (Land Division) of 1848; Boundary Commission Testimonies and Survey records of the Kingdom and Territory of Hawai'i; and historical texts authored or compiled by—D. Malo (1951); J.P. I'i (1959); S. M. Kamakau (1961, 1964, 1976, and 1991); Wm. Ellis (1963); J. Goodrich (1826); Chas. Wilkes (1845); and A. Fornander (1916-1919 and 1996). The study also includes several native accounts from Hawaiian language newspapers (compiled and translated from Hawaiian to English, by the author), and historical records authored by nineteenth century visitors to the region.

Archival-historical resources were located in the collections of the Hawai'i State Archives, Land Management Division, Survey Division, Natural Area Reserves office, and Bureau of Conveyances; the Bishop Museum Archives; Hawaiian Historical Society; University of Hawai'i-Hilo Mo'okini Library; private family collections; and in the collection of *Kumu Pono Associates LLC*. This information is generally cited in categories by chronological order of the period depicted in the narratives.

The historical record—including oral testimonies of elder native residents of lands in the Waiākea-'Ōla'a vicinity—provide readers with detailed descriptions of traditional and customary practices, the nature of land use, and the types of features to be expected on the landscape. The descriptions of land use and subsistence practices range from antiquity to the middle 1900s, and represent the knowledge of *kama'āina* (natives) of the land.

A CULTURAL-HISTORICAL CONTEXT OF THE LANDS AND FORESTS OF THE HILO AND PUNA DISTRICTS

Hawaiian Settlement

Archaeologists and historians describe the inhabiting of these islands in the context of settlement which resulted from voyages taken across the vast open ocean, with people coming from small island groups. For many years archaeologists have proposed that early Polynesian settlement voyages between Kahiki (the ancestral homelands of the Hawaiian gods and people) and Hawai'i were underway by A.D. 300, with long distance voyages occurring fairly regularly through at least the thirteenth century. It has been generally reported that the sources of the early Hawaiian population—the Hawaiian "Kahiki"—were the Marquesas and Society Islands (Emory in Tatar 1982:16-18).

For generations following initial settlement, it appears that communities were clustered along the watered, windward (*ko'olau*) shores of the main Hawaiian Islands. Along the *ko'olau* shores, in areas such as Waiākea, Punahoa-Pi'ihonua, and Laupāhoehoe, streams flowed, rainfall was reliable, and agricultural production could become established. To a lesser extent, locations in Puna, such as in the Kea'au and Hā'ena vicinity, and in the Kapoho vicinity, early populations could also find the necessary resources for establishing community centers. Along these *ko'olau* shores, sheltered bays offered access to both deep sea and near shore fisheries. The latter, being enriched by nutrients carried in the fresh water flowing from the mountain streams, and in underground lava tube systems, and by which fishponds and estuarine systems could be developed. In these early times, the residents generally engaged in subsistence practices in the form of fishing, and in agriculture on lands extending towards the uplands from the bays (Handy, Handy and Pukui 1972:287).

Over a period of several centuries, areas with the richest natural resources became populated and perhaps crowded, and by ca. 900 to 1100 AD, the population began expanding to the more remote sections of Puna and the larger Kona (leeward) side of the island (Cordy 2000:130).

As a general summary of lowland residency and cultivation of food resources in the Waiākea section of Hilo, Handy, Handy and Pukui (1972) reported that:

> Hilo as a major land division of Hawaii included the southeastern part of the windward coast...the northern portion, had many scattered settlements above streams running between high, forested *kula* lands, now planted with sugar cane. From Hilo Bay southeastward to Puna the shore and inland are rather barren and there were few settlements. The population of Hilo was anciently as now concentrated mostly around and out from Hilo Bay... The Hilo Bay region is one of lush tropical verdure and beauty, owing to the prevalence of nightly showers and moist warmth which prevail under the northeasterly trade winds into which it faces…
>
> In lava-strewn South Hilo there were no streams whose valleys or banks were capable of being developed in terraces, but cuttings were stuck into the ground and on the shores and islets for many miles along the course of the Wailuku River far up into the forest zone. In the marshes surrounding Waiakea Bay, east of Hilo, taro was planted in a unique way, known as *kanu kipi*. Long mounds were built on the marshy bottom with their surface two or three feet above water level. Upon the top and along the sides of these mounds taro was planted. Flood waters which occasionally submerged the entire mound are said to have done no harm, as the flow was imperceptible. This swampy land is now abandoned to rank grass. *Kipi* (mounds) were also formerly made along Alenaio Stream above Hilo… [Handy, Handy and Pukui 1972:538-539]

Natural Resources and Land Management in the Hawaiian Cultural System

In Hawaiian culture, natural and cultural resources are one and the same. Native traditions describe the formation (literally the birth) of the Hawaiian Islands and the presence of life on, and around them, in the context of genealogical accounts. All forms of the natural environment, from the skies and mountain peaks, to the watered valleys and lava plains, and to the shore line and ocean depths are believed to be embodiments of Hawaiian gods and deities. One Hawaiian genealogical account, records that Wākea (the expanse of the sky–father) and Papa-hānau-moku (Papa, who gave birth to the islands)—also called Haumea-nui-hānau-wāwā (Great Haumea, born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawai'i, the largest of the islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor all Hawaiian people are descended (David Malo, 1951; Beckwith, 1970; Pukui and Korn, 1973). It was in this context of kinship, that the ancient Hawaiians addressed their environment, and it is the basis of the Hawaiian system of land use.

Through their generations of residency, the ancient Hawaiians developed a sophisticated system of land- and resource-management. By the time 'Umi-a-Līloa rose to rule the island of Hawai'i in ca. 1525, the island (*moku-puni*) was divided into six districts or *moku-o-loko* (cf. Fornander 1973–Vol. II:100-102). The district of Hilo is one of six major *moku-o-loko* on the island of Hawai'i. The district of Hilo itself, extends from the shore up to the 9,000 foot level on Mauna Kea, and up to the summit of Mauna Loa, where it joins the districts of Ka'ū, Kona and Hāmākua. Towards the east, Hilo joins Puna at Māwae, and continues *ma uka* (towards the mountains), adjoining the land of 'Ōla'a; and on it's north eastern boundary, Hilo joins Hāmākua at Ka'ula. Within this district, today simply described as North and South Hilo, there were at least three traditional regions. The area from Waiākea to the Puna boundary was known as *Hilo Hanakāhi*—Hilo, land of Hanakāhi, one of the noted chiefs of Hilo, whose reign was one of peace. The middle section of Hilo, fronted by the sandy beach of Waiākea Bay, extending from Kanukuokamanu (at the mouth of Wailoa Stream) to Wailuku River was simply known as *Hilo One*—Hilo of the sandy shore. The remainder of Hilo, extending from the cliffs on Wailuku River to Ka'ula was called *Hilo Palikū*—Hilo of the upright cliffs.

The entire district of Hilo has been most famed for its rains, and is commemorated in many traditional *mele* (chants) and *'ōlelo no'eau* (poetical sayings) by reference to the rains. This may seem to some to be an undesirable epitaph, but in the Hawaiian mind, the rains were god given—manifestations of the gods Kāne and Lono, and also forms of lesser gods and goddess of the forests and expanse of the land. Rains gave life to, and healed the land, thus a land of water was a rich one.

Native tradition records that lands with "*wai*" (water) names were themselves associated with the god Lono (G.W. Kahiolo in *Ka Hae Hawaii*, July 10, 1861), thus another level of cultural significance might be associated with the land of Waiākea (Expansive-waters, or the Water of Ākea, progenitor of the Hawaiian race). We also find that one of the famous sayings of Hilo describes the beauty of the rains—source of the waters given by Lono—that seem to resonate from the leaves of the *'ōhi'a lehua* (*Metrosideros polymorpha*) trees which at one time grew luxuriantly from shore to mountains—

> *No ka pehi mau o ka ua iluna o ka lihilihi o ka lehua i ka wā a nā manu e kani hone ana a mūkīkī i ka wai e kilihune iho la i ka liko o ka lehua... o ka ua kani lehua o Hilo ia!* — Because the frequent pattering of rains upon the *lehua* blossoms is accompanied by the sweet singing of the birds as they sip the nectar which drips upon the young budding *lehua* leaves... the rain of Hilo is called the rain which resounds upon the *lehua* blossoms of Hilo! [Wise and Kihe in *Ka Hoku o Hawaii*; February 24, 1916 (Maly, translator)]

The land of ʻŌlaʻa stood alone, almost independent of other lands adjoining it in Puna, though it had no ocean frontage—being cut off by Keaʻau and Waiākea. The name connotes sacredness and sanctity; the root of the name being "*laʻa*." ʻŌlaʻa is famed in native tradition for it's sacred lands, forest, native birds, and *olonā* resources. One ancient *mele* (chant), commemorating the forests, birds, and weather of ʻŌlaʻa, noting too that man traveled across the land tells us:

Ka uka holo kia ahi manu ʻŌlaʻa	The birds fly like flaming darts to the uplands of ʻŌlaʻa,
I pō e noe ka uahi noe i ka nahele,	Where the mist and smoke darken the forest,
Nōhenohea ka makani ʻūhau pua,	Spread out by the breeze which lays out the blossoms,
He pua ʻoni ke kanaka, he mea laha ʻole…	Man is like flower, roving about, something that is irreplaceable… [collection of Hoʻohila Kawelo; Maly, curator]

In the traditional system of land management, the large districts (*moku-o-loko*) like Hilo and Puna, and sub-regions (*ʻokana* and *kalana*) such as ʻŌlaʻa, were further divided into political regions and manageable units of land. These smaller divisions or units of land were tended to by the *makaʻāinana* (people of the land) (see Malo 1951:63-67). Of all the land divisions, perhaps the most significant management unit throughout the islands was the *ahupuaʻa*.

Ahupuaʻa are subdivisions of land that were usually marked by altars with images or representations of a pig placed upon them, thus the name *ahu-puaʻa* or pig altar. In their configuration, the *ahupuaʻa* may be compared to wedge-shaped pieces of land that generally radiate out from the center of the island, extending to the ocean fisheries fronting the land units. Their boundaries are generally defined by topography and geological features such as *puʻu* (hills), ridges, gullies, valleys, craters, or areas of a particular vegetation growth (see Boundary Commission testimonies in this study; and Lyons, 1875).

The *ahupuaʻa* were also divided into smaller manageable parcels of land—such as the *ʻili*, *kōʻele*, *mahina ʻai*, *māla*, and *kīhāpai*—that generally run in a *mauka-makai* orientation, and are often marked by stone wall (boundary) alignments. In these smaller land parcels the *makaʻāinana* cultivated crops necessary to sustain their families, and supplied the needs of the chiefly communities they were associated with. As long as sufficient tribute was offered and *kapu* (restrictions) were observed, the common people who lived in a given *ahupuaʻa* had access to most of the resources from mountain slopes to the ocean. These access rights were almost uniformly tied to residency on a particular land, and earned as a result of taking responsibility for stewardship of the natural environment and supplying the needs of ones' *aliʻi* (see Malo 1951:63-67 and Kamakau 1961:372-377).

Entire *ahupuaʻa*, or portions of the land were generally under the jurisdiction of appointed *konohiki* or subordinate chief-landlords, who answered to an *aliʻi-ʻai-ahupuaʻa* (chief who controlled the *ahupuaʻa* resources). The *aliʻi-ʻai-ahupuaʻa* in turn answered to an *aliʻi ʻai moku* (chief who claimed the abundance of the entire district). Thus, *ahupuaʻa* resources supported not only the *makaʻāinana* and *ʻohana* (families) who lived on the land, but also contributed to the support of the royal community of regional and/or island kingdoms. This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resource management planning. In this system, the land provided fruits, vegetables and some meat in the diet, and the ocean provided a wealth of protein resources.

We find that the system described above, is documented in native testimonies recorded as a part of court proceedings in the 1870s, by elder Hawaiian residents of Waiākea, ʻŌlaʻa and neighboring

lands. The witnesses to the Commissioner of Boundaries reported that traditional access and use of resources in the mountain lands was controlled and monitored by landlords and chiefs. Knowledge of the boundaries of *ahupua‘a*, and the extent of rights on the mountain lands was important. If someone from another land (*ahupua‘a* or district) was caught taking resources from a land other than their own, the items were taken from them. Indeed, the large collection of testimonies for the island of Hawai‘i record that infractions of *ahupua‘a* rights led to fights and death of the intruders. Interestingly, collection of native birds such as the *mamo* and *‘ō‘ō*, and the collection of *olonā* in the Waiākea and ‘Ōla‘a forest lands (presumably those which also fall within the present-day Natural Area Reserve) was recorded by elder *kama‘āina*, though no reference to other forms of hunting, or pigs was made in the testimonies by natives in the 1800s (see Boundary Commission Testimonies in this study).

MOʻOLELO ʻĀINA: NATIVE TRADITIONS AND HISTORICAL ACCOUNTS OF THE WAIĀKEA-ʻŌLAʻA FOREST LANDS

This section of the study provides readers with access to a collection of native traditions of the Hilo-Puna forest lands, some of the accounts translated from the original Hawaiian language narratives by Maly. The narratives span many centuries, from Hawaiian antiquity to the later period following western contact. Some of the narratives make specific references to places on the mountain lands associated with the Puʻu Makaʻala NAR, while other accounts are part of larger traditions that are associated with regional and island-wide events. The traditions describe customs and practices of the native people who resided on these lands, walked the trails, and who were sustained by the wealth of the mountain lands, the *kula* (plains and plateau lands), and the adjacent marine fisheries. It is also appropriate to note here, that the occurrence of these traditions—many in association with place names of land divisions, cultural sites, features of the landscape, and events in the history of the lands which make up the Puʻu Makaʻala NAR—are an indicator of the rich native history of those lands.

"He Kaao no Pikoiakaalala, ke Keiki Akamai i ka Pana"
(The Tradition of Pikoiakaʻalalā–Describing Canoe Making and Bird Hunting in the Uplands of Waiākea and ʻŌlaʻa)

The tradition of Pikoi-a-ka-ʻalalā (Pikoi-son-of-the-crow), printed in the Hawaiian language newspaper, *Ku Okoa*, in 1865-1866, is one of the earliest written accounts, that provides detailed narratives of the traditional and customary practices associated with the upland forests of Waiākea and ʻŌlaʻa. The tradition was submitted to the paper by S.M. Kaui, and ran from December 16th, 1865 to March 10th, 1866.

Pikoi-a-ka-ʻalalā was born to ʻAlalā and Koukou on the island of Kauaʻi, and his family were *kūpua* (beings with supernatural powers and multiple body-forms). Pikoi-a-ka-ʻalalā possessed exceptional sight and excelled in the Hawaiian art of *pana pua* (shooting with bow and arrow). Through the tradition of Pikoi-a-ka-ʻalalā, readers learn that many localities throughout the islands are named for places where he competed in matches with archers, shooting *ʻiole* (rats) and birds from great distances. The tradition is set in the late 1500s when Keawe-nui-a-ʻUmi, the king of Hawaiʻi Island, was in need of an expert to shoot some supernatural *ʻelepaio* birds that continually interrupted the work of his canoe makers in the uplands of ʻŌlaʻa and Hilo.

Keawe-nui-a-ʻUmi learned of Mainele, a champion in the sport of *pana pua*, who resided on Oʻahu, and promised him that if he could rid the forest of the enemy *ʻelepaio*, he could wed his daughter, the beautiful Keakalaulani. As the story unfolds below, we learn that Mainele boasted of his great skills, but he was unable to kill the two birds. In the meantime, Waiākea (for whom the land of Waiākea was named), one of the stewards of Keawe-nui-a-ʻUmi, befriended Pikoi-a-ka-ʻalalā, and learned that he was an expert in the art of *pana pua*.

Prior to his arrival in Hilo, Pikoi-a-ka-ʻalalā made Waiākea promise that he would not tell anyone who he was, for he had heard of the boastful nature of Mainele, and he wished to teach him a lesson. The narratives below (translated by Maly), focus on events in the uplands of Waiākea and ʻŌlaʻa. By the description of the events in this part of the tradition, we learn about the make up of the upland forests, named localities, and some of the practices of ancient Hawaiians in the region coinciding with the Puʻu Makaʻala NAR.

Arriving in the Hilo District Pikoi-a-ka-ʻalalā asked Waiākea:

HELU 5.
"…Aia i hea kahi o ua mau manu hanaino waa nei?" "Aia no ma waho aku o Panaewa," "e pii hoi ha kaua i ike au," wahi a Pikoiakaalala.

Part 5.
"…Where are those birds who make trouble for the canoes found?" "They are there, outside of Panaʻewa." Pikoi-a-ka-ʻalalā then said, "Let us go up there so that I may see."

O ka hele aku la no ia o laua a hiki, a ike aku la o Pikoiakaalala i kahi i kau ai na manu hanaino waa, a me ke kahua kahi hoi e kalai ai na kahuna a Keawenuiaumi, o ka inoa o ia wahi, o Kalehuapueo, aia no kela wahi ma kai ae o Kaluaopele, mauka ae o Olaa, iwaena konu o ka ululaau, he ahua nae, ina e hiki ilaila, e hiki ia oe ke nana mai ia kai o Hilo, me kou ike maopopo no nae ia kai, he loihi no nae, ua ane hiki paha i ka 27 mile ka loa; a hoi aku la no laua i kai o Hilo, e like no me ka mea mau i ke kaumaha i ka manu i na la a pau a laua e hele ai; a he mea mau no hoi ia laua ka lawe pinepine aku i manu na ke alii Keawenuiaumi, a o ka ke alii mea hoohuoi mau no hoi ia, no ka nui launa ole o ka manu, a he mea mau no hoi ia Keawenuiaumi ka ninaninau mau ia Waiakea kona kahu, i ka mea nana i hoomake ina manu he nui, ike kela ano manu i keia ano manu.

The two traveled till they reached the place, and Pikoi-a-ka-ʻalalā saw where the birds who made trouble for the canoes were perched. He also saw the grounds where the canoe making priest of Keawe-nui-a-ʻUmi worked. The name of this place was Kalehuapueo, it is there below Kaluaopele (the Volcano), in the uplands of ʻŌlaʻa, in the middle of the forest. There is a small hill there, and if you go there, you will be able to look to the sea of Hilo. By the sight of the sea, you will know that it is a great distance off, perhaps 27 miles away. The two then returned to Hilo, and as was the custom, they were weighted down by birds on all the days they went to the mountains. They frequently went and took birds for the chief Keawe-nui-a-ʻUmi, who grew suspicious because so many birds were brought down. Keawe-nui-a-ʻUmi regularly asked Waiākea, who was killing these birds, for many different kinds were brought down.

Eia na inoa pakahi o na manu a Pikoiakaalala i pana ai i mea ai no ka wa maka pehu o Hilo. O ka Oo, ka Iiwi, ka Ou, ka Akakane, ka Amakihi, a me ka Mamo, o na manu ai-lehua no a pau o ka uka i Olaa a me ka nahele laau loloa o Panaewa; oia mau manu ka ke keiki Pikoiakaalala i panai, a o ka Waiakea hoi ia e haawi aku ai i ke alii nui me na lii malalo iho, na kaukaualii, na puali, me na koa a me na kanaka hoi o ke alii.

Here are the names of the birds which Pikoi-a-ka-ʻalalā shot during his time in Hilo; the *ʻŌʻō, ʻIʻiwi, ʻŌʻū, ʻAkakane, ʻAmakihi*, and the *Mamo*, the birds which eat of the *lehua* blossoms in the uplands of ʻŌlaʻa, and the long-treed forest of Panaʻewa. Those were the birds shot by Pikoi-a-ka-ʻalalā, and given by Waiākea to the king, the chiefs below him, the attendant chiefs, the warriors and the men of the chief.

A no ka ninau mau o Keawenuiaumi i ka mea nana i pana kela mau manu—i hoike iae la maluna—alaila, hai aku la o Waiakea penei: "He wahi aikane no nau." "No hea?" wahi a ke alii, "no Oahu mai no," alaila ninau mai la o Keawenuiaumi, "O wai ka inoa oia aikane au?" "O wai la, aole i hai mai i kona inoa iau," wahi a Waiakea, he oiaio no hoi paha ia, no ka mea hoi, aole no i ike na mea a pau o Pikoiakaalala keia, aole no hoi i hai i kona inoa ia Waiakea; aka nae, o na hana akamai a pau a Pikoiakaalala kana i ike ai, mai ko laua holo ana mai o Oahu aku a hiki i keia wahi i olelo iae nei, a ua hoopaa loa o Waiakea i kana mea i ike ai, no ke akamai lua ole o ua aikane nei ana, (Pikoiakaalala) oia hoi na pana ana i na iole mai Oahu mai a hiki ma Kohala i Hawaii.

Because Keawe-nui-a-ʻUmi continually asked questions about the one who shot the birds—as described above—Waiākea answered thus: It is a friend of mine." "Where from?" Asked the chief. "From Oʻahu." Keawe-nui-a-ʻUmi then asked, "What is the name of your friend?" "What indeed? He has not told me his name," responded Waiākea. Now this is perhaps true, because very few people knew of Pikoi-a-ka-ʻalalā, and he had not actually told his name to Waiākea. But because of all the amazing things that Pikoi-a-ka-ʻalalā had done—that is the shooting of rats from Oʻahu to Kohala, Hawaiʻi, Waiākea knew that his friend (Pikoi-a-ka-ʻalalā) was second to none in the skill.

(E waiho iki iho kakou i ka hoonioniolo ana no Pikoiakaalala ke keiki o Kauai o Manokalanipo, a me Waiakea hoi kahi kanaka o Kauakanilehua o Hilo Hanakahi, a e kuehu ae kakou i ka lehu o kapuahi no Mainele a me na hoe waa.)

(Let us now leave the upright nature of Pikoi-a-ka-ʻalalā, the youth of Kauai of Manokalanipō, and Waiākea, the man of the land of Hilo Hanakāhi, where the rains resonate on the leaves of the *lehua*; and let us stir up the ashes of the fireplace of Mainele and the canoe paddlers.)

Ia Mainele ma i noho ai iuka o Kohala i ke kalai hoe, a hala hookahi malama, a loaa ka hoe, alaila, makaukau na waa e holo aku i Hilo, kahi hoi o ke alii nana i hoouna aku e kii ia Mainele. A hiki o Mainele ma i Hilo, ua makaukau mua hoi ka ai, ka puaa, me na mea no hoi a pau e lawa ai ka malihini; a o ke o no hoi ia i pii ai e pana i ko Keawenuiaumi enemi mau.

While Mainele and folks were residing in the uplands of Kohala, cutting wood for paddles, there passed one cycle of the moon, and they then had the paddles made. Therefore the canoes were made ready to travel to Hilo, the place from which the king had sent for Mainele and his companions. The food was made ready, the pig and all the things to be brought for the visitor; and those things necessary for the journey to the uplands to shoot the enemies of Keawe-nui-a-ʻUmi.

O ka hoomaka iho la no ia o ka pii o Mainele me ke alii, a me na kanaka a pau he nui, a o ka poe makaikai no hoi o kela wahi keia wahi o Hilo a me Puna. A hiki no hoi o Mainele i ke kahua kahi kalai-waa, a ike iho la nae i ke kumu koa kahi e kau mau ai ua mau manu nei, aole nae he ikeiaku o na enemi o ke alii, no ka mea hoi, aia no a koele ke koi i ka waa, alaila, o ka manawa iho la no ia e lele mai ai o ua mau manu nei a kau i ke kumu o kekahi koa nui. Hookoele no hoi na kahuna a ke alii i kekahi kaele waa kahiko no a lakou mamua i haalele ai, i mea hoi e lohe ai ua mau manu la, alaila lele mai, oiai o ka laua hana mau ia ke lohe i kekahi koi e koele ana.

Mainele and the King, and many of the people, those who had traveled from one place or another in Hilo and Puna, began their journey to the uplands. When Mainele arrived at the canoe making grounds, he saw the *koa* trees where birds had perched, though the (bird) enemies of the king were not to be seen. But when the striking of the adzes was heard on the hulls of the canoes, the birds flew and perched atop a large *koa* tree. When the priest of the king, began to dig out one of the old canoe hulls, left by from an earlier time when they had fled; it was then, when the birds heard the chipping, that they began to fly about.

O ka manawa no ia e hiki ai, me ko laua manao paha he kalai-waa, no ka mea, o ko laua enemi nui hoi ia o ke kalaiwaa. A he oi no hoi o na manu pololei nui wale i ke koho e mai no mamua i na olelo hooiloilo, e olelo mai ai penei: "E Keawenuiaumi e! haalele ia he waa ino, he waa puha, ua loli kaele." Aole no hoi ma ko Keawenuiaumi waa wale no ka laua hana e hooiloilo ai, o ka waa o kela kanaka keia kanaka ka laua e hanai.

That was what they did, when they heard the digging, because their great enemy were the canoe makers. Now normally, these types of birds were foremost in stating whether worms were in the wood, but here, they called out always: "Say Keawe-nui-a-ʻUmi! Leave it behind, it is a bad canoe, a canoe that will shatter, a rotted hull." It was not only the canoes of Keawe-nui-a-ʻUmi, but the canoes of other men as well, that the two birds did this to.

O ka lele mai la no ia o ua mau manu la a kau mai la iluna, ma ko laua wahi mau e kau ai. I ua mau manu la no a kau mai, ike aku la no hoi o Mainele, ke akamai kaulana; o kona manawa iho la no ia i haalele koke ae ai i kana mea make, me ka olelo kaena e anae mamua o kona hookuu ana i kana pua, penei no hoi: "Heaha la ke kumu o ke ku ole ana o keia mau manu i ka poe i hele mai ai e pana i keia mau manu, ma ke kua paha

These birds flew and perched at their usual place above. When the birds perched there, Mainele saw them, he then began boasting about his fame and skill with the bow, and that he could kill them for which he released his arrow: "There is no tree that these birds can land on that the people cannot shoot them. They will be shot in the back perhaps, for their bodies are large, and they land nearby…"

ka pana ana i ku ole ai? No ka mea, he nui na kino, a he kokoke loa no hoi laua e kau mai nei…"

A lohe ae la ke alii, a me ka aha kanaka e ku pu ana me ia, (Mainele) oliloli nui ae la lakou. O ke kuu aku la no ia o Mainele i kana pua, me kona manao hoi e ku aku na manu ia ia, he ole ka hoi ua mea he ku aku, mai ku no nae, o ka pololi ana o ka pua a ku no i ka mino kahiko o na manu, oia no ka mea i halai, o ka hoomau aku la no ia o Mainele i kana hana i kaulana ai o ka pana, oi pana wale a la aohe wahi mea ku aku o na manu, a po ia la, moe iho la no o Keawenuiaumi me Mainele, a me na kanaka a pau ilaila.

Hearing this, the king and the people gathered there with him (Mainele), and were exceedingly happy. Then Mainele released his arrow, thinking that he would strike the birds, but he did not hit them. He tried again and again, his arrows hungered for the birds, but all the shots of this famous person, missed. When darkness fell, Keawe-nui-a-'Umi, Mainele, and all the people with them went to sleep.

A i ke ao anae no, oia ka lua o ka la, i lawa no i ka maamaa anae, o ko Mainele manawa iho la no ia e panai, me ke ake nui e ku na enemi mau o ke alii, aole no hoi he komo wahi ai iki i kona opu, a no ke ku ole o na manu, olelo ae la ia i ke alii e hana i laau alanui nona e pii aku ai iluna o ke kumu koa, i kokoke i kahi o ua mau manu nei e kau ana, me kona manao a kokoke iki ae, alaila, ku ke panae. A paa ke alanui, pii ae la o Mainele alaila, pana ae la no ia i na manu, oi pana wale no ia la a ahiahi, aohe no he mea a ku iki, a moe hou no ilaila.

With the light of day—this was the second day—Mainele practiced and when it was enough, he began again to shoot, with great desire for these enemies of the king. Because the birds did not land nearby, he told the king to have a wooden ladder made so that he could climb atop one of the *koa* trees, close to where the birds regularly perched. He thought that if he could get closer, he would be able to shoot them. The ladder was made secure, and Mainele climbed upon it. But again, his arrows missed, and with the coming of night, the people again slept there.

A ao ae la, o ke kolu ia o ka la, alua no hoi alapii, i mea hoi e kokoke ae ai o ka pana no hoi ka Mainele, o ka nana no hoi ka ke alii, a me na kanaka iluna, me ke ake nui e ku aku ana no ia Mainele na manu, hele no hoi a uakaha ka a-i o ke alii, a nalulu ka lae, me na kanaka a pau i ka ua mea o ke kali ana no ke ku o na manu i ke akamai kaulana o Mainele a po wale no ke kolu o ka la, aohe no he ku o na manu.

At day light, the third day, a second ladder was made so as to enable Mainele to shoot from a closer location. The king and all of the people looked on and saw the great desire of Mainele to get the birds. Looking up, the neck of the king was stiff, and his brow ached, it was so with all of the people who were awaiting the striking of the birds through the ingenuity of Mainele. But as the third night approached, the birds had not been struck.

Moe no a ao ae, o ka ha ia o ka la, a akolu hoi alapii o ka hana ana, e like no me ka Mainele e olelo ai, pela no ke alii e olelo ai i kona poe kanaka e hana, a ane kokoke loa o Mainele ma kahi a na manu e kau ai, o kana no ka pana, oi pana wale no a aohe no he ku o ua mau manu la, he akamai no hoi o Mainele i ka pana, he akamai no hoi na manu i ka alo ana i ka Mainele mea make e lele aku ana he pua.

They slept again, and arose at daylight, and had a third ladder made. Thus Mainele drew near to the place where the birds perched. He shot his best arrow, and it did not strike the birds. While Mainele was smart with the bow, the birds too were smart at dodging the deadly arrows of Mainele.

A po iho la ka ha o ka la, moe no ke alii, me na kanaka a pau, a ao ae la, o ka lima ia o ka la, aha no hoi alapii o ka hana ana, a ia hana ana o

The fourth night settled in, and the king and all his people slept. At daylight on the fifth day, a fourth ladder was built, and Mainele was even

ke alapii, ua kokoke loa i kahi a na enemi e kau mau ai, a e lalau ae no o Mainele i na manu me kona mau lima, e loaa no, aole no hoi i ike na manu i ke kokoke loa o ke alapii, kahi hoi a Mainele e noho ana, a haalele la hoi i ko laua wahi e kau mua ai, i loa no i ka po a ao ae no, o ka na kahuna hana mau no hoi ka hookoele me ke koi i na kaele-waa e waiho ana… Oiai ua hiki ae o Mainele iluna o kahi i hana ia nona, i na manu no a kau mai, o ko Mainele lalau ae la no ia me kona mau lima, alo ae la no na manu, oi lalau wale o Mainele me kona mau lima huluhulu a aole he loaa iki o na manu. Hele no hoi a uluhua o Mainele i na manu, me he hoa hakaka kanaka la. A o ke alii hoi o Keawenuiaumi, ua hele a uiha, a luhi, a uakaha ka a-i, a me kona poe kanaka pu kekahi, oi noke wale o Mainele i ka lalau lima a aohe he loaa iki o na manu, a po wale ka lima o ka la, moe no ilaila a ao ae o ke ono ia o ka la, ike ae la o Mainele ua ao, hoomaka ae la ia e pii iluna o kahi ana e hopu ai i na manu, alaila pane mai la o Keawenuiaumi, "Aole au i upu i kau kaikamahine maikai a na ke kanaka akamai i ka hopu lima i kuu mau enemi, i upu au i kau mea maikai a na ke kanaka akamai i ka pana, e like hoi me oe e Mainele, wahi a ka poe i ike ia oe; a no kou lohe ana hoi ia oe he akamai lua ole i ka pana, hoouna aku ai au i kou mau hoe waa ponoi, me kou mau waa kapu, nou wale iho no, aole no hai; a ka inoa he akamai io oe, aole ka, hoi iho ilalo."

closer to the place where his enemy perched. Mainele then grasped for the birds with his hands, trying to catch them, but he could not , as the birds wouldn't come near the ladder, where Mainele was sitting. They left where they had originally perched through the days and nights that they had bothered the priest and the canoe carvers… Mainele was situated atop the place made for him, and the birds landed. Mainele then reached out to try and grab the birds, but he could in no way grab them. Mainele went after the birds, fighting as if they were a human enemy. The king, Keawe-nui-a-'Umi became wearied, and the necks of all gathered there became stiff and sore. Again, Mainele was unable to secure the birds, and the fifth night fell. They all slept and at daylight the sixth day, Mainele again climbed the ladder and tried to grab the birds. Keawe-nui-a-'Umi called out to him, "I did not think that I was going to give my pleasing daughter to a man who was smart at grabbing my enemies with his hands. I thought that my daughter was going to go to a man who was skilled with the bow, like I thought you were, Mainele. Everyone who told me of you said that you were second to none in your skill with the bow, thus I sent my paddlers and sacred canoes, reserved only for me, after you. But now I see that it is not so. Return down here."

O ka hoi iho la no ia o Mainele me ka hilahila nui. [Ianuari 13, 1866]

Thus, Mainele returned down with great shame. [January 13, 1866]

HELU 6.

E ka poe e heluhelu ana, ua ike ae la hoi kakou i ko Mainele akamai ole, a me kana mau olelo kaena e ana mamua, a me kona ku ana i ka leo a ke alii (Keawenuiaumi). A e olelo ae hoi kakou no ke keiki Pikoiakaalala, a me Waiakea hoi kona kuleana o ka ua Kanilehua a me ke one o Ohele i Kanukuokamanu.

Part 6.

So my readers, we have seen that Mainele was not so smart, as was declared by his boastful words spoken earlier, and in his rising up to the voice of the king (Keawe-nui-a-'Umi). Now let us speak again of our youth, Pikoi-a-ka-'alalā and of Waiākea, and his place in the *Kanilehua* rains, and the sands of 'Ōhele at Kanukuokamanu.

Ia Keawenuiaumi ma i pii ai iuka me Mainele, e like me ka mea i kii iai nona, a o Waiakea pu no hoi kekahi i na la a Mainele e pana ana, ma ke ao wale no nae, a ahiahi no hoi no o Waiakea i kai, oiai o kana aikane (Pikoiakaalala) wale no ko ka hale, no ka mea, aohe he lana nui o kona manao i ka pii iuka e ike i ko Mainele pana ana, no ka mea hoi, ua maopopo no iaia, aohe e ku ana na manu ia Mainele, nolaila no ke kumu o ko

When Keawe-nui-a-'Umi and his companions traveled to the uplands with Mainele, Waiākea, who had gone to fetch him was there as well. He stayed during certain days when Mainele was shooting at the birds, but in the evening, Waiākea returned to the shore where his friend (Pikoi-a-ka-'alalā) remained at the house. This was because he had no great desire to travel to the uplands to see Mainele's efforts at

Pikoiakaalala noho ana i kai, a no ka hoonanea ia hoi kekahi e ke aheahe makani he Malanai, a me ka hooholu maikai ia e ka lau o ka niu o Mokuola, a o kana mea loa ia e lealea loa ana; mai kona wa i hiki mai ai a hiki i ka manawa a kakou e lohe nei. A he mea mau no hoi i ke Kama Aliiwahine a ke Alii Kalani Keawenuiaumi i ka hele mau ana ma ko Waiakea hale, no ka mea hoi, ua kaomi mau ia kona kania-i e na lawalu manu ai-lehua i ka uka i Olaa, a me ka nahele o Panaewa. A na ia mea i kau-o holookoa mai i kona nui kino e hele mai i kahi o Waiakea, a no ka halawai ana o ke kiionohi o ke kaikamahine alii me ke akawailiula o Mana (Pikoiakaalala) a no laila, ua loaa i ke kaikamahine alii ka haawina kaumaha o kona puuwai palupalu no Pikoiakaalala…

shooting. He knew that Mainele would have no luck in striking the birds, thus Pikoi-a-ka-ʻalalā remained at the shore, relaxing in the soothing *Malanai* breeze which causes the fronds of the coconut trees of Mokuola to sway. This was his great pleasure, from the time of his arrival through that of which we have heard. The royal daughter of King Keawe-nui-a-ʻUmi (named Keakalaulani), also regularly went to the house of Waiākea, where she frequently ate the broiled birds that eat the *lehua* blossoms in the uplands of ʻŌlaʻa and the forests of Panaʻewa. Thus this fair chiefess met with the youth of the red glistening waters of Mānā (Pikoi-a-ka-ʻalalā). The chiefess had grown heavy, with a softness in her heart for Pikoi-a-ka-ʻalalā…

A eono la o Keawenuiaumi iuka, a elima hoi po, a i ke ono hoi o ka la i olelo iae la, oia hoi ka la a Keawenuiaumi i pane aku ai ia Mainele a kakou i kuehu aku nei i kela Helu.

Now, for six days and five nights, Keawe-nui-a-ʻUmi was in the uplands. It was on the sixth day the Keawe-nui-a-ʻUmi told Mainele, that which we read above.

Pii hou aku la no o Waiakea e ike no i ka Mainele hana, a o kana hana mau iho la no ia o ka pii, a o ka Pikoiakaalala mea mau no hoi ka ninau, "Pehea mai la na manu?" O ka hoole no hoi ka Waiakea hana, "Aohe he ku o na manu." A ia Waiakea i hiki aku ai iuka, ike aku la oia e kulou mai anao Mainele, aohe he ekemu iki, aohe hoi he kau mai ma kona wahi mau, oiai ua hala iho la na enemi o ke alii ia Mainele.

Waiākea went again to the uplands to see what Mainele was doing, and when he returned, Pikoi-a-ka-ʻalalā would ask him, "How are the birds?" Waiākea would tell him, "The birds have not been struck." When Waiākea had gone to the uplands last, he saw Mainele standing with his head bent down, he had no answer, and no place to go at all, thus the enemies of the king had passed on to Mainele.

Nolaila, ninau ae la o Waiakea i ke alii, "No keaha hoi ka mea e kulou nei o Mainele, aohe hoi he ekumu iki, aohe hoi he pana mai i na manu?" "No ke akamai ole," wahi a Keawenuiaumi.

Waiākea then asked the King, "Why is Mainele standing there with his head bent down, with the least bit to say, did he not shoot the birds?" "No, because he did not have the skill," said Keawe-nui-a-ʻUmi.

Alaila, pane aku la o Waiakea penei, oiai he wahi kahu iwikuamoo ponoiia no ke alii; "E kuu Haku e; e aho paha e hoao hoi i kau wahi pana." "Aia i hea kau pana?" wahi a Keawenuiaumi. "Aia no hoi i kai o Hilo, i kou hale no ia e noho la." Ninau mai la o Keawenuiaumi, "Nohea ia kanaka?" "No Oahu mai no hoi," wahi a Waiakea. "Oia no hoi ka mea nana e pana na haawe manu au i amo aku ai i na la maka pehu ai o kakou la, au no hoi i ninau mai ai iau la," wahi a Waiakea.

Waiākea then spoke as a true retainer of the king, "My lord; perhaps you will try my friend with the bow." "Where is your bow-man?" Asked Keawe-nui-a-ʻUmi. "There at the shore of Hilo, at my house where I live." Keawe-nui-a-ʻUmi then asked, "Where is this man from?" "From Oʻahu," said Waiākea. "He is the one who has shot the abundance of birds, which we ate until our eyes bulged. I will ask him," said Waiākea.

…Penei hoi o Waiakea i olelo ai, "He oi wale no kela keiki akamai nui wale, ia lakou nei i holo e mai ai (Mainele ma) ma na waa kaulua mai Oahu mai, hoi mai hoi au mai ka makaikai ana mai, a hiki mai au i kahi i kau ai na waa o makou, o kou wahi waa wale no ke kau ana, a e ku ana ua keiki la malaila, a iau e hoomakaukau ana i kuu wahi waa, ninau mai la ua keiki la, E holo ana kou waa a i hea? hai aku la au, "E hoi ana au i Hawaii, o makou hoi me ka waa kaulua, i kii mai nei ia Mainele, a eia ka hoi ua hala e aku nei." Alaila, olelo mai la kela iau, "O kaua hoi ha ke holo i ike au i kou aina o Hawaii." ae aku la au, ae, o ko ia la ee mai la no ia, a o ka holo mai la no ia o maua.

Waiākea then said, "The knowledge and skill of this youth is above everyone elses. When we went on our journey to Oʻahu (for Mainele and companions), and the double-hulled canoes, landed on Oʻahu, when we came back from our journey on land, I saw this youth standing next to my canoe. And as I prepared my canoe, the youth asked me, "Where is your canoe off to?" And I answered, "I am returning to Hawaiʻi, all of us and the double-hulled canoes. We have fetched Mainele, and he has gone." He then said to me, "Let the two of us travel, so that I may see your land, Hawaiʻi." I agreed and he boarded the canoe, and we two traveled together.

…Alaila, kena koke mai la o Keawenuiaumi, "O kii hoi ha," o ke kii mai la no ia o Waiakea a hiki ana, ia hiki anaku o Waiakea…olelo aku la o Waiakea, "I kii mai nei au ia oe e pii kaua iuka e panai oe i na enemi o kuu alii Keawenuiaumi, no kou ike ana ia oe no kou akamai lua ole i ka pana, nolaila, ua hai aku nei au i ke alii i na mea a pau au i ike ai nou, a oia ka mea i hoouna mai nei o Keawenuiaumi iau e kii mai ia oe, no ka mea, ua huhu loa ia o Mainele, a ua uluhua loa no hoi ke alii no ke ku ole o kona mau enemi."

Keawe-nui-a-ʻUmi then ordered, "Bring him here." So Waiākea went and fetched him. When Waiākea came to stand before his friend (Pikoi-a-ka-ʻalalā)… Waiākea said, "I have come to bring you to the uplands, that you may shoot the enemies of my king, Keawe-nui-a-ʻUmi, for I have seen your unsurpassed skill with the bow. Thus I told the king all that I had seen you do, and so he is the one who sent me to get you. He is very angry with Mainele, the king is very troubled that he did not strike down his enemies."

Alaila, olelo mai la o Pikoiakaalala, "He punahele no nae paha oe ia Keawenuiaumi?" "Ae," wahi a Waiakea. Alaila, i aku la o Pikoiakaalala, "A i na he punahele io oe ea, E pii oe a olelo aku i poi nui, e hoopiha a piha pono i ka wai, a e lawe ae a malalo pono o ke kumu o ke koa, kahi a na manu e kau ai," he ae wale no ka Waiakea. "A eia hou, ina e ike oe ua hiki aku au, alaila, e paae oe me ka pauku laau i ko lima, a iau e ku ana ma kahi o ke poi wai a nanae iluna i kahi a na manu e kau mai ana."

Pikoi-a-ka-ʻalalā then spoke, "Perhaps you are a favorite of Keawe-nui-a-ʻUmi?" "Yes," answered Waiākea. Pikoi-a-ka-ʻalalā then said, "If you are a true favorite, you must go up there and take a large container and fill it with water. Take it below the *koa* tree where the birds perch." Waiākea agreed to do so. "Here also, when you see that I have arrived, strike your hand with a piece of wood until I am standing at the place where the water container is set, and I am looking up to where the birds perch." [January 20, 1866]

HELU 7.

"A pau auanei kuu nana ana iluna i na manu la ea, alaila, e hahau iho oe i kekahi kanaka o Mainele ma, oiai elima ko lakou nui mai Oahu mai. A iau auanei e kilo ana ilalo i ke poi wai la ea, alaila, hahau no oe i kekahi kanaka; pela no oe e hahau ai a pau i ka make eha kanaka, a o Mainele hoi, e waiho oe ia ia, aia a ike mai oe iau e lena ana au i kuu kikoo, a heluhelu au i ke mele, a pau ia, hookuu au i kuu pua, a make na

Part 7.

"When I am finished looking above at the birds, you must strike down one of the men with Mainele folks, for there are five of them who have come from Oʻahu. And then when I gaze into the water container, you must again strike down one of the men; and so it must be that you strike and kill four men, you must only leave Mainele. You will then see me string my bow, and I shall recite a chant. When I release

manu, alaila, hahau iho no oe ia Mainele, i hookahi kona make ana me na enemi mau o ke Alii; pela auanei oe e hanai, e like me kau olelo ia oe, ke punahele io hoi oe na ke alii."

my arrow, the birds shall be killed. Then you will kill Mainele, thus his death shall come at the time of the death of the enemies of the King. These are the things that you must do, as I have instructed, then you will become the true favorite one of the king."

O keia mau olelo a pau a Pikoiakaalala i aoao ai ia Waiakea, he ae wale no ka Waiakea. A pau ko laua kamailio ana no keia mau mea i olelo ia; hoomaka koke iho la o Waiakea e kukini mama, e hai aku i kona Haku Alii i na mea a pau a kana pana akamai, ana i kaena e ai imua o ke alii nona ka enemi mau o na manu.

All of the instructions given by Pikoi-a-ka-ʻalalā to Waiākea, Waiākea agreed to. When they finished their conversation, Waiākea swiftly ran back to tell the King all about the skilled one with the bow, and what had been said about the one who had boasted before the king and the despised birds.

Ia Waiakea i pii ai, oia aku no mamua o ka pii ana, mahope wali aku no o Pikoiakaalala, o kona kumu hoi i emi hope ai, no ka walea i ke kui lei lehua mamo ai a ka manu, a me kona hoonaue pu ana aku kekahi me ka ua i Hilo one, (Keakalaulani) ia Waiakea e ahai ana i na huaolelo i haiia iaia, aole no hoi oia i ike mai i ka Pikoiakaalala ma hoonaue ana mai mahope. A hiki e o Waiakea i kahi a ke alii Keawenuiaumi e noho ana, ma Kalehuapueo, a o Pikoiakaalala ma aku no hoi a Makaulele, ike aku la o Pikoiakaalala i ka popohe maikai mai a ka lehua ula me ka lehua kea, olelo ae la ia i ke Kama Alii Wahine, "Ina paha e ike au i ke kui ana o ka lei lehua, ina la wau ua hele e kui i lei no kaua," pane mai la ke Kama Alii Wahine opio, "Owau no kai ike, nau no e kui aku i lei nou, a paa ko lei, pii hoi oe, a hoi no hoi au a Alenoho, kakali o ka huikau o na manu i ka pua o ka lehua."

While Waiākea was going to the uplands, Pikoi-a-ka-ʻalalā was slowly following behind. The reason being that he was enjoying himself, making garlands of the *lehua mamo* blossoms, food of the *mamo* birds, and traveling with Keakalaulani, who was like the rains of *Hilo One*. Waiākea followed the instructions given him, but he did not know that Pikoi-a-ka-ʻalalā them, were following behind. When Waiākea arrived before the King, Keawe-nui-a-ʻUmi, who was then dwelling at Kalehuapueo, Pikoi-a-ka-ʻalalā them were at Makaulele, where they saw the perfect fullness of the *lehua* blossoms—red *lehua* and white *lehua*. He said to the Chiefess, "If only I knew how to string a *lei* of these *lehua* blossoms, I would make a *lei* for us two." The Chiefess answered, "I am one who knows how, let me make a *lei* for you. And when you go to the uplands, I will return and wait at ʻAlenoho, waiting with tumult of the birds on the *lehua* blossoms.

O ke kui iho la no ia o Keakalaulani a lawa na lei lehua eha. O ke kui ana a ua Kama Alii Wahine opio la i na lei lehua eha, i pauku ia ka lehua ula me ka lehua kea, a hoolei aku la no hoi o Keakalaulani ia Pikoiakaalala i na lei; a no ke kokolo waianuhea ana mai a ke aheahe makani mailoko mai o ka ululaau, a o ka laua mea hoi ia e nanea ana ma ia wahi, me ko laua manao e kali ia Waiakea a kii hou mai. Ia ia i kuehu pau mai ai ka lau o ka palai noho uka a me ka maile lauliilii i ko lakou onaona, a he mea oluolu loa i ko ke Alii Wahine manao.

Keakalaulani then made four perfect garlands of *lehua*. The four *lehua* garlands made by the young chiefess, were made in sections of red *lehua* blossoms and white *lehua* blossoms, with which she adorned Pikoi-a-ka-ʻalalā; the cool moist breeze caressed the forest, they two relaxed and awaited the return of Waiākea. They then thought to go gather the *palai* of the uplands and the *maile lauliʻi*, for their fragrance was something that gave comfort to the thoughts of the Chiefess.

A ia Waiakea hoi i hoea aku ai oia wale no, aole hoi ka mea ana i kii hou ai (Pikoiakaalala.) Ninau mai la o Keawenuiaumi, "Auhea la hoi ke keiki

Now when Waiākea returned, he was by himself, the one whom he had gone to fetch, (Pikoi-a-ka-ʻalalā) was not with him. Keawe-

akamai i ka pana, au i olelo iho nei iau, a o ka makou ia e kali aku nei?" Olelo aku la no hoi o Waiakea, "Ei ae no mahope mai, i pii e mai nei au mamua nei e olelo aku ia oe, a ina oe e ae mai alaila, e olelo aku au?" "Pehea ia olelo au e ae aku ai au?" Alaila, hoopuka mai la o Keawenuiaumi i kona manao penei: "Ua ike no oukou a pau i kau mau mea i hooko ai no ka poe a pau i na mai e pio kou mau enemi manu; a ma ka lakou mau olelo wale no au e hooko aku ai; o kau mau olelo no hoi a pau au e olelo mai nei no kau akamai, pela no au e hooko aku ai." A pau ka olelo ana a ke alii, hoomakaukau ia iho la na mea a pau i oleloia. Hoopiha ia iho la kekahi poi nui a piha i ka wai, hapaiia aku la a ke kumu o ke koa. A ike iho la o Waiakea ua hooko ia kona mau olelo a pau e kona Haku.

nui-a-'Umi asked, "Where is the youth that is skilled with the bow of whom you told me, and for whom we wait?" Waiākea answered, "He is following behind, I came to the uplands first to speak with you." "What are the words that you wish to speak?" "What do you think of these words that I have spoken to you?" Keawe-nui-a-'Umi the spoke his thoughts, "All of you know the things that I have done for the one who would extinguish my enemies. And it was only by their saying it, that I fulfilled the needs. Now, all that you have said, from your skilled one, so I shall fulfill his instructions." When the king finished speaking, all things that were instructed were prepared. A large container was filled with water and carried to the *koa* tree. Waiākea saw that all that he had spoken to his Lord had been accomplished.

Alaila, ua kii aku la o Waiakea ia Pikoiakaalala, a loaa no iaia e pukukui ana no i ke anu a ka ua lililehua o Makaulele. "O oe mai la ia?" wahi a Pikoiakaalala. "Owau keia o Waiakea o kau aikane aloha, i kii hou mai nei au ia oe, ua ae mai nei kuu Haku i na mea a pau au i kena mai ai iau e pii e mamua, a o ia hoi au i holo hou mai nei ia oe." "Ina kaua," wahi a Pikoiakaalala o ka pii aku la no ia o laua (Pikoiakaalala ma), a hoi no hoi o Keakalaulani ma me kona wahi kahu wahine i kai o Hilo.

Then Waiākea went to fetch Pikoi-a-ka-'alalā , and found him there in the cold misty rains of Makaulele. "So it is you?" said Pikoi-a-ka-'alalā. "It is I, your friend," said Waiākea, "Come to fetch you, for my Lord had agreed to all that you said, before I went up. And now I have come for you." Pikoi-a-ka-'alalā said "It is for us." So they two made preparations to go to the uplands. Keakalaulani and her female attendant returned to the shore of Hilo.

Ia Pikoiakaalala ma i hiki aku ai ma kekahi oioina, o Mahinaakaaka ka inoa, aia no kela wahi ma ke alanui e pii ana i Olaa. Ilaila, ike aku la o Pikoiakaalala i kekahi iole nui, pane aku la ia ia Waiakea, "Ka iole nui hoi!," "Aia i hea?" wahi a Waiakea, "Ei aku mamua o kaua, ua hele ka nuku a paa i ka pulu hapuu." O ka pana aku la no ia o Pikoiakaalala, ku no ua iole nei, o Akiakaiole, a ua pana ia no ia wahi o Akiakaiole, aia no ma Olaa. Mahope aku no hoi laua nei, a ike iho la o Waiakea i keia iole nui io e waiho ana. A pii aku la no laua nei a hiki i Kapueuhi, malaila no ko laua komo anaku, no ka mea, o ke alanui no ia e pii ai a hiki i kahua kalaiwaa o ke alii Keawenuiaumi, oia hoi o Kalehuapueo.

Pikoi-a-ka-'alalā and his companion arrived at a trailside resting place known by the name of Mahina'akaaka; that place is along the trail that ascends to 'Ōla'a. There, Pikoi-a-ka-'alalā saw a very large *'iole*, he told Waiākea, "What a large *'iole*!" "Where?" "There in front of us. The snout is held fast in the *pulu* of the *hāpu'u*." Pikoi-a-ka-'alalā then shot, and struck the *iole* named 'Aki'akia'iole. 'Aki'akia'iole is now one of the storied places in 'Ōla'a. Afterwards, Waiākea saw the great *iole* left there. They then continued upland till they reached Kapu'euhi; they entered there because the trail rises up to the clearing of the canoe makers of the king, Keawe-nui-a-'Umi, that is Kalehuapueo.

A hiki aku la laua nei i kahi i oleloia ae nei, pihoihoi nui mai la ka ahakanaka me na huaolelo ma ko lakou waha, "Eia ua pana akamai loa la! A pela mau ka ka aha olelo, a no ka hooho nui ana o na kanaka, oiai e noho ana no o Mainele ia Kepookulou, a i kee anae iluna, ike aku la ia ia

They then arrived at the place spoken of above, and the people were greatly excited, and the words from their mouths were "So here is the expert with the *pana!*" Such were the words and murmuring of the people. Meanwhile, Mainele was sitting with his head

Pikoiakaalala ma e pii mai ana, a i kona ike ana o ke keiki no a laua i pana ai i Kulaokahua, a i mua hoi o Kakuihewa, manao maopopo loa iho la ia, me ka olelo ae i kona mau hoa eha, "E make ana paha kakou," "I ke aha hoi?" wahi a kona mau hoa. O ke keiki no hoi keia a maua i pana ai iloko o ka hale o Kakuihewa i Oahu." Kai no paha he keiki e keia i olelo iae nei…

hung down, as Pikoi-a-ka-ʻalalā and his companion drew near. Then he knew that this was the youth with whom he had competed in the sport of *pana* at Kulaokahuʻa (Oʻahu), before the king, Kakuihewa. He then knew, and told his four companions, "We are going to die." Why?" they asked. "This is the youth that we competed with in the sport of *pana* at the house of Kakuihewa, at Oʻahu." "Perhaps this is a different youth," they said.

A ma ia wa i hooili ia iho ai ko Mainele naau e ka ukana kaumaha he hilahila, me ka manao no nae hoi, o ka hilahila wale no ke loaa iaia, aole la hoi o ka make pu kekahi e hana ia nona. A ku o Pikoiakaalala ma ke kumu o ke koa, kahi hoi a ke poi wai e ku ana, ka laau hoi a na manu e kau mau ai, nanae la ia iluna, a ike ae la i na manu e kau ana i ka wekiu, oiai ua hookoele e iaku mamua, i mea e lohe ole ai ka mea kaulana i ka pana; a ike lea ae la o Pikoiakaalala i na manu, hoi iho la kona mau maka ilalo i ke poiwai hoomanao ae la o Waiakea i kona kauoha, hapai ae la i kana laau, a hahau iho la i kekahi kanaka o Mainele, a make loa, ka Pikoiakaalala no ke kilo i ke poi wai, o ka Waiakea hana no hoi ka pepehi i kanaka o Mainele, a pau eha kanaka i ka make, a o Mainele aku no hoi ka hope, aia a heluhelu ae o Pikoiakaalala i kana mele mau, alaila, o ko Mainele wa ia e make ai ia Waiakea. A ma ia wa no, hoomaka iho la o Pikoiakaalala e lena i kana kikoo, me ka nana no nae o na maka ilalo i ke poiwai.

Then Mainele's very core trembled with sadness and the burden of shame, knowing that only shame would be had by him; he did not know that death would be the result of his deeds. Pikoi-a-ka-ʻalalā stood at the *koa* tree, where the water container had been set, and below the branch where the birds regularly perched. He looked up and saw the birds perched at the very top of the tree. He then caused the tapping of the wood to begin, so that the sound of the bow of this famous one would not be heard. Pikoi-a-ka-ʻalalā rejoiced at seeing the birds, and then looked down into the water container. Waiākea then remembered what he had been instructed, and took up his club and struck and killed the first of the men who had accompanied Mainele; and so he killed all four of the men. Only Mainele remained. Then Pikoi-a-ka-ʻalalā began his chant, and that was the time that Mainele was to die. At the same time, Pikoi-a-ka-ʻalalā began to string his bow, while his eyes were looking down into the water container.

Heluhelu ae la ia i kana wahi mele mau. Penei no ia:

"Aia la, aia la o Pikoiakaalala,
O Alala no ka makuakane,
O Koukou no ka makuahine,
Hanau o Kikoookalani,
O Kikoookahonua,
O Kikoookamauna,
O Kikoookamoana,
O Kikoookapo,
O Kikoookeao,
O Kapunanui,
O Kapunaiki,
O Ke-i,
O Ke-hamau,
Hamau - Aia ka hoi ua manu iluna,
Eia hoi au ilalo nei,
E lele ae oe e kuu pua,
O ka a-i o kela manu,

He recounted his mele, thus:

"Behold, there is Pikoi-a-ka-ʻalalā,
ʻAlalā is the father,
Koukou is the mother,
Born was Kīkoʻokalani
(Expanse of the heavens),
Expanse of the earth,
Expanse of the mountain,
Expanse of the sea,
Expanse of the night,
Expanse of the light,
Of the large spring,
Of the little spring,
That which is spoken,
That which is silent,
Silence, there are the birds above,
And here I am below,
Let you fly my arrow,

O ka a-i o keia manu,
Huihui a kahi hookahi."

The target is that bird,
The target is that bird,
Joined together as one."

O ka hookuu aku la no ia o Pikoiakaalala i kana pua, oia kolili no a ku ana na a-i o a na manu a elua; i ka pua no ana a lele, o ka manawa koke iho la no ia o Pikoiakaalala i holo ai i kai, me kona ike ole aku i ke ku ana o na manu. Uwa nui ae la ka pihe kanaka, me ka hooho ana; "a make ka manu e!" A pela mau aku no ka ikuwa hauwalaau ana o nalii me na kanaka.

Pikoi-a-ka-ʻalalā then released his arrow, it twirled and struck the two birds; the moment the arrow flew, Pikoi-a-ka-ʻalalā immediately departed for the lowlands, not knowing whether or not he had hit the birds. There was a great roar from the people there, calling out, "The birds are dead!" And such was the din of the voices of the chiefs and people.

A o Pikoiakaalala hoi, aia kela ke holo kiki la i kai, me kona manao no, aole e ku ana iaia na manu, no ka mea, he mau manu akamai loa i ka alo ana i ka pua. Eia ka auanei ua ku aku la no, a no ke ku ana ka ka mea e uwa nui ia mai nei mahope. A iaia i akakuu iki iho ai kona holo ana, ua komo aku la nae keia i ka nahele loloa o Panaewa; halulu ana hoi o Waiakea ma-hope ona, a alawa ae la ia, o Waiakea no; ninau ae la o Pikoiakaalala, "Pehea na manu, ua ku nae paha?" "Ae, ua ku," wahi a Waiakea. "A heaha hoi kou mea i holo mai nei?" "No kou manao no aole i ku na manu…" "E hoi hou kaua," wahi a Waiakea, o ka hoi hou aku la no o laua nei a hiki i kahi o ka luahi a kana pua, o na enemi mau hoi o Keawenuiaumi."

Now Pikoi-a-ka-ʻalalā had arrived at the shore, not knowing if he had killed the birds or not; for the two birds were extremely clever at dodging the arrows. But he had hit them, and that was the reason for the great cry rising behind him. So he slowed down his pace, and entered into the dense forest of Panaʻewa. Waiākea was noisily following him, and saw him. Pikoi-a-ka-ʻalalā asked Waiākea, "How are the birds, were they hit?" Waiākea said, "Yes." "And why have you followed me?" Because at first I thought that perhaps the birds had not been hit…" Waiākea then said, "Let us two return to the place where the arrow struck the enemies of Keawe-nui-a-ʻUmi."

Ku kohana iho la o Pikoiakaalala imua o ke alii, nona na enemi e waiho ana i ka make. Ia wa, hoike ae la oia i kona inoa, a me kona akamai nui, penei no ia:

Pikoi-a-ka-ʻalalā stood alone before the king, and the dead enemies were there on the side. At the time he revealed his name to the king, his great skill was known, the king spoke thus:

"O kuu mea i upu ai, o ka mea e make ai o kou mau enemi, alaila, e lilo kau kaikamahine i wahine hoao nana, a e hooili aku no hoi au i kou Noho Alii maluna ona, oiai hoi, o oe ae nei ke akamai lua ole, nana i pale ae nei i ka mea uluhua a kou naau, e enemi mau ai i ke Kau me ka Hooilo, o ka noho ana o nei aina, me ka lana nui o kou manao, e lilo i keiki oe nau, a owau hoi kou makua, a o Hawaii nei ka Moku noho ia, o luna, o lalo, o uka, o kai, o ke kanaka nui, o ke kanaka iki, a hale nui, a hale iki, ua pau a me oe. A o kuu Kama Lei aloha he kaikamahine, o ka mea ia nana e hoopumehana kou poli o na po ua lanipili o ua wahi nei" (Hilohanakahi).

"My desire was that my enemies be killed, and to the one who succeeded, would be wed to my daughter, and also inherit my kingdom. Therefore, because you have unsurpassed knowledge, and have protected me from my enemies—those who caused me grief summer and winter, in the dwelling upon this land—it is with great hope that you will become a son to me, and I will be your father. Hawaiʻi will be the Island upon which you dwell—above, below, from the uplands to the sea; the great men, the little men; the great houses, the little houses, all are for you. And my cherished daughter, a beloved lei, is the one who will warm your breast on the rainy nights of this place here" (Hilo Hanakāhi).

A pau na olelo a ke alii, o ka hoi iho la no ia o ke alii me na makaainana a pau, a halihali pu ia o Mainele me na manu i kai o Hilo, a kau ia i ka Heiau i Poo, aia no kela wahi ma Hilo one, a malaila pu o Kanukuokamanu, o ka nuku no ia o ua mau manu la... [Iaunari 27, 1866]

When the king finished speaking, he, all the chiefs and people, and those carrying Mainele and the birds, returned to the shore of Hilo. Mainele was placed on the Temple at Po'o; that place is there on *Hilo One*, at Kanukuokamanu; and it is named for the *nuku* (beaks) of those birds… [January 27, 1866]

Another indication of the traditional importance of resources in the lands of 'Ōla'a and Waiākea is found in the writings of native historian, John Papa I'i (1959). I'i reported that following the death of Kalani'ōpu'u in 1782, the island of Hawai'i was to have been ruled by Kīwala'ō, Kalani'ōpu'u's son, while the gods and *heiau* were to be cared for by Kamehameha I. Disagreements arose over the division and redistribution of lands following Kalani'ōpu'u's death. I'i reported that while the division of lands to be made by Kīwala'ō was being discussed, his half-brother, Keōua, was told by one of his advisers:

> "…Perhaps you should go to the chief and ask that these lands be given to us. Let Waiakea and Keaau be the container from whence our food is to come and Olaa the lid [5]." Keoua did so, but the other Kau chiefs objected to this and spoke disparagingly to him. When Keoua returned, his advisor asked, "How was your venture?" When Keoua told him all that had been said, the man remarked seriously, "A break in a gourd container can be mended by patching, but a break in the land cannot be mended that way..." (I'i 1959:14)

Kū-ka-'ōhi'a-Laka

The tradition of Kū-ka-'ōhi'a-Laka dates from the period of settlement of these islands, when the gods themselves took human forms and resided upon the land. It is recorded that the gods Kū-ka-'ōhi'a-Laka and his sister Ka-ua-kuahiwi came from Kahiki (the ancestral home land) to Hawai'i, and settled at Kea'au and 'Ōla'a, Puna. Kū-ka-'ōhi'a-Laka (Kū) and his wife resided near the shore at Kea'au, and Ka-ua-kuahiwi, her husband and children lived upland in 'Ōla'a. Kū's wife was stingy, and at one time denied Ka-ua-kuahiwi and her family fish that Kū had caught. Out of desperation, Ka-ua-kuahiwi turned her husband and children into rats, and turned herself into a spring of water. When Kū learned of this occurrence, he went to the spring and turned himself into an *'ōhi'a* tree (cf. Green and Pukui 1995:19-20; and Beckwith 1970). This *'ōhi'a* tree was known as a supernatural tree and the spring and tree were one of the *wahi pana* (special storied places) along the ancient trail leading to and from the volcano area in 'Ōla'a. The location of Kū-ka-'ōhi'a-Laka was near the 13 mile marker of the old Volcano Road (pers comm. M.K. Pukui, 1976).

Ka U'i Keamalu (Keamalu the Beauty)

There once lived at Paliuli, an upland region of 'Ōla'a, a beautiful chiefess named Keamalu. Keamalu was raised in the seclusion of the forests by her supernatural elders, and until she matured, she was never seen by anyone. A spring in 'Ōla'a is named Pūnāwai o Keamalu, and it was there, that the chiefess went to bathe. One day while at Pūnāwai o Keamalu, a young man came upon her, and he was so taken by her beauty that he asked her to become his wife. She refused, but he would not leave her, and her bird guardians took her away on their wings. Word of Keamalu's beauty went throughout Puna, and the young man's sweetheart, the beautiful Kalehua'ula and her parents spoke disparagingly about Keamalu. Keamalu's guardians were angered by the comments, and a contest was arranged so that all the people of Puna could see and compare the two beauties. Keamalu, adorned with *maile* and *lehua kea* (white blossomed *lehua*), with *'i'iwi* flying over her, won the contest.

[5] The reference to 'Ōla'a as the "lid," may be taken to imply that the fine resources of bird feathers, *olonā* fiber for cordage, and the famous *kapa* (bark cloth) called *'ō'ū-holo-wai-o-La'a* were the wealth which covered the needs of the chiefs.

She and the young man were married, and they lived at Paliuli. “As for the spring of Keamalu, it was hidden and is shown to very few people” (Green and Pukui,1995:32-33).

“Kaao Hooniua Puuwai no Ka-Miki”
(The Heart Stirring Story of Ma-Miki)

Perhaps one of the most detailed native traditions which includes rich accounts of place names and traditional practices associated with the Puna-Hilo forest lands, and associated *ahupua‘a*, is the historical account titled “*Kaao Hooniua Puuwai no Ka-Miki*” (The Heart Stirring Tale of Ka-Miki). The story of Ka-Miki was published in the Hawaiian language newspaper *Ka Hoku o Hawaii* (1914-1917). It is a long and complex account that was recorded for the paper by Hawaiian historians John Wise and J.W.H.I. Kihe (translators of the work of A. Fornander), with contributions from others of their peers. While “Ka-Miki” is not an entirely ancient account, the authors used a mixture of traditions, local stories, tales, and family traditions in association with place names to tie together fragments of site specific history that had been handed down over the generations.

The complete narrative include historical accounts of more than 800 place names (many personified, commemorating particular individuals) around the island of Hawai‘i. While the personification of individuals and their associated place names may not be entirely “ancient,” such place name-person accounts are common throughout Hawaiian and Polynesian traditions. The selected narratives below, are excerpted from various sections of the tradition, and provide readers with descriptions of the land, resources, areas of residence, and practices of the native residents, as handed down by *kama‘āina* (those familiar with the land). Of particular interest, specific documentation is given pertaining to the practice of bird catchers, the nature of weather patterns, and the naming of many places on the mountain landscape.

The English translations below (translated by Maly), are a synopsis of the Hawaiian texts, with emphasis on the main events of the original narratives. Also, when the meaning was clear, diacritical marks have been added to help with pronunciation of the Hawaiian place names and words.

> This *mo‘olelo* is set in the 1300s (by association with the chief Pili-a-Ka‘aiea), and is an account of two supernatural brothers, Ka-Miki (The quick, or adept, one) and Maka-‘iole (Rat [squinting] eyes). The narratives describe the birth of the brothers, their upbringing, and their journey around the island of Hawai‘i along the ancient *ala loa* and *ala hele* (trails and paths) that encircled the island. During their journey, the brothers competed alongside the trails they traveled, and in famed *kahua* (contest fields) and royal courts, against *‘ōlohe* (experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians). They also challenged priests whose dishonorable conduct offended the gods of ancient Hawai‘i.
>
> Ka-Miki and Maka-‘iole were empowered by their ancestress *Ka-uluhe-nui-hihi-kolo-i-uka* (The great entangled growth of *uluhe* fern which spreads across the uplands), who was one of the myriad of body forms of the goddess *Haumea*, one of the creative forces of nature—also called *Papa* or *Hina*—who was also a goddess of priests and competitors.

Pōhaku-loa (Long stone)
The boundary point between Keauhou, Waiākea and ‘Ōla‘a.

Pōhakuloa was a deity of the forest lands which extended across Mauna Loa towards Mauna Kea, and he was called upon by canoe makers. In his human form, Pōhakuloa was an *‘ōlohe* expert and wood worker.

When Ka-Miki and Maka-‘iole left ‘Uwēkahuna *mā* (and companions) at Kīlauea, they traveled into the upland section of the district of Puna. Hearing the striking sounds of

koʻi pōhaku pāhoa (large adze against wood), the brothers thought that perhaps canoe makers were working nearby. As they approached the source of the sounds, Ka-Miki and Maka-ʻiole saw a large round house, of the type with a high pitched roof (*pūʻoʻa*). And at the center of the house a man was working on a *koa* log which was seven fathoms long and three feet in diameter. [September 16, 1915]

Working intently, this man was startled at hearing a voice call to him, thus he stopped his carving. Ka-Miki then asked, "Is this the path by which one would travel to Keaʻau?" Angered at being interrupted, Pōhakuloa responded, "Donʻt you know the direction of the path upon which you two travel? If you just go straight on you will reach Keaʻau." He then went on to say, "My job is not to stand here directing travelers along the trails."

Ka-Miki told Pōhakuloa, "We only asked because we thought that you were a man like us, had we known you were one of the — *Pahulu ke akua ʻāhuluhulu o ka mauna* (Ghoulish broad adze gods of the mountain), we would not have bothered you."

Ka-Miki and Pōhakuloa exchanged taunts, and Pōhakuloa threatened to throw Ka-Miki and Maka-ʻiole into a deep pit. Ka-Miki then told Pōhakuloa, "It is unlikely that you could beat *Nana-i-ke-kihi* and *Kahuelo-ku*. It was more likely that the great grandchildren of *Ka-uluhe* and *Lani-nui-kuʻi-a-mamao-loa* will bind you like a pig, and leave you along the *ala loa* for travelers to see."

Angered, Pōhakuloa leapt to attack Ka-Miki, and was immediately bound, unable to move. Though he tried with all his might and skill, Pōhakuloa was unable to free himself. Ka-Miki called out to Pōhakuloa —

> *Paʻa loa e Pōhakuloa. Paʻa i ka ʻalihi o Kanikawī ke kōkō aīwaiwa a kuʻu mau kūpuna wahine... Paʻa ʻoe i ke kāwelewele o Halekumukaʻaha ka ʻupena kuʻu a ka nananana, o Kai-halulu ia, o kuʻi a holo, piʻi a noho, pupuʻu a moe mālie, kau i ke Kōkī o Wailau...*
>
> Pōhakuloa is secured. Bound in the lines of *Kanikawī*, the mysterious net of my female ancestors... You are bound in the ropes of Halekumukaʻaha, in the net set down by the spider, and though thrashing about like the sea of Kaihalulu, which strikes and runs, which rises and recedes, which mounds up and lies calm, you cannot escape, for you are placed like the shrimp at Kōkī, Wailau (Molokaʻi)...

…Pōhakuloa realized that these young travelers were no ordinary people, but that they traveled with the gods, deities and guardians of the *ʻōlohe*, and he surrendered, acknowledging the skill and nature of Ka-Miki and Maka-ʻiole. Pōhakuloa also promised that from then on, he would use his knowledge wisely.

Pōhakuloa then went to his brother-in-law, Kapuʻeuhi, to ask his assistance in preparing food and *ʻawa* for Ka-Miki and Maka-ʻiole. Kapuʻeuhi laughed upon hearing Pōhakuloa's story and planned to show up Pōhakuloa, by tricking and defeating Ka-Miki and Maka-ʻiole [September 23, 1915].

Kapuʻeuhi lost and vowed revenge, but Pōhakuloa remained true to his word of friendship, refusing to assist Kapuʻeuhi. Kapuʻeuhi then went to Kaniahiku to enlist her assistance [October 14, 1915].

Ka-puʻe-uhi (The yam planting mound).
The lands of Kapuʻeuhi, in the upper forests of Kaliʻu, at ʻŌlaʻa, were named for the *ʻōlohe* chief, Kapuʻeuhi.

Kapuʻeuhi went to get Ka-Miki and Maka-ʻiole from Pōhakuloa's compound and invited them to his house for *ʻawa* and food. Kapuʻeuhi challenged Ka-Miki and Maka-ʻiole to drink five cups of *ʻawa*, stating that if they were unable to drink that amount, he would throw them out of his house. Now this type of *ʻawa*, the *ʻawa kau lāʻau* (*ʻawa* planted by the birds on tree branches) was very powerful, and few people could drink large quantities. Thus, many people were thrown from Kapuʻeuhi's compound and left to wonder drunk and lost in the forest. This practice of Kapuʻeuhi's was the source of the saying — *"Lilo i Puna i ke au a ka hewahewa!"* (Lost in Puna in a time of demented thoughts–drunkenness; descriptive of aimless wandering, or senseless work!).

Ka-Miki accepted the challenge, but stated that if they won, they would throw Kapuʻeuhi out of his compound. Ka-Miki then offered an *ʻawa* prayer chant to *Ka-uluhe*, *Haumea*, and their associated god forms:

Iā Kumakua-moe-awakea	To (the deity) Kumakua [tall *lehua* which reclines in the afternoon sun]
Iā ʻŌhiʻa-nui-moe-awakea	To *ʻŌhiʻa-nui* [great *ʻōhiʻa* which reclines in *the afternoon sun]*
I nā Wahine-moe-awakea	The women who sleep in the midday sun
Iā Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau	To the mist which creeps atop the forest
Iā Ka-uluhe-nui-hihi-kolo-i-uka...	To Ka-uluhe the great entangled *uluhe* fern growth of the uplands...
Iā Hai-uli wahine o Mākea	To Hai-uli wife of Mākea
O Kamehanalani, O Kāmehaʻikana	Who is also called Kamehanalani, or Kāmehaʻikana,
O Haumea, O Haumea-nui-a-ke-aīwaiwa.	It is Haumea, great mysterious Haumea.

Hearing Ka-Miki's prayer, his deified ancestresses responded, and *Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau* caused a mist to envelope Kapuʻeuhi's compound, and its' foundation was rocked by the strong winds, the *ʻōhiʻa, kōlea, kāwaʻu, kōpiko, ʻamaʻu*, and *koa* were all broken in the winds that blew. [September 30, 1915]

Ka-Miki and Maka-ʻiole drank all the *ʻawa* and Kapuʻeuhi was startled at the strength of the two young strangers. Kapuʻeuhi tried to back out of his earlier challenge, but Ka-Miki would not release him from the arrangement, thus Kapuʻeuhi had to fetch more *ʻawa* for Ka-Miki and Maka-ʻiole.

Now Kapuʻeuhi lived near the spring of Wai-uli. His compound consisted of several houses, and in one guest house he killed many travelers while they slept. He placed his compound near the *ala loa* which ran from Panaʻewa through ʻŌlaʻa, into coastal Puna and on to Kaʻū. Kapuʻeuhi's regular practice was get travelers drunk on *ʻawa*. Once the travelers were asleep, Kapuʻeuhi would play a *hōkiokio* (gourd nose flute) to call his assistants who were hiding in another one of his houses. They would kill the guests and take their valuables; *kapa*, finely woven mats, feathers, and *olonā*... [October 7, 1915]

Unable to get Ka-Miki and Maka-ʻiole drunk, and angered that Ka-Miki discerned his true nature, Kapuʻeuhi leapt to attack Ka-Miki and was quickly beaten and thrown out of his compound onto the *ala loa*. Kapuʻeuhi was startled at his quick defeat, and he feigned friendship with Ka-Miki and Maka-ʻiole. Ka-Miki told Kapuʻeuhi that to live, he and his companions would need to give up their waylaying of travelers. Kapuʻeuhi asked for three days to consider, Ka-Miki agreed.

Kapuʻeuhi then began to plot for revenge, Pōhakuloa refused to help, so Kapuʻeuhi went to enlist the aid of the most feared *ʻōlohe* of Puna's forests; Kaniahiku and her

grandson, Keahialaka. Kaniahiku and her god Kūlilikaua were guardians of the forests of Kali‘u and Malama, damaging the forest greatly angered them. Many people died while traveling in the forests, carelessly breaking plants or loudly calling out, disturbing the silence.

Kaniahiku told Kapu‘euhi to tell Ka-Miki and Maka-‘iole that the guardians of the *‘awa* grove had nearly killed him while he gathered the *‘awa*. She then told Kapu‘euhi to take Ka-Miki and Maka-‘iole to the *‘awa* grove of Mauānuikananuha, where she would cause them to get lost and die. This happened to many who traveled through the Puna forests. And once lost in the forest, there was no way out. Calling out in the forest caused an echo which sounded like a person calling, but following the echo led one deeper into the forest, and this is the reason that the famous saying of Puna came about. Travelers through the forest were warned —

> *E nihi e ka hele mai ho‘opā, mai pūlale i ka ‘ike a ka maka o ako hewa i ka nui o ka lehua, a ho‘opuni ‘ia e ka ‘ino!* (Travel cautiously, being careful not to touch the *lehua*, don‘t rush to see things lest you mistakenly break something and the many *lehua* become offended, causing you to become surrounded by a storm!) [October 21, 1915]

Following Kaniahiku's instructions, Kapu‘euhi led Ka-Miki and Maka-‘iola deep into the forest of Kali‘u, under the pretext of taking them to the *‘awa* grove of Mauānuikananuha. Wandering to and fro, Kapu‘euhi secretly broke *lehua*, *‘ōhelo*, and *kupali‘i* plants as a sign to Kaniahiku of their whereabouts in the forest. Kaniahiku then caused the mist rains and forest envelope Ka-Miki and Maka-‘iole. Kapu‘euhi then abandoned them, and was led to safety by ‘Akialoa, Kaniahiku's dual-formed sister.

Kaniahiku then caused a heavy mist to settle upon them and the forest. The plants also grew in tangled mats, blocking the trail from sight. Ka-Miki and Maka-‘iole called upon the deity forms of *Ka-uluhe* and her god companions to assist them —

Lani-pipili, Lani-‘oaka,	Clinging and flashing heavens*
Lani-ki‘ei, Lani-hālō,	Peering and peeking gods
Lani-kilo, Lani-papanu‘u,	Divining and highest gods
Lani-ka‘ahele, Lani-hāko‘i,	Traveling and agitated gods
Lani-mamao,	God who clears (the heavens),
Lani-Uli-wahine o Nu‘umealani	Uli-wahine of Nu‘umealani
Ia Haumea!	Oh Haumea!
Ia Haumea-nui-a ke aīwaiwa...	Great mysterious Haumea...

Thus the darkening of the sun was ended, *Ka-‘ōnohi-o-ka-lā* caused the mists to recede, and the forest growth withdrew before Ka-Miki and Maka-‘iole, and was scattered as a pathway for their feet. As the forest receded, an *‘auwai* [the name of a wet forest trail] was formed by *Ka-uluhe* and she led Ka-Miki *mā* to the sacred *‘awa* plantation of Mauānuikananuha and Kūlilikaua.

Seeing that Ka-Miki and Maka-‘iole had escaped from her efforts at killing them in the forest, Kaniahiku sent her sister, who possessed the form of an *‘Akialoa* (*Hemingnathus munroi*) bird to have Mauānuikananuha and Kūlilikaua carry the *‘awa* to her compound and hide in her house, where an altar was prepared. Ka-Miki and Maka-‘iole reached Mauānuikananuha before the instructions could be carried out, and Ka-Miki and Maka-‘iole climbed upon the tree-form of the god. Kaniahiku then called to

* These are all names of gods and goddesses of the forests and weather phenomena.

Mauānuikananuha to extend its' body high into the sky, and then fall to the forest, thinking this would kill Ka-Miki and Maka-ʻiole. *Ka-uluhe* caused forest growth to cover Mauānuikananuha, and thus this plan was thwarted as well.

Ka-Miki then captured Kapuʻeuhi and imprisoned him underneath the tangled branching growth of Mauānuikananuha, telling Kapuʻeuhi that he would remain there until Maka-ʻiole and he had their fill of the *ʻawa*. *Kaniahiku t*hen sent her *ʻAkialoa* formed sister to fetch her grandson Keahialaka, in preparation for hand to hand combat [October 28, 1915].

Finding Kapuʻeuhi with Kaniahiku, Ka-Miki confronted him with his treachery, and then securely bound him in the net of his ancestresses... Maka-ʻiole then entangled Kapuʻeuhi in the fallen branches of Mauānuikananuha, where Kapuʻeuhi was left bound… [November 4, 1915]

Ka-Miki went on to defeat Kaniahiku, her grandson, and other famed *ʻōlohe* of Puna as well… [November 11, 1915] …Among the contestants from Puna, was the *ʻōlohe* master, Kahaualeʻa. It was agreed that Kahaualeʻa and Ka-Miki would compete in three contests; *uma* (hand wrestling), *kūpahu* (pushing one's opponent from the arena), and *kūkini* (running) contests. In the *kūkini* contest, Ka-Miki and Kahaualeʻa were required to gather certain famous items to prove that they had actually reached the designated places. These things were:

> The sacred water of the goddess *Waka-keaka-i-ka-wai* and accurately describe the nature of the spring Keakaikaliʻulā and forest of Pali-uli;
>
> A valuable bark-cloth sheet–*kuina kapa ʻŌʻūholowai-o-Laʻa* for which ʻŌlaʻa was famed;
>
> Ten *olonā* (*Touchardia latifolia*) leaves of ʻŌlaʻa;
>
> One of Puna's famed *moena makaliʻi pua hīnano* (fine mesh mats woven from the pandanus flower sheaths); and
>
> To bring back living *ʻoʻopu ʻai lehua* (*Gobidae* fish) of Hiʻilawe and *ʻanae momona* (fat plump rich mullet) which swam in the waters of Pākaʻalana. [January 6, 1916]

Now the lands of Puna are famed for the forest and mist rains called *Uakuahine*. The nature of this place is described by *kamaʻāina* as —

> *Ka noe pōhina i ka uhiwai kokolo iluna o ka lāʻau holo kia-ahi manu pō i ka nahele i ka uka ʻŌlaʻa, a me nā lehua wena o Panaʻewa-nui-moku-lehua ʻōhiʻa kupu-hāoʻeoʻe i ka ua [kani] lehua i ka wī a ka manu a pō e!*
>
> The dark dripping mists crawl above the trees, the birds dart to and fro in the upland forest of ʻŌlaʻa, and the glowing *lehua* blossoms of Panaʻewa-nui-moku-lehua, the sculpted (staggered) *ʻōhiʻa* growth in the *lehua,* rain that resounds with the song of the birds.

The mist laden forests of upper ʻŌlaʻa and Hilo are also described in the mele—

Pō Puna, pō Hilo	Darkened is Puna, darkened is Hilo
Pō wale Hilo e	Indeed Hilo is completely darkened
Pō Hilo i ka uahi o kuʻu ʻāina	Hilo is made dark by the mists of my land
Ola ia kini ke ʻā mai la no i ke ahi...	The multitudes live by the lighting of the fire…

At the outset of the competition, Keahialaka provided the *kapa*, *olonā* leaves, and *moena*, thus eliminating Ka-Miki's need to gather those items. The two competitors then participated in the *uma* and *kūpahu* contests and the roar of the crowd was heard from the shore to the depths of the *waokele*, the upper forests of Kali‘u and Malama. Kahauale‘a was defeated in both of those contests. Then the *kūkini* contest between Kahauale‘a and Ka-Miki began. Ka-Miki was carried to Pali-uli [in the uplands of ‘Ōla‘a and Kea‘au] on *‘Ōhi‘a-nui-moe-awakea* [one of the body forms of Ka-uluhe]. Thus, he arrived at the spring Keaka-i-ka-li‘u-lā which was the dwelling place of Lā‘ie-wai (who came to be called Ka-wahine-i-ka-li‘ulā) and Lā‘ie-lohelohe, the sacred chiefesses and wards of Waka-ke-aka-i-ka-wai and Ka-puka-i-haoa-ka-lā-o-lalo. This was an exceedingly sacred area. Guarded by Waka, it was encircled by rainbows, filled with the songs of *‘i‘iwi,* and *‘ō‘ō* birds, and surrounded by all manner of plants. On the lands around the spring were grown the prostrate sugar cane called *Mikioi-o-lehua*, the bananas called *Mānai-‘ula-i-ka-wao*, the taro called *Pāpākole-koa‘e-o-lele-kea*, and the *‘awa* called *Waimaka-a-ka-manu o Puna*.

Ka-Miki took a leaf of the *pāpākolekoa‘e* taro, and folded it into a cup (*‘a‘apu lā‘alo*) to hold the water…and returned to Pū‘ula *mā*. Ka-Miki presented the water to Pū‘ula and described the beauty of Paliuli to those assembled. Kahauale‘a had been unable to reach Paliuli and the spring of Keakaikali‘ulā, so instead, he brought the water of Wai-uli at ‘Ōla‘a. His deception was detected, because of the dark nature of the water, thus Ka-Miki won this part of the *kūkini* contest… [January 13, 1916]

Ua-kuahine (Elder sister rain – a famous mist rain of the ‘Ōla‘a forest).
Ua-kuahine was an exceedingly beautiful woman who lived in ‘Ōla‘a. One day while traveling on the *ala loa* through the upland forest, to visit the family of her husband in Ka‘ū, a strong storm arose. Uakuahine grasped onto a tree, and her husband held on to a different tree. While waiting out the storm, a traveler held onto the same tree as Uakuahine. He inquired where she was bound on her journey, and she told him Ka‘ū, to visit the family of her husband.

Once the storm passed, Uakuahine's husband killed her in a fit of jealousy and buried her under a *kukui* tree there. Where she was killed, a grove of *kukui* and *‘ōhi‘a* trees grew, and to this day, the forest grove is called *Ka ulu kukui o Ua-kuahine*. As her skin darkened in her grave, the water in the neighboring spring also darkened, and so came to be called Wai-uli (Dark water). Uakuahine herself, was transformed into the mist which clings to the trees in the forest of ‘Ōla‘a, and the thick mist for which the region is famed, is mentioned in *mele* and sayings like —

> *‘Āina holo kia ahi manu ala i ka pō i ka nahele...*
>
> Land where the birds dart to and fro in the darkened forest...

Now during the contest between Ka-Miki and Kahauale‘a, Kahauale‘a was unable to get water from the spring Keakaikali‘ulā at Paliuli, so instead, he brought the water of Waiuli. His ruse was detected, because of the dark nature of the water… [February 3, 1916]

…Following those contests, Ka-Miki and Maka-‘iole befriended Keahialaka, and agreed that he could become their traveling companion. Ka-Miki returned to Kaniahiku and released Kapu‘euhi who was near death. Kapu‘euhi then returned to his compound and with Pōhakuloa, he prepared food for Ka-Miki, Maka-‘iole and Keahialaka. When Ka-Miki, Maka-‘iole and Keahialaka departed from the compound of Kapu‘euhi, they descended the *ala loa* towards Hilo to continue their journey.

> The travelers arrived at a large compound and community, where they saw a man coming towards them with a club. This man was Kūkulu-a-hāneʻe-a-hina-pū [Kūkulu]. Kūkulu was a guardian of the chiefess and lands called Panaʻewa-nui-moku-lehua [Great Panaʻewa of the *lehua* forest]. Panaʻewa was a sacred chiefess of Hilo, the sister of the chiefs Waiākea and Piʻihonua.
>
> The chiefess' compound and surrounding community were forbidden to strangers, and Kūkulu regularly killed unaware travelers [thus the name "Pana-ʻewa" (Unjust place)]. Kūkulu challenged Ka-Miki *mā* but he was quickly defeated, and Ka-Miki left him there as an example to other *ʻōlohe* and to receive his due justice. Ka-Miki *mā* then continued their journey into Hilo, seeking out ʻŪpēloa, Kuʻu-aho-hilo-loa, and Haili-kula-manu, unjust competitors of Waiākea and vicinity… [February 17, 1916].

Bird Catching Techniques of the Ancient Hawaiians

In addition to the references cited earlier, there are a number of traditional accounts describing the arts of the class of people who caught native birds in order to collect their feathers. Several methods of bird catching were widely practiced by native Hawaiians. Except for the account of Pikoi-a-ka-ʻalalā, cited above, most of the early historical accounts recorded in the 1800s tell us that traditionally, the rarer birds, whose feathers were sought for ornamental purposes were not killed by the bird catchers. One account from the later period in the life of Kamehameha I, reported that as a result of growing commercial activities in the islands, traditional methods of harvesting resources and catching birds, were changing. Regarding these changes, and the response of Kamehameha I to careless collection of bird feathers, Kamakau (1961) wrote:

> Troubles that arose were not of his making, and those that had to do with disputes about religion came after his time. He ordered the sandalwood cutters to spare the young trees and, not to let the felled trees fall on the saplings. "Who are to have the young trees now that you are getting old?" he was asked and he answered, "When I die my chief and my children will inherit them." He gave similar orders to bird catchers, canoe makers, weavers of feather capes, wood carvers, and fishermen. These are the acts of a wise and Christian king who has regard for the future of his children, but the old rulers of Hawaii did the same. [Kamakau, 1961:209-210]

While researching various ethnographic records of the Bernice Pauahi Bishop Museum (BPBM), the author reviewed Hawaiian language papers (handwritten and typed) collected by island historian, Theodore Kelsey. Kelsey was born in Hilo in the late 1800s, and spent his entire life speaking with elderly Hawaiian people, collecting their stories, and translating their writings. Among his papers curated at the Bishop Museum (BPBM Archives–SC Kelsey; Box 1.5), are notes on various aspects of Hawaiian culture including bird catching. Kelsey's informant, was the elder Reverend Nālimu, who shared his account of bird catching, both as a means of providing feathers used for making Hawaiian emblems of royalty, and with other birds, as a food source. The account specifically references localities in the uplands of the Hilo District and ʻŌlaʻa, and is a first-hand description of traditional and customary practices which had broad application in the mountain regions.

The following Hawaiian texts are presented verbatim as recorded by Kelsey in c. 1921 (including his use of diacritical marks). The English translation of the Hawaiian narratives was prepared by the author of this study, and reflects the basic tenor of the Hawaiian narratives. It should be noted here, that in the Hawaiian language, occurrences of certain words naturally imply a specific action or statement, which is reflected in the translation:

> ***"AHELE MANU"***
> ***by H.B. Nalimu***
> *Poʻe kia manu o Laa, oia ka poʻe ahele manu, kekahi me ka laau a kekahi me ka lehua. O ka mea ahele manu ma ka lehua malaila ka puka e hanai kokoke i ka lehua, he puka paa ke-ia. Kekahi piko o ke kaula ma ka la-la o ka ʻohiʻa e paa ai. Elima, eono paha*

anana ka lo-ihi o ke aho mai ka puka mai a hiki i ka lima o ke kanaka e paa nei i ka piko o ke aho. A o ka puka aia ma kahi kokoke i ka lehua e kiko aku ai ka manu i ka lehua. I ka wa e lele mai ai ka manu lele no a ku maluna o ke-ia puka e kiko aku i ka lehua. A ia manawa e huki ai ke kanaka i ka piko o ke kaula a paa ka wawae o ka manu. Pii ke kanaka iluna a lawe i ka manu a hana hou aku i kela puka malaila. O ka akakane a me ka ʻiiwi, a me ka ʻo-oʻ iluna o ka pua lehua. Ahele me ke aho olonaʻ makalii. Maluna o ka maiʻa pala e ahele iʻ ai ka manu o-u'.

***"KĀWILI KĒPAU**."*
O ke kepau oia ke kohu o ka ʻulu. E ʻoki-oki ai i ka ʻulu a kahe mai ke kohu keʻokeʻo, a i ka wa e maloo ai ua kohu ʻla i ke ahiahi alaila ua paa aʻe ua kohu la.

Hele oe e ho-ulu-ulu ke-ia kohu a pau. Ho-ulu-ulu a nui, alaila lilo aʻeʻla uaʻ kohu nei i kepau. Alaila hele oe e ʻohi i hookahi kukui maka a hemo kona iwi ʻa ʻo kona ʻiʻo malama 'oe kelaʻ. Hele hou oe i ka' pa-ihi ku-kepau (kind of clover) he pa-ihi ʻele-ele ia, a hoohui me ke kukui maka, alaila nau a wali ke kukui maka me ka pa-ihi. Hookomo iloko o ke kapa wauke (he mea uaua ia), alaila ʻuwiʻ i ka wai o ke kukui a me ka pa-ihi iloko o ka ʻopihi, oia ka "ipuhao" e kupa ʻai iluna o ke kapuahi. I ka wa e hoomaka ai e paila alaila ʻoki-oki i ke kepau a liilii a hookomo iloko o ke-ia wai kukui me ka pa-ihi i paila ia. Kii elua ni-au ai ʻole ia, mau laau liilii paha e koali ai iloko o ke-ia wai paila.

Pela e hanai a pau kelaʻ wai a moʻa kelaʻ kepau. Hookomo iloko o ke poho ʻopihi a i ʻole he la-iʻ a wahi i ka la-iʻ. Kāwili ʻiuka a'e nei o Mokau-lele. Neenee ke pulu ʻohiʻa o ia wahi ilalo o ka pahoehoe.

Ilalo no oe e ku ai o ka pahoehoe a hana oe i ke kepau iluna o ka pua lehua. Ina ekolu, ehaʻ pua lehua au i kāwili ai i ke kēpau alaila i ka wa e pili ai kekahi pua lehua i ka manu alaila alualu a loaa. Pee hou oe iloko o ka pulu ʻohiʻa (kāhi o ka lau ʻohiʻa e luhe ana ilalo, oia ka pulu ʻohiʻa) a pili hou kekahi manu. Opaʻ ke poo o ka manu a make. Hookomo iloko o kekahi eke. Hola ekolu paha alaila hoʻi, nui ka manu, i hookahi kaau, iwakalua, kanakolu paha. A kela manu makalii; ua momona——kuhikuhi kona iʻo, momona. Oia ke kāwili kēpau.

***"LAAU KIA MANU**."*
Ekolu, ehaʻ paha anana ka lo-ihi o ka laau. Kau ia ka pua lehua iluna o ia laau nei mai kekahi ʻao-ao o ka laau a hiki i kekahi poo o ka laau. Hana elua kanaka, kekahi ma kekahi laau a kekahi ma kekahi. Kepau maluna o ka laau a he mau pua lehua mawaena o ke-ia mau kēpau——he laau kia manu ia |_____|. Olaa ka aina kia manu a me Piihonua. Nui ka manu o-oʻ ma Puu O-oʻ. Malaila ka poʻe kia manu e hele ai a loaa na lei hulu no na lii. O Pana-ʻewa kekahi wahi kia manu.

Huki ka laau kia manu iluna mawaena o na ʻohiʻa elua. Hana me ka ʻupena kekahi. Huki ia iluna ka ʻupena, hookahi laau maluna, hookahi laau malalo. He ʻupena ʻolonaʻ maka hakahaka, a he kaula ʻolonaʻ ma na poo. ʻElima, ehaʻ, ekolu paha anana kela' ʻupena palupalu. Lele no ka manu, paa ka wawae, paa ka pekekeu. Inaʻ hookahi, elua manu, waiho no pela', oia na manu e kahea ana i na manu e aʻe. Nui ka manu, hookuu ilalo ka ʻupena a huki hou iluna. He ulu ʻohiʻa ma kekahi ʻao-ao a me kekahi ʻao-ao. Oia ka hana ana o ka poʻe lawaiʻa manu. Hoʻi i ka hale e wehe ai ka hulu o ka manu ʻo-oʻ. Piha ke poʻi i ka hulu a haku lei. Malalo o ka po-ae-ae o ka o-oʻ oia ka hulu a-aʻ, a maluna o ka piapia oia me pue.

Bird Snaring (or Trapping)
Bird catchers (*kia manu*) of ʻŌlaʻa were people who snared (*ʻāhele*) birds. Some with branches and others with *lehua* blossoms. The individual who snared birds among the *lehua* made a snare (lasso) close to the *lehua* flower, the snare was secured there.

One end of the line was securely fastened on the branch of the *ʻōhiʻa*. The cord of perhaps five or six fathoms long, extended from the lasso (on the branch) to the man's hand where the end of the line was held tightly. The snare was placed close to a *lehua* blossom, where the bird would step (*kīkoʻo*) to the *lehua*. At that time, the man would then pull the end of the cordage and secure the feet of the bird. The man then climbed the tree, took the bird, and he would make the snare there again. The *ʻakakane* (*ʻapapane*), the *ʻiʻiwi*, and the *ʻōʻō* were caught up in the *lehua*, snared with fine *olonā* cordage. The *ʻōʻū* bird was snared while it was on the ripe banana fruit.

Preparing Bird Lime to Kāwili, or Ensnare Birds.
The bird lime (*kēpau*) is made from the sap of the breadfruit. Cut the breadfruit bark and the white sap flows, and when the sap is dry, say in the evening, the sap is hardened. You go and gather the sap. When enough has been gathered, the sap can be made into bird lime. Then you go and gather some raw *kukui*, removing the shell, you keep its meat. You then go and get the "clover" for making bird lime (*ʻihi-ku-kapu*, the *Nasturtium sarmentosum*), it is a black *pāʻihi*, and you mix it with the raw *kukui*. Then you chew it, and the *kukui* and *pāʻihi* become slimy. This is put into a *wauke* bark cloth (it is a tough piece), then the juice of the *kukui* and *pāʻihi* are squeezed into the *ʻōpihi* (shell), it is the "pot" for cooking the broth over the fire. When it starts to boil, the (*ʻulu*) gum is cut into small pieces and put in the juice of the *kukui* and *pāʻihi* so it can boil. Then get two coconut mid-ribs or perhaps little sticks to stir this boiling juice. This is how it is done until the juice is cooked and becomes the birdlime. It is then placed into the empty *ʻōpihi* or a *ti* leaf, wrapped up in *ti* leaves. Kāwili is in the uplands adjoining Mokaulele. Then go to where there is low branching *ʻōhiʻa* (*pulu ʻōhiʻa*), where the *pāhoehoe* is below.

You are below on the *pāhoehoe*, and you apply the bird lime above around the *lehua* flowers. Now you *kāwili* (twist, i.e. apply) this bird lime in among three or four *lehua* flowers, then when a bird is stuck by one of the *lehua* that blossoms, you free it and it is caught. You then hide again among the low *ʻōhiʻa* branches (a place where the *ʻōhiʻa* tops droop down, that is the *pulu ʻōhiʻa*), and catch another bird. You squeeze the birds head and it is killed. It is placed into a bag. Returning (home) perhaps around three ʻo clock, there are many birds, perhaps forty, twenty, or thirty. Those small birds; when fat——the meat is tasty and sweet. That's how one prepares *kawili kēpau*, or bird lime to ensnare birds.

Snaring Birds on Branches.
The (decoy) branch is perhaps three or four fathoms long. *Lehua* blossoms are placed on this branch, from one side of the branch up to the tip of the branch. Two men do this job, one at one (end of the) branch and one at the other. Bird lime is placed on top of the branch along with many *lehua* blossoms in between this bird lime——this is a bird catchers (*kia manu*) branch [drawn] |_____|. ʻŌlaʻa and Piʻihonua are lands of bird catchers. The are many *ʻōʻō* birds at Puʻu ʻŌʻō. It is there that the bird catchers go to get the feathers for adornments (*lei*) of the chiefs. Panaʻewa is also a place of the bird catchers.

The bird catchers (decoy) branch is pulled in between the *ʻōhiʻa lehua* trees. One (person) uses the net. The net is pulled up, one branch is above, one branch is below. It is an open (wide) meshed *olonā* net (*ʻupena olonā maka hakahaka*), and *olonā* cordage at the tip. It is a soft (pliable) net perhaps five, four, or three fathoms long. As the birds fly their feet are caught, or their wings caught. Now if there are one or two birds, they are left, these are the birds that call out to the other birds. When there are many birds the net is let down (the birds taken), then the net is pulled up again. *ʻŌhiʻa* growth is all around. So this is the work of the "bird-fishers," or *lawaiʻa manu*. They return to the house and then remove the feathers of the *manu ʻōʻō*. When the container

> is filled with feathers, a *lei* is made. Below the wing-pit is where the male *ʻōʻō* bird feathers are, and above on the back by the tail, are the pale yellow feathers. [Nalimu in Kelsey; Bishop Museum , Archives–SC Kelsey; Box 1.5; Maly, translator]

One additional tradition collected by Kelsey in 1921, references named locations in the uplands of Waiākea. Kelsey's aged informant, Reverend Henry B. Nalimu, who was born in Hilo in 1835, shared with him his recollections of ʻĪ-hālau (the long house of the chief ʻĪ):

> I, a relative of Rev. Nalimu's, constructed the ditch of I-auwai…
>
> I-halau, the great long house of I, was *mauka* of Waiakea, near Pooholua and *mauka* of that place. Rev. Nalimu has only heard of the place. He thinks that it is in the forest. When the occupants of I-halau finished a meal they slammed the covers down onto their calabashes in unison so that the report could be heard at I-koʻa, the fishing-grounds of I where he fished for *ahi*. The location of this *koʻa* was obtained by bringing into line the coconuts of Papaʻi and the Cape of Anapuka (ka lae o Anapuka) on the Puna side, and on the Hilo side, the coconuts of Kau Maui (near Keaukaha), and the cape of Kiha… [Kelsey notes, 1921; in collection of June Gutmanis]

THE MAUNA LOA MOUNTAIN LANDS OF THE ʻŌLAʻA, WAIĀKEA AND KEAUHOU VICINITY DESCRIBED BY VISITORS OF THE HISTORICAL PERIOD (1794-1875)

Because the lands of the upper ʻŌlaʻa and Waiākea region were remote, it appears that access was most frequently made by specialists in the collection of bird feathers, the makers of canoes, and collectors of other unique items for which the region may have been known. Except for the detailed narratives of the tradition of Pikoi-a-ka-ʻalalā, most other traditions, and early historical accounts by native Hawaiians, seem to place the routes of travel beyond the limits of the lands within the Puʻu Makaʻala NAR. The main routes being out of Hilo through ʻŌlaʻa, *mauka*, near its boundary with Keaʻau, or *mauka* between Kīlauea, across Keauhou (of Kapāpala in Kaʻū), within view of the boundary between ʻŌlaʻa (Puʻu Kūlani), and out across the Waiākea and Humuʻula lands of the Hilo District. Thus, there appears to be little specific reference in the historical record to the immediate study area lands.

From the journals, letters, and articles of historic visitors traveling the routes mentioned above, we are given a glimpse into the nature of the landscape, and a record of changes thereon, with the passing of time. As outlying lands were changed—resulting from the impacts of introduced grazing animals, and in some instances from lava flows of Mauna Loa—we develop a sense of why the Puʻu Makaʻala NAR is important to the future well-being of the Hawaiian natural environment. The NAR is a remnant of the unique cultural and natural landscape as described in the traditional accounts.

The narratives below, date from 1794 to 1875, and are the first-hand records of observations and travel across the mountain lands and in the forest adjoining the Puʻu Makaʻala NAR.

First Foreigner Ascends Mauna Loa in 1794

In 1793-1794, botanist, Archibald Menzies visited Hawaiʻi with Captain Vancouver, during which time Menzies and crew members walked inland with native guides to botanize and take readings of the topography. While ascending Mauna Loa, Menzies observed that the Hawaiians kept "*Morai*" (*heiau* – ceremonial sites) along the trails in the forests and up the mountain, at which they regularly stopped in prayer and to make offerings (Menzies 1920:85). The following excerpts from Menzies notes describe this practice:

> ***Forest Shrines***
> "So bigoted are these people to their religion that here and there, on the sides of the path, they have little Morais, or spots consecrated to their Deity, which none of them ever pass without leaving something—let it be ever so trifling—to obtain his good will, and they were highly delighted, indeed, when we followed their example in throwing a nail or a few beads, or a piece of tapa, before their Deity, which the women were not allowed to pass without uncovering their breasts and shoulders." [Menzies 1920:85]

From Kapāpala, Menzies and party traveled *mauka* of Kīlauea, and from there, they cut across the mountain lands, to begin their ascent of Mauna Loa. Menzies narratives provide readers with the first written account of the forest lands and nature of Mauna Loa:

> ***Kapapala.***
> Though we had much reason to be satisfied every step we went, with the kind attentions and unbounded hospitality of the natives, yet we could not help being now a little out of temper with them at the great distance they were taking us as it were round the foot of the mountain, till in the afternoon we reached a fine plantation called Kapapala, belonging to the king, from which they told us we were to as- [page 187] cend the mountain. As the chief had here to provide his last supplies of provisions for our journey up, we were obliged to stop for the night to allow him some time for that purpose…

…We were now within a few miles of the volcano, of which there seemed to be this day a considerable eruption, and as the wind blew from that direction, the smoke, dust and ashes arising from it proved very troublesome to our eyes in travelling with our faces towards it.

February 13th. Before we set out on the morning of the 13th, I observed the barometer at eight, when the mercury stood at 28 in. 20 pts., which made our height at this place 1800 feet above the level of the sea. The thermometer was at the same time 67 degs.

After breakfast, everything being got ready, and the party arranged, we continued our march through the plantation for two or three miles further, and then began our ascent up the south-east side of Mauna Loa in an easy slanting direction, passing through groves of trees and clear spots alternately by a narrow rugged path without meeting any more cultivated ground after we quitted the plantation of Kapapala, or any houses till towards sunset, when we came to two or three old huts where our guides told us we must encamp for the night. The chief no longer depended on his own knowledge of the path, but brought men with him from the last plantation to conduct the whole party up the mountain, which now lay between us and Kealakekua. We had the volcano to our right most part of this day and in the forenoon the smoke and ashes arising from it made [page 188] the air very thick, which at times proved very tormenting to our eyes.

At sunset the thermometer was at 54 degs., and the barometer stood at 26 in. 50 pts., which made our height from the sea 3,510 feet.

February 14th. At sunrise next morning the thermometer was so low as 41 degs… …the air was at this time so chilly that the natives complained so much of the cold that we did not stir from the place of our encampment till after breakfast, when we again set forward up the mountain in a reversed oblique direction to what we came the day before, but in so winding and circuitous a manner and through such pathless and rugged tracts, avoiding the clumps of forest here and there, that, had we not good guides with us, we should have met with insurmountable difficulties.

We had sight now and then of the lower edge of the snow which did not appear to be far above us… Towards evening, we reached the upper verge of the forest nearly over Kapapala, where we encamped for the conveniency of having wood at hand to burn and erect our huts with… Near our encampment [page 190] I found a large beautiful species of *Vicia*[128] clambering up amongst the thickets in full bloom.

Reaches the Upper Edge of Forest.

Being now at the upper edge of the forest I observed the barometer at six in the evening, when it stood at 23 in. 73 pts., which is equal to 6,500 ft. in altitude. This may be considered the height at which the wood ceases to grow upon the sides of this immense mountain. The thermometer observed at the same time was at 41 degs., and as we had heated ourselves a good deal in this day's march up the mountain, we felt the air after sunset remarkably chilly and cold, which induced us to keep large fires burning near our huts the whole night. Notwithstanding this precaution, many of the natives were so restless with the cold and continued coughing that they enjoyed very little repose, and not indeed without cause, for when we got up next morning, the thermometer was at 28 degs, and the grass which grew about our huts was so stiff and whitened with hoar frost, and the earth that was in anywise moist or swampy was encrusted with icy concretions about our encampment. The frost must therefore have

[128] *Vicia Menziesii*, Sprengel, or V. *grandiflora* Smith. This species of legume has not been found by modern collectors.

been keen during the night time, and from this circumstance I think we may consider the upper edge of the wood as the lower line of congelation upon this mountain. Meeting with it so low down as we here did and that, too, on a tropical mountain so closely surrounded by the mild temperature of sea air, will no doubt stagger the belief of those who have been led to consider the lower line of congelation within the tropics; and having a much greater altitude even in continental regions which are always allowed to be colder than islands of moderate size. [page 191]

Natives Unwilling to Proceed.
February 15th. The natives, who were all barefooted, could not stir out of their huts in the morning until after breakfast, when the cheering influence of the sun dispersed the frost, but they greatly dreaded its consequences further up the mountain where they said that the cold was so intense that it would certainly kill us and them, too, and they described its effects by contracting and shivering themselves and cautioning us very strongly against going higher up or exposing ourselves or them to such danger. Even the old chief Luhea was so strongly prepossessed of this opinion that he now entreated us in the most earnest manner to relinquish the idea of going higher, for that he and several others were already nearly overcome with the fatigue of the journey and that the cold of the mountain would kill them… [Menzies, 1920:192]

On February 16th, 1794, Menzies and party arrived at the summit of Mauna Loa, the first foreigners to do so. It was not until January 1834, that another foreigner would again reach the summit of Mauna Loa.

Waiākea Described in 1823
Following the death of Kamehameha I in 1819, the Hawaiian religious and political systems began undergoing radical changes. Just moments after his death, Ka‘ahumanu proclaimed herself “*Kuhina nui*” (Prime Minister), and approximately six months later the ancient *kapu* system was overthrown in chiefly centers. Less than a year after Kamehameha’s death, Protestant missionaries arrived from America. In 1823, British missionary William Ellis and members of the American Board of Commissioners for Foreign Missions (ABCFM) toured the island of Hawai‘i seeking out communities in which to further the work of the growing Calvinist mission.

During the visit, Ellis and his companions traveled around the island and upon portions of the mountain lands. While Ellis and his party did not travel the *mauka* route between Mauna Kea and Mauna Loa to Kīlauea, Ellis did write about the mountain lands as described by others he’d spoken with:

Few Inland Settlements
There are a few inland settlements on the east and north-west parts of the island, but, in general, the interior is an uninhabited wilderness.

The heart of Hawaii, forming a vast central valley between Mouna Roa, Mouna Kea, and Mouna Huararai, is almost unknown, no road leads across it from the east to the western shore, but it is reported, by the natives who have entered it, to be "bristled with forests of *ohia*," or to exhibit vast tracts of sterile and indurated lava.

The circumstance of large flocks of wild geese being frequently seen in the mountains, would lead to the supposition that there must be large ponds or lakes to which they resort; but if any exist, they have hitherto remained undiscovered… [Ellis, 1963:4]

Travel Across the ‘Ōla‘a-Humu‘ula Uplands in 1830
In 1830, Reverend Hiram Bingham and family visited Waimea, and in September they were joined by members of the royal household for a visit to Mauna Kea. During the same visit, a trip was made to

Kīlauea, and Binghams' journal includes as description of the journey over land to the plateau lands between Mauna Loa and Mauna Kea, on their way back to Waimea.

> …After spending about thirty hours at Pele's chief seat, we set off, towards evening, on the 21st, to cross the wilderness to Waimea, which required the time of a little more than two days and two nights. Walking till late, we laid ourselves down where we could find a place. The next day we continued our journey northwardly, towards Mauna Kea, lodging out in the wilderness, in the same manner, at night, the majestic mountain being half a day's walk to the north of us.
>
> Rose at four o'clock from our mountain couch, — a day's journey from any human habitation; saw lightning at a great distance at sea – our elevation being 4000 or 5000 feet; packed our sleeping *kapa*; offered our morning sacrifice in these solitudes of the centre of Hawaii, and as the day dawned, set forward on our journey. We passed over several large tracts of lava, of different kinds, some smooth, vitreous, and shining, some twisted and coiled like huge ropes, and some consisting of sharp, irregular, loose, rugged volcanic masses, of every form and size, from an [page 393] ounce in weight, to several tons, thrown, I could not conceive how, into a chaos or field of the roughest surface, presenting a forbidding area, from one to forty square miles in extent, and though not precipitous, yet so horrid as to forbid a path, and defy the approach of horses and cattle. In the crevices of the more solid lava we found the *ohelo*, somewhat resembling the whortleberry, nourished by frequent showers and dew. At ten o'clock, we halted for breakfast; raised a smoke, as a signal for the horse keeper, at the watering-place, at the south base of Mauna Kea, to approach, and moved on, till twelve o'clock, when I was very glad to see and mount the horse sent over from Waimea to meet me… [Bingham, 1969:394]

The Mauna Loa Mountain Lands Described by David Douglas (1834)

Scottish Naturalist, David Douglas toured the interior lands on Hawai'i in 1834, and also traveled to the summits of Mauna Kea and Mauna Loa. After a visit and observations at Kīlauea, Douglas traveled to Kapāpala, and made preparations for the ascent of Mauna Loa. The route traveled took Douglas *mauka* of the lands that now make up the Pu'u Maka'ala NAR, and on to the summit of Mauna Loa. Excerpts from Douglas' narratives, published in the Hawaiian Spectator in 1839, provide readers with a description of the lands traveled through, the nature and make up of the forest; and the presence of native dwellings for bird catchers:

> …Tuesday, January the 28th. I hired two guides the elder of whom, a short stout man, was particularly recommended to me by the chief for his knowledge of the mountain. By profession he is a bird-catcher, going in quest of that particular kind of bird which furnishes the feathers of which the ancient cloaks, used by the natives of these islands, are made. The other guide was a young man. Three volunteers offered to accompany me; one a very stout fat dame, apparently about thirty, another not much more than half that age, a really well looking girl, tall and athletic: but to the first, the bird-catcher gave such an awful account of the perils to be under-gone, that both the females finally declined the attempt, and only the third person, a young man went with me. My original party often, besides Honori and the two guides, set out at light, with as usual, a terrible array of taro, calabashes full of *poi*, sweet potatoes, dry *poi* tied up in Ti-leaves, and goats flesh, each bearing a pole on his shoulder with a bundle at either end… [page 418] …Among my attendants was one singular looking personage, a stripling, who carried a small packet of instruments, and trotted away, arrayed in a Cutty-Sark of most "scanty longitude," the upper portion of which had once been of white, and the lower of red flannel. Honori brought up the rear with a small telescope slung over his shoulder, and an umbrella, which owing perhaps to his asthmatic complaint, he never fails to carry with him, both in fair and foul weather.

We returned for about a mile and a half along the road that led to the Great Volcano, and then struck off to the left in a small path that wound in a northerly direction up the green, grassy flank of Mauna Roa. I soon found that Honori's cough would not allow him to keep up with the rest of the party, so leaving one guide with him, and making the bird-catcher take the lead, I proceeded at a quick rate. This part of the island is very beautiful; the ground, though hilly, is covered with a tolerably thick soil, which supports a fine sward of Grass, Ferns, climbing plants, and, in some places, timber of considerable size. *Koa*, *Tutui*, and *Mamane* trees. Though fallen trees and brush-wood occasionally intercepted the path, still it was by no means so difficult as that by which I had ascended Mauna Kea. To avoid a woody point of steep ascent, we turned a little eastward, after having traveled about five miles and a half, and passed several deserted dwellings, apparently only intended as the temporary abodes of bird-catchers and sandal wood-cutters. Calabashes and Pumpkins, with Tobacco, were the only plants that I observed growing near them. At eleven, A.M., we came to a small pool of [page 419] fresh water, collected in the lava, the temperature of which was 55º; here my people halted for a few minutes to smoke. The barometer stood at 26 inch., the air 62º, and the dew point 58º. The wind was from the south, with a gentle fanning breeze and a clear sky. Hence the path turns north-west, for a mile and a half, becoming a little steeper, till it leads to a beautiful circular well, three feet deep, flowing in the lava, its banks fringed with strawberry vines, and shaded by an *Acacia*-tree grove. Here we again rested for half an hour. We might be said here to have ascended above the woody country; the ground became more steep and broken, with a thinner soil and trees of humbler growth, leading towards the south-east ridge of Mauna Roa, which, judging from a distance, appeared the part to which there is the easiest access. I would recommend to any Naturalists who may in future visit this mountain, to have their canteens filled at the well just mentioned, for my guide trusting to one which existed in a cave further up, and which he was unable to find, declined to provide himself with this indispensable article at the lower well, and we were consequently put to the greatest inconvenience.

Among the brushwood was a strong kind of Raspberry bush, destitute of leaves; the fruit, I am told, is white. At four P.M. we arrived at a place where the lava suddenly became very rugged, and the brush wood low, where we rested and chewed sugar-cane of which we carried a large supply, and where the guides were anxious to remain all night. As this was not very desirable, since we had no water, I proceeded for an hour longer, to what might be called the Line of Shrubs, and at two miles and a half further on encamped for the night. We collected some small stems of a heath-like plant, which with the dried stalks of the same species of *Compositoe* which I observed on Mauna Kea, afforded a tolerably good fire. The man who carried the provisions did not make his appearance—indeed it is very difficult except by literally driving them before you, to make the natives keep up with an active traveler… [Douglas, 1839:420]

The United States Exploring Expedition, 1840-1841

In 1841, members of the United States Exploring Expedition, under the command of Charles Wilkes, accompanied by a party of native Hawaiians and foreign residents (numbering nearly three hundred individuals) traveled to the summit of Mauna Loa. The party departed from Waiākea, traveled *mauka* through ʻŌlaʻa, and on to Kīlauea. Observations and exploration were undertaken at Kīlauea, and then the party traveled through Keauhou, *mauka*, along the forest above the ʻŌlaʻa Forest Reserves and Puʻu Makaʻala NAR, and on to Mauna Loa. The following narratives are excerpted from Wilkes' account of departure from Kīlauea, and journey to the Mauna Loa summit:

At dawn on the morning of the 18th, the signal called us to make preparations for our journey, and as all things had now been more systematically arranged, we anticipated less difficulty in our onward journey. The natives seemed to be all in good spirits, and

moved with alacrity… The water that I have mentioned as being found in the small pools, the product of condensation, was exhausted before we left the crater. This was in consequence of the natives having filled their calabashes; and we had particularly instructed our servants and the sailors to do the same. The former provided themselves; but the latter, sailor-like, preferred to take their chance of meeting with it on the road, rather than carry a load for their future supply. I discovered, after we started, that they were unprovided, but was informed that there was, within about two miles, an old canoe which would be found full of [page 130] water. On our arrival at it, we found that the natives, who had preceded us, after supplying themselves had emptied out the rest.

Our route was taken at first and for a few miles in a due west line, for the top of Mauna Loa, over the extensive plain surrounding the volcano; it then deviated to the southward, over an ancient lava-bed, very much broken, that appeared never to have been traversed before. We now became for the first time acquainted with clinkers. To describe these, it is merely necessary to say, they are like the scoria from a foundry, only instead of being the size of the fist, they are from one to ten feet square, and armed on all sides with sharp points; they are for the most part loose, and what makes them still more dangerous, is that a great deal of the vitreous lava is among them. Of the origin of these immense masses and their extent, I shall have occasion to speak hereafter; suffice it for the present to say, there never was more difficult or unpleasant ground to travel over.

Our guide Puhano of Puna, who we understood had accompanied Douglass and Lowenstern on their ascents, now took the lead, but it soon appeared that he knew little of the route. I therefore, in company with Mr. Brinsmade, took the lead, compass in hand; and after walking over the broken and torn-up ground, we turned again towards the hill-side, and began a rapid ascent through a belt of long grass, where the rock was covered with white clay, and seldom to be seen. This part appeared to have suffered much from drought; for in passing along we came to several narrow and dry water-courses, but met with no water.

At two o'clock we had nearly reached the upper limit of the woods, and as the clouds began to pass over, and obscure the path, we determined to halt and encamp. We made several fires along the route, in order to guide those behind, and as a mark for the stragglers; bushes were also broken off, and their tops laid in the direction we were going, by the natives; and I likewise had the trees blazed, as a further indication, well known to our men. Chronometer sights were taken here, and the altitude by barometer was five thousand and eighty-six feet.

During the day, the reason that had induced the natives to empty the water out from the canoe, became evident in their anxiety to sell us water. My friend the consul had hired an especial bearer for his calabash of water, determining that he would have a sufficient supply. By our watching and cautioning the old man who had it in charge, he became somewhat alarmed and unsteady, as I thought also from fatigue. When he had arrived within a short distance of the camp, he stumbled on a smooth place, fell, and broke the calabash into numerous pieces. Those who were coming up, seeing the accident, rushed to partake of its contents, but the fluid quickly disappeared in [page 131] the loose and absorbent lava. This was a dreadful blow to my friend's feelings, and produced much laughter among us, in which the consul himself at length joined; although I must confess I was somewhat of his opinion, that it had been done designedly, either to secure the sale of that belonging to others, or to get rid of the load, which had been a great annoyance and trouble to the bearer all day, and for which he had already been paid…

> We were now for a long time enveloped in mist, for we had reached the region of clouds. The thermometer at 6 P. M., stood at 54°; the dew-point at 44°. Instead of trade-winds from the northeast, we had a mountain breeze from the west, which caused the temperature to fall to 43°, and produced a feeling of great cold, being a fall of forty degrees since we left the coast… [page 132]
>
> At sunrise on the 19th, we had the temperature at 48°.
>
> As the ascent was now becoming laborious, we selected and left the things we had no immediate use for, to follow us by easy stages. We then took a diagonal direction through the remaining portion of the woods. By one o'clock we had lost all signs of trees, and were surrounded by low scraggy bushes: the change of vegetation became evident, not only in species, but in size; we also passed through extensive patches that had been destroyed by fire. Sandalwood was seen, not as a tree, but a low shrub.
>
> During the day we had passed extensive caves, in all of which I had search made for water. These often lead a long distance under ground, and some of the men passed in at one end and out at another.
>
> Intending to stop on Sunday not far above these caves, calabash-tops were left in one or two where water was found to be dropping, in hopes by this means to procure a small supply; but on returning the next day, it was found that very little had accumulated. These caves or tunnels had apparently been caused by a flow of lava down the side of the mountain, which on cooling had left the upper part arched or vaulted, the fluid running off at its lower extremity or opening and spreading itself over the surface. The opening into them was formed by the roof having fallen in, and partly blocked up the tunnel. At no great distance from the opening, the floor on each side was smooth and closely resembled the flow of the lava on the surface. These openings were usually known by the quantity of raspberry and other bushes around them; and they reminded me of the caverns in limestone districts… [Wilkes, 1970:133]

The landscape of the mountain lands was again described by Wilkes, when his party descended from Mauna Loa, returning to Kilauea:

> …. After a rest of two hours, and obtaining new shoes, we went on and reached the Sunday Station at five o'clock, scarcely able to drag one foot after the other. Here we were soon enveloped in mist, and found the soft and delightful temperature of spring. I cannot venture to describe the effect this produced on us after our three weeks' sojourn on the cold, bleak, and barren summit. I felt for the first time in my life fairly broken down, and almost past the soothing effects of the *loomi-loomi*, which the natives at once offered as a relief to me: it may be called a lesser shampooing, and consists, as practiced in the Sandwich Islands, of a gentle kneading of the limbs, which has a great tendency to restore the circulation, and relax the muscles and joints. The natives use it for rheumatism, headache, and all kinds of pains. It requires some skill to do it well, and there is the greatest difference in the performance between persons who are practiced in it and those who are not. The chiefs generally have two persons employed at the same time. We soon had a good fire made before our Hawaiian hut; its warmth, together with an excellent supper, made us comfortable, and we were soon asleep on the dried grass.
>
> The next morning, when I awoke, all nature seemed to be alive: the [page 166] songs of the birds, the cheerful voices of the natives, were delightful; the green foliage gave everything an air of spring. We were so stiff as scarcely to be able to move, which was all that now remained to remind us of the scenes we had left, and the fatigues we had undergone. When we again set off, it was amusing to see the whole party moving

along with their stiff and aching limbs, trying to appear but little fatigued. At twelve o'clock we reached the station where he had abandoned our chairs, and I never was more relieved than when I reached mine, for I was quite unable to walk any further. Here, also, we were met by the natives with fruit; indeed, every step we took seemed to be restoring us to the comforts of life. Late in the afternoon of the 14th we reached the crater of Kilauea, after an absence of twenty-eight days, eight of which had been consumed in travelling, six in going up and two in returning from the summit… [Wilkes, 1970:167]

Travel to Kīlauea and the Mountain Lands (1875)

In 1875, Henry M. Whitney, editor of the Hawaiian Gazette, published a "Hawaiian Guide Book." The publication was produced as one of the early promotional guides to encourage visitation to the Hawaiian Islands, and included descriptions of the islands, harbors, agriculture, plantations, scenery, volcanoes, climate, population, commerce, and places to stay while visiting. His publication of 1875 provides readers with interesting commentary on travel via the old roadways from Hilo, via ʻŌlaʻa Village and the half-way house (presumably Hawelu's half-way house), to Kīlauea.

To The Volcano Kilauea [1875]

Two routes may be taken to the crater Kilauea, on the slope of Mauna Loa, one by Puna, the other by Olaa. It will be advisable to combine both, by going one way and returning the other. Time being an object, the trip to and from the crater via Olaa can be accomplished in three days, which will give one day and two nights at the volcano house… [Whitney 1875:78]

…The short route to Kilauea Crater, leads out of Hilo [page 80] village by Volcano street, adorned with white cottages… The road soon becomes densely fenced with the *ohia* bushes, then crosses the end of the famous Waiakea fish ponds and only fairly starts in the wilderness after passing Gov. Lyman's cattle ranch in Waiakea. It is no macadamized thoroughfare and will try the patience of most travelers. Ten miles bring the traveler into the magnificent woods…

Fifteen miles from Hilo Olaa is reached, the half-way stopping place. The intermediate territory is covered with *ti* plants and ferns, while the road consists mostly of *pahoehoe* lava, covered with bunch grass and occasional bushes and trees.

"The Half-way House" at Olaa is merely a cluster of grass houses, a passable rest for visitors… Although this point is 1138 feet above the sea level, and ten miles from Keaau, (the nearest point on the sea shore) the roar of the sea may be distinctly heard during a heavy surf. Leaving Olaa, the route is over *pahoehoe* in all its varieties, thickly covered with wild grass, straggling ferns, creeping vines, and that vegetation which in tropical lands seeks only water to become impenetrable. Fires have swept over parts of the adjoining land and the blackened rocks with their scant supplies of soil, demonstrate how little alluvial earth nature requires to run wild, when it has plenty of light, warmth and moisture. [page 81]

Here the ascent hitherto very gradual becomes more rapid, reaches into a second rim of *Koa* woods, becomes more level and after a short gallop, the traveler finds himself, (eight hours from Hilo,) on the brink of the famous crater, and, four thousand feet above the level of the sea, dismounts from his tired animal and enters the Volcano House… [Whitney 1875:82]

Whitney's narratives continue, describing travel around and through Kīlauea, and he then references the ascent of Mauna Loa. The route being across Keauhou, *mauka* of the lands that make up the ʻŌlaʻa Forest Reserve and Puʻu Makaʻala NAR. (Whitney 1875:93-95).

THE WAIĀKEA-ʻŌLAʻA FOREST LANDS DESCRIBED IN LAND TENURE DOCUMENTS, SURVEY RECORDS, AND GOVERNMENT COMMUNICATIONS

The most detailed historical descriptions of the Waiākea and ʻŌlaʻa forest lands, and of neighboring Keauhou, including documentation of traditional and customary rights, are those found in the Kingdom collections, documenting the history of land tenure, and defining the boundaries of *ahupuaʻa* in the Hilo, Puna, and Kaʻū Districts. This section of the study presents readers with the laws of the Hawaiian Kingdom, which established fee-simple land ownership and codified native tenant rights. Subsequent to the definition of land rights, the Kingdom set about the processes to determine the metes and bounds of the lands which had been granted in fee-simple interest to various parties. As a result, detailed oral testimonies from elder native tenants were taken in court proceedings, which further documented the occurrence of traditional and customary practices, and nature of the resources within given *ahupuaʻa*. In those records, which follow below, we learn of the traditional knowledge and occurrence of native practices in the lands which today are a part of, and adjoin the Puʻu Makaʻala NAR.

The Māhele ʻĀina (Land Division) of 1848

In Hawaiʻi prior to western contact, all land, ocean and natural resources were held in trust by the high chiefs (*aliʻi ʻai ahupuaʻa* or *aliʻi ʻai moku*). The use of land, fisheries and other resources was given to the *hoaʻāina* (native tenants) at the prerogative of the *aliʻi* and their representatives or land agents (*konohiki*), who were generally lesser chiefs as well. By 1845, the Hawaiian system of land tenure was being radically altered, and the foundation for implementing the *Māhele ʻĀina* (a fee-simple right of ownership) was set in place by Kauikeaouli (Kamehameha III).

Following implementation of the *Māhele*, the King also initiated a land grant program, issuing fee-simple "Royal Patents" on granted land. In addition to the sale of fee-simple interests in land, the Crown and Government lands were also made available for leases and, in some cases, for sale. Together, these three land programs opened the door for the development of the large ranching interests in the lowlands below ʻŌlaʻa and Waiākea, and on the Keauhou-Kapāpala forest lands. Because of the remote nature of the lands and dense forests of the ʻŌlaʻa-Waiākea lands that make up the Puʻu Makaʻala NAR, no leases or conveyances were recorded for those lands. This said, it is likely that Hawaiian visitation collection of resources associated with traditional and customary practices continued in the Puʻu Makaʻala NAR lands for some time through the middle to late 1800s.

On December 10th, 1845, King Kamehameha III (Kauikeaouli), signed into law "Article IV. –of The Board Of Commissioners to Quiet Land Titles," a joint resolution defining the responsibilities of the Board of Commissioners. Several actions were implemented by this law, among them:

> SECTION I. His Majesty shall appoint through the minister of the interior, and upon consultation with the privy council, five commissioners, one of whom shall be the attorney general of this kingdom, to be a board for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property acquired anterior to the passage of this act; the awards of which board, unless appealed from as hereinafter allowed, shall be binding upon the minister of the interior and upon the applicant…
>
> SECTION VII. The decisions of said board shall be in accordance with the principles established by the civil code of this kingdom in regard to prescription, occupancy, fixtures, native usages in regard to landed tenures, water privileges and rights of piscary, the rights of women, the rights of absentees, tenancy and subtenancy, — primogeniture and rights of adoption; which decisions being of a majority in number of said board, shall be only subject to appeal to the supreme court, and when such appeal shall not have been taken, they shall be final…

> Section IX. The minister of the interior shall issue patents or leases to the claimants of lands pursuant to the terms in which the said board shall have confirmed their respective claims, upon being paid the fees of patenting or of leasing (as the case may be)… [In the Polynesian; January 3, 1846:140]

As the *Māhele* evolved, it defined the land interests of Kauikeaouli (King Kamehameha III), some 252 high-ranking *Aliʻi* and *Konohiki*, and the Government. As a result of the *Māhele*, all land in the Kingdom of Hawaiʻi came to be placed in one of three categories: (1) Crown Lands (for the occupant of the throne); (2) Government Lands; and (3) *Konohiki* Lands. The "Enabling" or "*Kuleana* Act" of the Māhele (December 21, 1849) further defined the frame work by which *hoaʻāina* (native tenants) could apply for, and be granted fee-simple interest in "*Kuleana*" lands (cf. Kamakau in *Ke Au Okoa* July 8 & 15, 1869; 1961:403-403). The *Kuleana* Act also reconfirmed the rights of *hoaʻāina* to access on trails, subsistence and collection of resources necessary to their life upon the land in their given *ahupuaʻa*. The *Kuleana* Act, remains the foundation of law pertaining to native tenant rights. The Act was passed on August 6, 1850, and reads:

> An Act confirming certain resolutions of the King and Privy Council passed on the 21st day of December 1849, granting to the common people allodial titles for their own lands and house lots, and certain other privileges… That the following sections which were passed by the King in Privy Council on the 21st day of December A.D. 1849 when the Legislature was not in session, be, and are hereby confirmed, and that certain other provisions be inserted, as follows:
>
> **Section 1**. Resolved. That fee simple titles, free of commutation, be and are hereby granted to all native tenants, who occupy and improve any portion of any Government land, for the land they so occupy and improve, and whose claims to said lands shall be recognized as genuine by the Land Commission; Provided, however, that the Resolution shall not extend to Konohikis or other persons having the care of Government lands or to the house lots and other lands, in which the Government have an interest, in the Districts of Honolulu, Lahaina and Hilo.
>
> **Section 2**. By and with the consent of the King and Chiefs in Privy Council assembled, it is hereby resolved, that fee simple titles free of commutation, be and are hereby granted to all native tenants who occupy and improve any lands other than those mentioned in the preceding Resolution, held by the King or any chief or Konohiki for the land they so occupy and improve. Provided however, this Resolution shall not extend to house lots or other lands situated in the Districts of Honolulu, Lahaina and Hilo.
>
> **Section 3**. Resolved that the Board of Commissioners to quiet Land titles be, and is hereby empowered to award fee simple titles in accordance with the foregoing Resolutions; to define and separate the portions belonging to different individuals; and to provide for an equitable exchange of such different portions where it can be done, so that each man's land may be by itself.
>
> **Section 4**. Resolved that a certain portion of the Government lands in each Island shall be set apart, and placed in the hands of special agents to be disposed of in lots of from one to fifty acres in fee simple to such natives as may not be otherwise furnished with sufficient lands at a minimum price of fifty cents per acre.
>
> **Section 5**. In granting to the People, their House lots in fee simple, such as are separate and distinct from their cultivated lands, the amount of land in each of said House lots shall not exceed one quarter of an acre.

Section 6. In granting to the people their cultivated grounds, or *Kalo* lands, they shall only be entitled to what they have really cultivated, and which lie in the form of cultivated lands; and not such as the people may have cultivated in different spots, with the seeming intention of enlarging their lots; nor shall they be entitled to the waste lands.

Section 7. When the Landlords have taken allodial titles to their lands the people on each of their lands shall not be deprived of the right to take firewood, *aho* cord, thatch, or ti leaf from the land on which they live, for their own private use, should they need them, but they shall not have a right to take such articles to sell for profit. They shall also inform the Landlord or his agent, and proceed with his consent. The people shall also have a right to drinking water, and running water, and the right of way. The springs of water, and running water, and roads shall be free to all should they need them, on all lands granted in fee simple. Provided, that this shall not be applicable to wells and water courses which individuals have made for their own use.
Done and passed at the Council House, Honolulu this 6th day of August 1850. [copied from original hand written "Enabling Act"[6] – HSA, DLNR 2-4]

The most important source of documentation that describes native Hawaiian residency and land use practices — identifying specific residents, types of land use, crops cultivated, and features on the landscape — is found in the records of the *Māhele ʻĀina*. While the "Land Division" gave the *hoaʻāina* an opportunity to acquire fee-simple property interest (*kuleana*) on land which they lived and actively cultivated, the process required them to provide personal testimonies regarding their residency and land use practices. As a result, records of the *Māhele ʻĀina* present readers with first-hand accounts from native tenants generally spanning the period from ca. 1819 to 1855. The lands awarded to the *hoaʻāina* became known as "*Kuleana* Lands" and all the claims and awards (the Land Commission Awards or L.C.A.) were given *Helu* (numbers). The L.C.A. numbers remain in use today, and identify the original owners of lands in Hawaiʻi.

The work of the Land Commission was brought to a close on March 31, 1855. The program met with mixed results, and it has been calculated that the total amount of land awarded to *hoaʻāina* (native tenants – the common people of Hawaiʻi) equaled approximately 28,658 acres, of a total four million available acres (see Governor's report 1902:7).

Disposition of Primary Lands Making up and Adjoining The Puʻu Makaʻala Natural Area Reserve in the Māhele

The lands which make up the Puʻu Makaʻala NAR include *ahupuaʻa* belonging to the Hilo and Puna Districts, and are also bounded by lands in the Kaʻū District. In the *Māhele*, the following division of lands was agreed to by the King and participating *aliʻi* (all page references are to the "*Buke Mahele*" 1848):

Keauhou, Kaʻū	*Keauhou, Ili i Kau, Kapapala*; retained by V. Kamamalu (pp.5-6).
ʻŌlaʻa, Puna	Olaa (Kalana); relinquished by Kaunuohua to King Kamehameha III (pp. 91-92). Retained as Crown Land by the King.
Waiākea, Hilo	Relinquished by Kaunuohua to King Kamehameha III (pp. 91-92). Retained as Crown Land by the King.

[6] See also *"Kanawai Hoopai Karaima no ko Hawaii Pae Aina"* (Penal Code) 1850.

Within these lands, *hoa'āina* also made claims for small *kuleana*. Our review of all records of the *Māhele* revealed that the following number of claims were made in these lands[7]:

Ahupuaa	***Claims***	***Awarded***	***Not Awarded***
Keauhou, Ka'ū	0	0	0
'Ōla'a, Puna	1	0	1
Waiākea, Hilo	36	24	12

None of the claims by *hoa'āina* identified uses or parcels within the lands that are now a part of the Pu'u Maka'ala NAR, though it is understood (based on traditional and customary practices, and the laws cited above) that native tenants of the lands would have accessed the forest lands in order to collect resources or participate in other traditional practices.

An indicator of the cultural significance of the forest lands adjoining, if not also within the present day 'Ōla'a-Waiākea Forest Reserves and Pu'u Maka'ala Natural Area Reserve is found in the following letter of 1857, in which the important *koa* forests of the Kapāpala-Keauhou vicinity in Ka'ū are mentioned:

> ***Waimea, Hawaii***
> ***26, March, 1857***
> ***Isaac Y. Davis; to Keoni Ana, Minister of the Interior***
> ***(Regarding status of the King's Lands at Apua, Kapapala and other locations):***
>
> …I have made a circuit of the Island of Hawaii, and I have returned.
>
> I have seen all the places that I visited, and saw the lands of the King in Puna, Kau & Kona, some are good, and some are not good…
>
> ***Kapapala***, *Ahupuaa* in Kau, is a large land, but one side is stone, but, the side joining the mountain is good, plenty of earth, the land is rich and green as I observed. The canoe *koa* forest in Kau belongs to Kapapala, there is also a pond, but I did not visit it, and this land is similar to Waimea.
>
> I called the people to come, and I told them my desire to lease said land hoping that I would be able to get between $300.00 and $500.00, and if five hundred, all the better, but the natives said only $50.00 to $60.00, and then up to a hundred, and not more, so I did not consent… [HSA Interior Department Lands]

The forest lands of 'Ōla'a are noted for their growth of *hāpu'u* (*Cibotium*) tree ferns. The collection of *pulu* was one of the activities undertaken in the 'Ōla'a section, as mentioned in the following letter from 1866. At the time, the applicant, T. Spencer, also applied for the right to run a few head of animals in the forest lands:

> ***Honolulu, Oahu***
> ***23, April, 1866***
> ***Thomas Spencer. to J.O. Dominis:***
> …I would respectfully ask of you as a favor, to grant, or procure for me, a *Pulu* privilege on the land called ***Olaa***— I do not ask you for "The privilege," but a *Pulu* privilege, and to run what few animals I have connected with the business. I cannot afford to pay but a small sum, as the business will not warrant it—I am barely making both ends meet, I assure you, out of it. I called this morning on Mr. Rufus Lyman for information, in regard

[7] The on-going research of Kumu Pono Associates LLC in the nearly 60,000 records of the *Māhele 'Āina*, may lead to modifications in these numbers at a later date.

to this business who referred me to you, and has kindly promised me to write you for instructions. Be so good as to grant me this favor… [HSA Interior Department Lands]

Later in 1866, we find that native applicants were seeking "*pulu* privileges" in ʻŌlaʻa as well, and that they had knowledge of the native birds and other resources in the uplands:

> ***Hilo, Sept. 18th, 1866***
> ***R.A. Lyman; to J.O. Dominis:***
> …Kaaukai & Kaaua are the ones who wish to lease ***Olaa*** for five years from the first of next January. Provided that they are allowed to have the *pulu*, and only the *pulu*. Birds, & *awa*, to be reserved. They would like to have two or three weeks more to consider about it, and wish to know whether you will allow them to pay on the 1st of July of each year, or whether they will have to pay the first of every year. Please let me know about this, and I will let you know as soon as I can if they will take it… [HSA Interior Department Lands]

Proceedings of the Boundary Commission: Documenting Traditional and Customary Practices, and Land Boundaries (1873-1875)

In 1862, a Commission of Boundaries (the Boundary Commission) was established in the Kingdom of Hawaiʻi to legally set the boundaries of *ahupuaʻa* that had been awarded to *Aliʻi, Konohiki*, and foreigners during the *Māhele*. In 1874, the Commissioners of Boundaries were authorized to certify the boundaries for lands brought before them (W.D. Alexander in Thrum 1891:117-118). The primary informants for the boundary descriptions were old native residents of the areas being discussed (generally born between the 1780s to 1820s). The native witnesses usually spoke in Hawaiian, and their testimony was translated into English and transcribed as the proceedings occurred.

Readers will note that there are significant inconsistencies in spelling of various words, including place names, people names, and features on the landscape. This is problematic, but with the help of maps produced as a part of the surveys to establish boundaries, and other period maps (e.g. Register Map No.'s 42 & 524; and Land Court Application Map No. 1053), many of the locations described can be identified. We have also observed that in some testimonies, when the original translator-transcriber used two of the same vowels, it indicated that he/she heard a lengthened pronunciation of a particular vowel. This emphasis of pronunciation is now indicated by a macron mark—for example, the word "*neenee*" (for *nēnē*), the native goose formerly hunted on the mountain lands above the Puʻu Makaʻala NAR. While in the modern context of the language, two of the same vowels are generally both pronounced, and broken by an *ʻokina* or glottal mark.

The narratives cited below, are verbatim transcripts from the testimonies given by native residents or land owners, and those given by surveyors who recorded the boundaries based on the testimony of native guides. The testimonies include descriptions of the lands of ʻŌlaʻa and Keaʻau (Puna); Waiākea (Hilo) by association with the adjoining lands of ʻŌlaʻa, Kukuau, Kaūmana and Humuʻula; and Keauhou (Kaʻū).

While the excerpts from the testimonies, extend beyond the specific limits of the Puʻu Makaʻala NAR, they are important as they demonstrate thorough knowledge of the landscape, and demonstrate continuity in the types of traditional and customary practices described at various elevational zones. Thus, while something may not have been recorded for ʻŌlaʻa or Waiākea, the description of practices in a neighboring land, suggests that such knowledge existed within lands that make up the study area. The witnesses generally described the boundaries as they rose form the ocean or lowlands, running through the forest lands, to a point where they reached the slopes of Mauna Loa. ʻŌlaʻa and Waiākea are both cut off by larger lands of the Hilo and Kaʻū Districts. The primary upland boundary points given are Pōhakuloa, Kūlani, Kīpū, and Māwae.

Also, while situated in the *ahupua'a* of Waiākea and 'Ōla'a, access to the forest resources of what is now the Pu'u Maka'ala NAR and adjoining areas, would have sometimes been gained from neighboring lands such as Kea'au, Kukuau, Humu'ula, Keauhou and Kapāpala. The selected native testimonies describe a wide range of traditional practices in the uplands of Waiākea, 'Ōla'a, and in adjoining lands. The types of usage includes: travel on native trails, land use in a wide range of elevational zones; collection of resources; the collection of, or "hunting" of birds; canoe making; and the subsequent practices associated with hunting introduced ungulates—all under the control of *Konohiki* [8]. The testimonies also record that changes had occurred on the landscape during the life-time of the witnesses. It is of importance to note that the boundaries were known by the native tenants, and the rights to take or hunt resources in traditional times were fiercely protected—individuals without chiefly, genealogical claims, or residency ties to given lands were not allowed to trespass and take resources from the *ahupua'a*.

Underlining, square bracketing, bold and italic print are used by the compilers here, to highlight place names and particular points of historical interest recorded in the testimonies. The proceedings for the cited lands are given in alphabetical order, and date of recordation.

In the days leading up to the recordation of testimonies regarding the boundaries of Waiākea and Humu'ula, Hilo; and Keauhou, Ka'ū, we find that a difference of opinion had arisen among the witnesses. The commission proceedings standardized the boundaries of these lands, sometimes without following the former traditional boundaries:

> ***Hilo May 1st 1873***
> ***R.A. Lyman; to J.O. Dominis, Agt. of Crown Lands***
> ***(Regarding hearings for Crown Lands before Boundary Commission):***
> I have set the 2d of next June for the hearing of testimony for the settlement of the boundaries of Punahoa, Makahanaloa & Pepekeo in Hilo, Keaau & Keahialaka in Puna, Honuapo & Pakaniiki in Kau. I will have the hearing at Hilo. The Crown Com. are interested in the lands of Piihonua & ***Humuula*** joining Makahanaloa & Pepekeo, Ponahawai joining Punahoa 1st; ***Waiakea*** & ***Olaa*** joining Keaau in Puna.
>
> Please to authorize some one to appear at the hearing and look after your interests… [HSA – ID Lands]
>
> ***Hilo, June 9, 1873***
> ***R.A. Lyman, to J.O. Dominis, Agent of Crown Lands***
> ***(Regarding Boundaries of Humu'ula and Neighboring,***
> ***and Disposition of Pi'ihonua):***
> …Enclosed, please find a list of lands as near as I can make it out at present. I have written to Mr. Wiltse and Hoapili asking them to send you correct lists of lands in their districts and to forward me copies as soon as possible. Please to send me surveys of as many of the lands as you can. If the surveys made by my brothers have been lost, I think that any brother could make out new copies of most of them. The survey of ***Humuula*** made by Wiltse cuts way into Waiakea as surveyed by Webster and cuts off several miles of Kapapala and Keauhou.
>
> Kahue, Wiltse's *Kamaaina* swears that they did not go to a single point on the boundary of Humuula along in the woods and did not put any flags there but that he pointed out some above the woods where he guessed the points were and they sighted to them.

[8] In regards to hunting, it will be noted that descriptions of traditional hunting practices are limited to native species of birds, including the *ua'u, nēnē, mamo* and *'ō'ō*; while description of historical hunting practices are limited to goats, which were hunted under contract of *Konohiki*, the Crown, or the Government.

The Piihonua people are very much put out about the survey of ***Humuula*** as they supposed they had leased Piihonua by the ancient boundaries and the survey of Humuula cuts off a strip several miles wide clear across the head of the land and leaves no wild cattle to speak of for Piihonua. They say they cannot afford to pay $100 a year for the woods of Piihonua now. [HSA, Crown Lands File]

The Ahupuaa of Humuula

District of Hilo, Island of Hawaii
Boundary Commission, Hawaii, Volume A No. 1:238-240

Honolulu, July 7, 1873

R.A. Lyman, Esq.
Hilo

Dear Sir
Mr. F.H. Harris is authorized by the Commissioners of Crown lands to make application to you as Commissioner of Boundaries to have the boundaries of all Crown lands on the Island of Hawaii defined. He has a list of the lands with him.

I have also authorized Mr. F.H. Harris to make application to you for the settlement of boundaries of all lands belonging to Est. of His late Majesty and Her Excellency, R. Keelikolani.

I expect to be in Kona by the trip of the "*Kilauea*" which leaves here on the 28th inst. Can't you make it convenient to come round as the steamer goes to Hilo on that trip.

I wish also to apply for the settlement of the boundaries of Honohina.

I remain,
Yours Respy.
Jno. O. Dominis

Honorable R.A. Lyman
Boundary Commissioner
for Island of Hawaii, Haw. Is.

The undersigned would herewith make application for the settlement of the boundaries of the following named Ahupuaas or Lands belonging to the Crown, viz.:

Waiakea in the District of Hilo bounded by ***Keaau***, ***Olaa***, ***Kapapala***, ***Humuula***, ***Piihonua***.
Piihonua in the District of ***Hilo***, bounded by Punahoa, ***Waiakea***, ***Humuula*** and Puueo, Paukaa & Alae and other lands

names not known… [page 238]
Humuula in the District of Hilo bounded by
Kapapala, various lands in Kona and Kohala
and Hamakua, and Hakalau, Makahanaloa,
Papaikou, Paukaa, Piihonua and Waiakea
in the District of Hilo… [page 239]
…Olaa in the District of Puna, bounded by
Keaau, Wm. C. Lunalilo, H. M. ***Waiakea***
& ***Kapapala***…

Your Honor will therefore please appoint
a day for hearing the evidence
in the foregoing named lands and having
decided upon the same to grant a certificate
to that effect to the undersigned.

Hilo Hawaii, August 16th A.D. 1873

(Signed) Jno. O. Dominis
Crown Land Agent.
by F.H. Harris
atty. at law. [page 240]

Ahupuaa of Humuula
Boundary Commission, Hawaii Volume B:28-59

The *Ahupuaa* of ***Humuula***, District of ***Hilo***,
Island of Hawaii, 3d J.C.

On this, the 3d day of November A.D. 1873 by adjournment from the 30th October, the Commission of Boundaries for the Island of Hawaii, 3d J.C. met at the Court House in ***Hilo***, on the application of J.O. Dominis, Agent of Crown Lands for the settlement of the boundaries of ***Humuula***, situated in the District of ***Hilo***, Island of Hawaii. Notice personally served on owners or Agents of adjoining lands, as far as known. Also served by publication in the Hawaiian Gazette of _____ and *Kuokoa* of _____.

Present, E.G. Hitchcock for applicant, for
Mrs. L.K. Dominis, Her Ex. R. Keelikolani, the
Estate of Kamehameha V, C.R. Bishop and self,
D. Kamai for Hawaiian Government Lands
in ***Hilo***, and D. Alapai.

For Petition see Folio 238, Book A.

Testimony.

J.A. Simmons K., Sworn:
I have lived on Hawaii for forty two years
and in Hilo, District about half of that time. I
shot wild cattle on Humuula for eight years.

This was soon after I came into the Country, but
I have been there since. I used to live with
Ned Gurney at Lahohino [Lahohinu], a place above the
woods on Humuula…

Makaulaula [K.] and Opukeike [K.], old bird
catchers of Piihonua, also pointed out the
boundaries to me, when I lived at Pahukea,
saw mills on Piihonua… [page 28]

…A great deal of the forest has been killed
out by the cattle barking the trees and
destroying the underbrush. Therefore the
woods do not extend so far *mauka* as they
did twenty years ago.

Know the place called Puuoo, a big hill
on the plains of Humuula is now called
by that name, but the original Puuoo is
a hill covered with *ohia*, and was told it was on the land
of ***Waiakea***. It is *makai* of the hill on
Humuula, and I am certain it is not on
that land…

Nainoa [K.] Sworn.
I am a *kamaaina* of Hamakua, at the time
of Aipala [famine of ca. 1811], know a part of the boundaries
of ***Humuula***, as they were pointed out to
me by people who are now dead.
Li. Kauwila (his father) and Pali, who
were kamaainas of ***Humuula*** showed
me the boundaries, and told me not to go
to certain places… [page 30]

…I went with the *kamaaina*.
They told me that ***Humuula*** was bounded
by ***Kapapala*** of Kau, ***Keauhou*** of Kona,
and ***Kaohe*** of Hamakua. I have never
heard that ***Kaalaala*** of Kau or ***Waiakea*** of
Hilo joined ***Humuula***. The old trail
from ***Humuula*** towards ***Piihonua*** used
to run along the *mauka* edge of the woods,
near the boundary, not in the woods.

The ***Humuula*** and ***Piihonua*** people
used to go after water at Kelewa [Kaelewa]… [page 31]

…When I went after birds on ***Humuula***
Li told me not to catch the birds in *koa*
and *mamani*, as they belong to the *makai*
lands, and would be taken away by the people
of those lands if I caught them… [page 32]

Kahue K. Sworn:
I was born at ***Humuula***, am seventy three years of age, and a *kamaaina* of the land and know its boundaries. Kalaimaka, Mohaiku, Eekamoku (all dead) were *kamaaina* of ***Humuula*** and pointed out the boundaries to me… [page 33]

…***Kahiliku***, a *lae laau* [a section of forest that extends out from the surrounding forest on to an open area], outside of the woods. Thence to ***Mawae***, a crack in the woods that runs from *makai*. I have heard that ***Waiakea*** joins ***Humuula*** here, but I do not know which side of the lava flow of 1854 or 1855, the lands join. Thence the boundary of ***Humuula*** runs to ***Kawauwauwai*** a *kauhale*; the boundary running to this point in scattering bush. The forest ends at ***Elekalua***…[page 34]

…***Kapapala*** is said to cut ***Humuula*** off to ***Pohakuhanalei***. Boundary runs near ***Puuonioni*** on ***Humuula***; the boundary is a little beyond. ***Wekahuna*** [Uwēkahuna] is a hill on ***Humuula***. ***Waiakea*** ends at ***Pohakuloa***, and from there ***Humuula*** is bounded by ***Kapapala*** to ***Pohakuhanalei*** (I do not know whether ***Kapapala*** extends to ***Pohakuhanalei***). From Pohakuhanalei to Koaohe it is bounded by ***Kaalaala*** of Kau… [page 35]

Witness rested until 10 o'clock tomorrow morning
Nov. 4th 1873.
R.A. Lyman
Com. Boundaries 3d J.C.

Hilo Nov. 4th 1873. Court opened according to adjournment…

[Witness Kahue, continued]:
I went with Wiltse one time when he surveyed the land of ***Humuula*** [Register Map 668]… [page 36]

I do not know the places called Punaluu (on ***Mauna Loa***), ***Kaamaumauloa***, ***Puuulaula*** and ***Puukulua***, ***Puuonioni*** and ***Wekahuna***. I have not seen, but have heard that they are on the boundaries. ***Humuula*** does not reach to ***Kulani***. ***Puuiki*** is by the boundary of ***Humuula*** and ***Waiakea***… [page 37]

Waiki K. Sworn:
I live at ***Humuula***, was born there after the battle of Kekuakalani [1819], and know the boundaries of the land. My parents told them to me. Eekamoku was my father and Koapunini my grandfather, they were bird catchers

and canoe makers. Kalaimaka, father
of my wife pointed out the boundaries
and told them to me… [page 38]

…***Kahiliku*** *kauhale manu* [a bird catcher's house at Kahiliku];
thence to ***Kaelewa***, where there is now water. Thence to
Kawauwai by the edge of the forest. Thence to
Kaieie; Waiakea and Piihonua join Humu-
ula between these two places. Thence along
the edge of the forest to ***Kalapaohelo***. I have
been there with my parents, an old lava ground.
Thence to ***Pohakuloa***, a large rock where Kaehu
Paki laid down on the side of the mountain
towards Kau of Kalapaohelo. There I [page 40]
staid with my *kupuna* and they said the
boundary runs from here up the mountain to
Pohakuhanalei, a rock on the slope of the
mountain towards ***Kaleieha***. ***Waiakea***
bounded it to ***Pohakuloa***, but they did not
tell me what lands bounded ***Humuula***
from there to ***Pohakuhanalei***... [page 41]

Kaaua [K.] Sworn.
I was born at ***Waiakea Hilo***, at the time of
Akakai Mokuokai [*Hakaka i Mokuohai*, the Battle of Mokuohai in 1782].
I have always lived
there, and know where ***Waiakea*** joins
Humuula. I was told by ***Olaa*** *kamaaina*,
Opuloa and others (whose names I have
forgotten) at the time Webster surveyed ***Wai-***
akea. I have always heard that ***Waiakea***
joins ***Humuula*** from ***Puuhuluhulu*** to
Mawai [Mawae]. Webster set flags on ***Puuhuluhulu***
when he surveyed ***Waiakea***... [page 55]

The Ahupuaa of Kaumana

District of Hilo, Island of Hawaii, 3d J.C.
Boundary Commission, Hawaii Volume B:1-2

On this 29th day September A.D. 1873…

Kekai [K.] Sworn:
Kaiahua, a bird catcher (now dead) showed
me the boundaries of Kaaumana, ***Waiakea***
and Piihonua, in the woods. ***Kapulu*** is at
the *mauka* corner of ***Kukuau***, and at
the junction of ***Waiakea*** and ***Kaaumana***.
Thence the boundary between ***Waiakea***
and ***Kaaumana*** runs *mauka* to ***Kalapa-***
lapanui, an *oioina* [trailside resting place] and place where we
used to catch birds; a high ridge on the
Hilo side of the lava flow of 1852. There
used to be an old road for bird catchers to
Hoaa, a place on ***Waiakea***, where we

used to catch *mamo*. ***Kaaumana*** is on the
Hilo side of this ridge; thence *mauka* to
Kapualei, now covered by the lava flow of
1855. Thence to ***Kalaeokoieie***, *lae koa*
[a section of *koa* forest extending onto a lava flow] mostly
destroyed by the lava flow. ***Kaaumana*** ends
at the *mawae* [fracture], *makai* of this place, and
mauka of the tall woods, at the junction
of ***Piihonua*** and ***Waiakea***. Thence the
boundary of ***Kaaumana*** runs *makai* [page 1]
along ***Piihonua*** to ***Kapili***, an old *kauhale* [house site],
now covered by the lava flow; thence *makai*
to ***Kilohana***, now covered by lava; thence to ***Kawauwauwai***;
thence *makai* to ***Nahaleoeleele***, the *mauka* corner
of ***Ponohawai***.

C.X.'d… [page 2]

The Ahupuaa of Keaau

District of Puna, Island of Hawaii, 3^{d} J.C.
Boundary Commission Testimony – Volume A. No. 1:191-198
June 4, 1873

Uma [K.] Sworn: I was born at Keauhou at Keaau Puna,
at the time of the return of Kamehameha 1st from
Kaunakakai, Molokai [ca. 1791], I have always lived
there and know the boundaries between
Keaau and Waikahekahe. My parents pointed
them out to me when we went after
birds and sandal wood... [page 191]

…Alaalakeiki, which is the end of Waikahekahe Iki
and Kahaualea joins Keaau. This place is at an
old *kauhale manu* [bird catchers compound] (opposite a rise
of ground, above the seventeen mile post,
on the Volcano Road, about two miles above
Kanekoa), thence *mauka* to Palauhulu, an
ahua [rise] on the road to Kilauea, at the
place where the road to Panau
branches off. The boundary between Keaau and
Kahaualea is on the South east side of
Palauhulu about as far away from Hilo
Court House to seashore. Thence the boundary
runs *mauka* to Omaolaulau (*he oioina* [a resting place]
on *pahoehoe*) near the woods at Reeds bullock pen…
thence *mauka* to Keekee, *Kauhale kahi olona*
[house for stripping *olonā* bark for cordage]
in Olaa. The boundary is a short distance from
the Government road on the South East side.
Thence to Kauwaanahunalii (*he oioina*) this place
is on Keaau and the boundary runs to the
South East side of it. This is at the high ground
where you can look down in the woods
where the bullock pen is, thence to Kawaiaeae

a large water pond (South East side of the road). The boundary of Keaau and Kahaualea is close to the pond, on the south east side, thence *mauka* to Kalaninauli, the land on the south east side being only about six chains wide thence to Puuenaena (large *ohia* trees on the road *makai* of the *koa* woods) a short distance South East of the Government road. Thence the boundary runs *mauka* to a place called ***Pohakuloa***, a small cave south east of the Government road, and a very short distance above the *koa* woods, on the Government road to Kilauea. Thence Keaau is cut off by ***Keauhou***. ***Olaa*** bounds Keaau on the north west side. Keauhou cuts Keaau off to Government road to Kilauea, then runs *makai* along the old [page 192] Government road, through the *koa* woods. ***Olaa*** being on the North side of the road and Keaau on the South east side. Thence down the road passing these points ***Palauhulu*** and to ***Kapueuhi***, thence *makai* to Kahooku thence to Kanekoa, the houses on the South East side of the road are on Keaau, those on the other side are on ***Olaa***, thence to Kamahiki (14 mile post). Thence to Kalehinapuoa (where there is a *mauka* road which goes to Hawelu's) thence to Kaahakanaka, on the outer road passed Hawelu's thence to Kaluakaiole (Kaakeakaiole) *mauka* of where Haanio road to Kukulu leaves the present traveled road, thence to Mahinaakaaka on the outer road, out side of Kahuku, thence down to where Kahopuaku's houses used to be (Makaulele) along the old road, this is as far as I know the boundaries between ***Olaa*** and Keaau. Kahopuaku's houses were on ***Olaa***… [page 193]

Kanoi [K.] Sworn: I was born at Kapapala in Kau, at the time of the building of Kiholo [ca. 1811] lived there until a few years since; know the land of Keaau and the boundaries on the mountain adjoining Kahaualea. The upper end of Keaau is bounded on the South East-side by Kahaualea, and on the *mauka* side by ***Keauhou*** and on the Northwest side by ***Olaa***; Kaheana, Kaihe Kaheana[2], and Makanui my *Kupuna* showed me some of the boundaries of these lands. Kaheana was from Panau, Puna, and Kaihe was from Kau. These two men, with others from Kapapala showed me boundaries between Keauhou and Kahaualea where we went after the *oo* on ***Keauhou***. Went after sandalwood on Kahaualea. ***Keauhou*** cuts Keaau off at

Pohakuloa, the *huina alanui* [road intersection], where the marks or sign board is at the junctions of the Hilo and Puna [196] roads this side of the Kilauea House, the name of this place is Halemaumau. The boundary of Keaau runs *makai* along the Puna road to Kaluaiki, a small crater, at a place where the road runs between two craters. Onto the *mauka* side of crater Kaluaiki, said crater is on Kahaualea and Keauhou is on the South side of the road. Keaau and Kahaualea lay side and side, from Kaluaiki to Nawailoloa, a place on the road from Palauhulu to Panau. Kaluaiki is about as far Pohakuloa as from Hilo Court House to Kaina's house at Alenaio. Nawailoloa and Kilohana, two ponds of water, on the road to Panau from Palauhulu, from Nawailoloa the boundary between these two lands runs *mauka* to a grove of *Ohia* trees called Namauuo-kalahili, thence *mauka* to Puukea a hill in the woods where we used to go after sandal wood, thence *mauka* to Namamokalei where we used to catch *uwao* [*'ua'u*]. This place is opposite to Kauanahunahu, *mauka* of Keekee about a mile. Thence to Kaluaiki. I have often been to these points from ***Waiuli*** to ***Pohakuloa***. I have always heard that the old Government road to Kilauea is the boundary between Keaau and Olaa, I do not know the *makai* boundaries…

Nailima [K.] Sworn: (same witness as for Olaa) I was born at Olaa, and know the boundaries between Olaa and Keaau. My *kupuna*, now dead, showed them to me. Keaau ends at Halemaomao at the junction of the Hilo and Puna road. ***Olaa*** on the Hilo side of the road and Keaau on the Puna side. Thence *makai* to Pohakuloa, thence *makai* to Puuenaena (big *ohia* trees) thence to Kalaninauli, so called by Nahienaena. Thence to Waiaiai, thence to Kauailehulehu, thence to Keanapapa at the 24 mile post thence to Kauwanahunalii, thence to Keekee, thence to Omaolaulau (at *ohia* woods, and the bullock pen) thence to ***Pohakuloa***, thence to Palauhulu, thence to Kawaikahoohia. Thence to Kawaa, thence to Kaialuawai, thence to Kaluamanuahi, to Kaleinakeakua, which is at the 18 mile post, thence to Pahookui, thence to Pohakuloihi, to Punahaha, 17 mile post, thence to Kapuamau page 196]. Thence to Kawaiaiai, thence to

Kapae, 16 mile post, thence to Kanekoa,
thence to Mokuhaaheo, thence to Mahiki,
to Kahau, to Puualae, to Kaleiki, to Kanukea,
thence to Umihali at the fifteen mile post,
thence the boundary runs to Kalehuapua,
mauka of the road to Hawelu's house
(thence to Kaahakanaka, outer road to
Hawelu's house). Thence follow the outer
road to Popoiwi, where Haanio's road
branched off to go to Kukulu. Thence
follow the outer road to Mahinaakaaka,
opposite Kahuku, thence to Kapuhu, and
ohia grove, where the road turns towards
Hilo on the *makai* side, thence to Ahuapuu,
a *puuhala* tree by the road, thence to Makaulele,
a little *makai* of this place, Keaau road joins
at this point the boundary leaves the Hilo
road, and turns *mauka* along ***Olaa***, to
Kilohana, an *ahua* or mound with orange
trees. Thence the boundary runs up *mauka*
along *awaawa* on Kau side of Kilohana, up
a hill covered with *puu hala*, thence to *pali*
Puuaehu, the boundary on the brow of *pali*,
this side of Keaani, which is the name of
an *ohia* grove on the side of the *pali*, some
distance *mauka* of Haanio's road, thence
to Kaanamanu a place inside the woods.
I have never been there and only heard
of this place. Thence to Kaaipuaa, an old
village, where people used to live. Thence
to Waiaeli [also written Waiaele in text], a pond of water
with *aweoweo* growing in it. Said pond is
on the old road from Olaa to Pooholua.
Have heard ***Waiakea*** joins ***Olaa*** and Keaau at
Waiaele, Mawae is near there and have
always heard that it is the boundary
between Keaau and Waiakea.
From the Government road to Olaa,
seashore Kawiakawaa is at sea shore… [page 197]

The Ili of Keauhou, Ahupuaa of Kapapala
District of Kau, Island of Hawaii
Boundary Commission, Hawaii, Volume A, No. 1:245-246

Honorable R.A. Lyman
Boundary Commissioner
for Island of Hawaii

The undersigned would herewith make appli-
cation for the settlement of the Boundaries
of the following named Ahupuaas or lands
belonging to the Estate of the Kekuanaoa & V.
Kamamalu, viz…;

…Keauhou Ili of ***Kapapala***, District of Kau Hawaii
adjoining lands ***Kapapala***, Apua… [page 245]

…Your Honor therefore will please appoint a day for the hearing of said application, and grant a certificate in accordance therewith,

(sig) J.O. Dominis, admts.
J.F.H. Harris, Atty at Law
Hilo August 16th A.D. 1873 [page 246]

Keauhou, Ili of Kapapala Ahupuaa
District of Kau, Island of Hawaii
Boundary Commission, Hawaii, Volume A No. 1:444-446

The *Ahupuaa* of ***Keauhou***, District of Kau, Island of Hawaii, 3d J.C.

On this, the 24th day of October A.D. 1873 the Commission of Boundaries for the island of Hawaii, 3rd J.C. met at the Volcano House, Kilauea, Kau on the application of J.O. Dominis, acting for Administrator of the Estate of M. Kekuanaoa, for the hearing of the testimony in regard to the settlement of the boundaries of Keauhou, situated in the District of Kau, Island of Hawaii.

Notice personally served on J.G. Hoapili and L. Kaina; Agents for the owners of adjoining lands. Present: W.K. Moi in place of J.G. Hoapili, for applicant and for Agent of Crown lands and Kau Lands. J.N. Gilman for L. Kaina for Agent of Crown lands in Puna.

For Petition see Folio 246

Testimony

Kenoi K. Sworn
I was born at ***Kapapala***, Kau at the time of Kiholo mua [ca. 1811], and lived on said land or adjoining lands until about Eleven years since. Am a *kamaaina* of ***Keauhou*** and know its boundaries. My Father, Kaheana (now dead) told them to me when we used to go after *uwau* and geese.

Kapapala bounds Keauhou on the South side; Commencing at the seashore at a *heiau* called Makoloa, thence the boundary between these two lands runs *mauka* to Lapo (Kuhalu is a small *pali* on ***Kapapala*** near the boundary). Lapo is the lower *pali* of the two; thence to Haleolono, a hill above the *pali*; thence to ***Pohakuloa***, to an *ohia* tree on the *pahoehoe*;

thence to ***Kulanaokuaike***, a *pali kahua-manu* [bird catcher's flat], where Kaina's man jumped off; thence to ***Aiaawa***, *ohia* trees and *awaawa*; thence to ***Kaaiwaa*** or ***Ahuahoiwale***, a *puu* and *ahu*; thence to ***Kamokukolau***, an *ohia* grove [page 444]; thence the boundary runs to the South side of the crater, ***Keanakakoi***; thence to ***Wekahuna*** [Uwekahuna], crossing the crater of ***Kilauea*** a little to the South west of the highest part of the bluff (highest bank of the crater). Thence to ***Kilomoku***, a small grove of *koa* and *ohia*, the large grove to the South west being on ***Kapapala***, thence to ***Ohinale***, a long grove of trees in *aa*; thence to ***Keakanaloa***, passing up the center of the *aa* flow; thence along the Hilo side of the *aa* to ***Puukulua***, two small hills, the boundary passing between the two; a little toward Hilo of ***Puuulaula***. (As I came along over the road today, and was looking at the mountain, I saw I had made a mistake in saying ***Puuulaula*** was the boundary.) From ***Puukulua*** (I do not know what land cuts if off, Waiakea perhaps) the boundary runs towards Hilo to ***Kaamamauloa***, an *aa* flow on the Hilo side of the mountain. Cannot say where it is exactly as it is a long time since I have been there.

There the boundary turns *makai* towards *Kilauea*, to the South west side of ***Kipu***, the hill *mauka* of ***Kulani***; thence *makai* along ***Olaa*** to ***Kaloulukea***, a *pili a*; thence to ***Kaloi***, an open spot in the woods; thence to ***Kaolapalapa***, a *pali* at the road; thence along the road to ***Pohakuloa*** junction of the roads to ***Hilo*** and ***Keauhou***; thence along the road along ***Keaau*** to ***Kaluaike***, a crater on the East side of the road & on Kahaualea. Thence along ***Kahaualea***, along the road to ***Namanuakalei***, a large *ohia* on the Kau side of the road, thence *makai* along the road to ***Kilohana***; junction of ***Keauhou*** and Puna roads; thence along the land of ***Apua***, along the road to ***Ohiakuapu***, a cave; thence through the bush to ***Kuelua***, a cave on the road from Kau to Panau, thence to Opuohao, a cave; thence to Pali o Keawaa to a *kukui* tree on the side of the *pali*; thence to ***Keamoku***, a small flow of *aa*, on the *pahoehoe*, the *aa* on Apua Boundary, is on the South west side of it; thence to Ninanuhi, a *pali* from which you can see the seashore; thence down the *pali* to Kealaakahewahewa, an *ahu* at the *makai* road to Puna and Kau; thence to Okiokiaho a pile of stones at the sea shore; two piles of stones and a *mawae* [page 445].

The land of Keauhou is bounded on the *makai* side by the sea, and has ancient fishing rights extending out to sea… [page 446]

Ili of Keauhou Ili, Ahupuaa of Kapapala
Boundary Commission, Hawaii, Volume B:302-304

The *Ahupuaa* of Keauhou, District of Kau Island of Hawaii, 3d J.C.

Case continued from October 27, 1873.
See Folio 446, Book A

On this, the 8th day October A.D. 1874 the Commission of Boundaries for the Island of Hawaii, 3d J.C. met at the Court House in Hilo for the examination of witnesses as to the boundaries of Keauhou, situated in the District of Kau, Island of Hawaii. Due notice personally served on owners or agents of adjoining lands as far as known.

Present: L. Kaina on part of applicant and Crown Agent in Puna, E.G. Hitchcock for Crown lands in Hilo.

Testimony

Keliilohi K. Sworn.
I was born at ***Keauhou***, *Ili* of ***Kapapala*** at the time of *Okuu* [ca. 1804], and lived there till eight years since. I now live in Hilo. Am a *kamaaina* of ***Keauhou*** and know the boundaries. My *kupuna* and parents (Kaialii was my Father) told me the boundaries…

…***Keauhou***, I have always been told is bounded by Kahaualea; thence the boundary runs up the road to a large *ohia* tree and two mounds on each side of the road; this place is called [page 302] ***Namanuakalei***; thence to ***Kilohana***, a resting place *palipali* and *ohia* tree; thence to ***Mawae holopa***, a crack in the road where sticks are laid across to form a bridge; thence to ***Kaluaiki***, a crater on the Hamakua side of the road. I have heard that this crater is on ***Kahaualea***; thence to ***Pohakuloa*** which is the junction of the Hilo, Puna and Kau roads. Thence along the land of ***Olaa*** towards ***Kulani hill*** to a place called ***Kaloi***. Two open spots in the woods about as large as the Court House yard; the one toward Hamakua being the smallest, covered with *hapu* and ferns; thence to ***Kaloulukea***, a palm tree; thence to ***Kulani hill***; thence to ***Namaunamaka***, a place where

we used to catch birds; thence along the land of ***Waiakea*** to ***Kiipu*** [Kipu], a hill; thence to ***Kaamamauloa*** *aa* about as far as from here to Kalepolepo, above the woods. This is as far as I know the boundaries. I have heard that ***Waiakea*** bounds it on the Hamakua side.

There is a large *Mawae* there that runs *mauka* and *makai*. Thence the boundary runs up the mountain to ***Puumahoe***, called ***Puuula-ula*** and ***Puuiki*** at the junction of ***Keauhou*** and ***Kapapala***. ***Kapapala*** bounds this land on the Kau side. The boundary at shore is at the Eastern base of a hill called ***Kuhalu***; thence to ***Lapo***, thence to ***Kalakuono***; thence to the Kau side of ***Haleolono***; thence to ***Limahina***; thence to ***Kapuuwai***, a water cave; thence to ***Kulanakuaiki***, where Kaina's man was killed by jumping off of the *pali*. Thence to ***Aiaawa***; thence to ***Kahaualea*** at the old road to ***Kilauea***; thence to ***Wepiipaa***, a *pali* on the Kau side of ***Keanakaakoi***.

Kamokukolau is on ***Keauhou***; thence to ***Kilauea*** passing around the South end of the crater, ***Wekahuna***; Thence *mauka* towards the mountain to ***Puaulu*** *aa*, to ***Kauhiulii***; the *aa* belonging to ***Kapapala***, and aa to this land.

Thence to ***Kahiolo***, *aa*, thence to ***Mokuloa***, a large *aa* flow; thence to ***Kapuna***, a grove of small *koa* in the *aa*; thence to ***Kahoaka***, a grove of *koa* above ***Keawewai***; thence to ***Puulaula*** between this and ***Puuike***.

C.X.d.

I went with Lydgate when he surveyed Keauhou. [page 303] He surveyed from ***Pohakuloa*** to Okiokiaho and to the points I have testified to today…

…Keauhou is bounded *makai* by the sea and has Ancient fishing rights extending out to sea.

L. Kaina on the part of the Agent for Crown lands in Puna states that he accepts the boundary between ***Keauhou*** and ***Apua*** as surveyed to boundary between this land and ***Kahaualea***, and ***Olaa*** to the top of ***Kulani hill***, and from thence the boundary between ***Waiakea*** and ***Keauhou*** to ***Kipu***; thence as surveyed by W. Webster to ***Kamaa-mauloa***, and also the survey between ***Kapapala*** and ***Keauhou***.

E.G. Hitchcock on the part of the Agent from Crown Lands for Hilo accepts the boundary between ***Waiakea*** and ***Keauhou*** as given in evidence by Keliilohi, and Webster's survey, and from ***Kamaa-mauloa*** to ***Puulaula*** and ***Puuike*** according to the evidence of Keliilohi.

Testimony Closed.

Decision
The Boundaries of ***Keauhou*** are decided to be as given in evidence of Keliilohi from shore to ***Pohakuloa***, ***Kaloi*** and to top of ***Kulani***; Thence to ***Kipu***. Thence following W. Webster's survey of ***Waiakea*** to Kamaamauloa; thence up the mountain to between ***Puulaula*** and ***Puuike***. Thence following the survey of ***Kapapala*** made of J. M. Lydgate to shore. Notes of survey to be filed previous to Certificate of Boundaries being issued.

R.A. Lyman
Commissioner of Boundaries 3d J.C.

For Certificate of Boundaries see No. 62, Folio 116, Liber I.

Costs see Folio 119, Liber I. [page 304]

Ili of Keauhou, Ahupuaa of Kapapala
District of Kau, Island of Hawaii
Boundary Commission, Hawaii, Volume C No. 3:116-119

For Testimony of Keauhou, Kau,
See Folios 444, Book A and 302 book B.

Land Boundary Commission — No. 62, Hawaii, 3rd J.C.

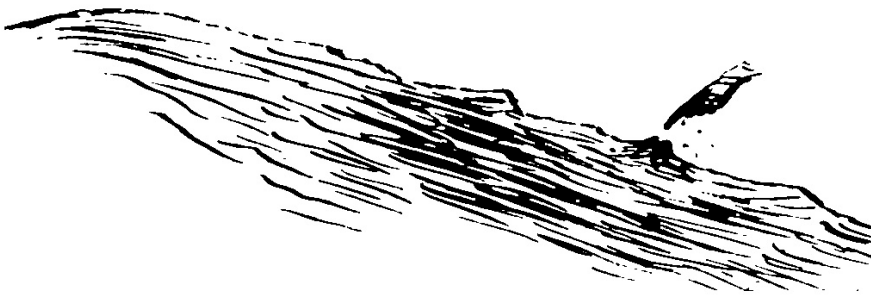
Certificate of the Boundaries of Keauhou, District of Kau, island of Hawaii, 3rd J.C.

Upon the application of F.H. Harris, attorney at law for J.O. Dominis, administrator of the Estate of M. Kekuanaoa, and by virtue of the authority vested in me by law, as sole Commissioner of land Boundaries for the island of Hawaii, 3rd J.C., I hereby decide and certify the boundaries of the *Ahupuaa* of Keauhou, situated in the District of Kau, Island of Hawaii, to be as hereinafter set forth.

Given under my hand at Hilo, Hawaii,
This Twenty-first day of January, A.D. 1875

R.A. Lyman
Commissioner of Boundaries 3rd J.C.

Boundaries of ***Keauhou***
Commencing at a pile of stones on
the sea shore at place called [page 118]
Oki-oki-aho, at the East corner of this
land, and running thence along the
land of ***Apua***, Magnetic bearings;
North 11º 15' West 19392 feet;
to an *ohia* tree marked by two notches
and standing on the brow of the
Poliokeawe *pali*, at the lower end of
a point of *ohia* just East of
the ***Keauhou*** road;
North 20º 40' West 13250 feet;
to an *ohia* marked ┼ at ***Ohiakua-***
puu, a large water cave;
North 11º 03' East 8200 feet;
to *ohia* tree marked ┼┼ at ***Kaloi***,
the junction of the Puna and
Keauhou roads. Thence along the land
of ***Kahaualea***;
North 35º 15' West 16100 feet;
to ***Kaluaike*** crater on the volcano
and Puna road;
North 6º 40' West 3600 feet;
to ***Pohakuloa*** *Koa* grove on the Hilo
and Volcano road; thence along ***Olaa***;
North 38º 20' West 37400 feet;
to top of large hill known as ***Kulani***.
Thence along land of ***Waiakea***;
North 59º 45' west 17400 feet;
To above and opposite a small hill in
the edge of the woods called ***Kipuu*** [Kipu];
North 33º 00' West 17,800 feet;
Along ***Waiakea*** in accordance with
Webster's survey;
South 45º 00' West 31100 feet; [page 117]
along ***Humuula*** to a double hill
on the mountain called ***Puuulaula***,
which presents somewhat this appearance
from the volcano;



Thence down along the land of
Kapapala;
South 57º 00' East 17,200 feet;
to an island in the *Aa* flow.
Thence down this lava flow, which is
the well defined boundary between
this land and ***Kapapala***;
South 53º 35' East 46,000 feet;
To a pile of stones by the side of
the Volcano and Kau road 1556 feet
South West of a pile of stones on the
top of the ***Wekahuna*** [Uwekahuna] bluff;
South 55º 00' East 5140 feet;
to ***Halemaumau*** lake in the crater.
This is the old South Lake;
South 75º 30' East 6670 feet;
to a pile of stones a little South
of ***Keanakaakoi*** crater;
South 8º 50' East 7300 feet;
To pile of stones on *ahua* at
Kamokukolau;
South 24º 30' East 11150 feet;
To a pile of stones on ***Kulanaokuaike***
pali and on the edge of the Puna [page 118]
and Kau road;
South 16º 40' East 30220 feet;
To pile of stones on the sea shore at
place called ***Makoloa***, an old *Heiau*.
This place is 6111 feet East of the top
of ***Kapukapu*** hill. Thence along the
sea shore to point of Commencement.

Containing an Area of 50,740 Acres

R.A. Lyman
Commissioner of Boundaries 3d, J.C.

Surveyed by J.M. Lydgate… [page 119]

The Ahupuaa of Kukuau 1st (bounding Waiakea)
District of Hilo, Island of Hawaii
Boundary Commission, Hawaii Volume B:160-165

Kaikamahine K. Sworn. [page 160]
…the boundary runs to ***Kanekaulukaau*** an old
planting place in the woods, belonging
to ***Waiakea***. ***Palaa*** is the name of the
adjoining planting place on ***Kukuau***.
Thence to the ***Hilo*** side of ***Ohuliipe***, a
heiau belonging to ***Waiakea***. This *heiau*
is on a hill and from it you can see the sea.
The boundary line is some distance from
this hill, it follows up a ridge that runs
mauka and *makai*, and is the dividing line;
it is where *painiu* [*Astelia*] grows. Thence

from the ridge to ***Nehuiki*** where we used
to get canoes eight fathoms long; very large
koa grows there; thence to ***Kailio*** where
koa and *ohia* grow together; thence to ***Kalai-holona***; thence to ***Kailiholoolei***, where the
bird catchers used to catch *oo*; thence to
Muanui, another bird catchers place.
This is as far as I know the boundaries of
Kukuau 1st.

C.X.d… [page 161]

Boundary Commission opened and case
continued on the 17th of December A.D. 1873
according to adjournment from the 16th inst.

Kaaua K. Sworn.
I was born at ***Waiakea uka*** at the time
of *Akakai Mokuakai* [The battle of Mokuohai, 1782]. I know a part
of the boundaries between ***Kukuau*** 1st and
Waiakea. Kuakaahalawa and Keike,
who were bird catchers and canoe makers
and old settlers on the land, and who
knew all the boundaries, told them to me… [page 163]

…***Niaheakealahau*** where
Waiakea takes all the road and Kukuau 1st
is confined to the tall *ohia*; thence the
boundary runs to the Hilo side of a
bathing place called ***Kuawai***; this place
is on Kukuau 1st; thence to ***Kahuakamoa***
(In olden times a noted place for cock
fighting); thence the boundary runs along
the line of the old road (now used for draw-
ing down wood) to ***Kuaiaina***, where the
roads from Kukuau and Waiakea
join. The *pahoehoe* and trees on it belong
to Waiakea, and the forest on the Hilo
side to Kukuau 1st. Thence to ***Kaai-popolo***, a place where *popolo* now grows.

Note.
Witness states that Mr. Webster marked
a tree, on the opposite side from Kaai-
popolo, as the true boundary between
the two lands, but as he objected to that
boundary Mr. Webster changed the survey
to Kaaipopolo.

There is a large tree with a blaze on
it at this place; thence to ***Kahamouli***;
thence to ***Ohuliipii*** [Ohuliipee], a hill on Waiakea.
I do not know of there being a *heiau* [page 164]
there in olden times; thence to a place call-
ed ***Kanoa***; thence to ***Nehuiki***, an old canoe

building place; thence to ***Kaileo***, another canoe building spot where *koa* trees are growing. I have lived there; thence to *Kalaiholona*, a canoe building place; thence to ***Kailihelelei***, a grove of *koa* trees; thence to ***Muanui***, a great bird catching place; thence to ***Hoaa***, the boundary is on a line with Hoaa, but the place itself is way inside of Waiakea. I have always been told that Kukuau ends at Piliiki. I do not know what other lands join above it. Opuloa K. and Nahua (now dead) and Kaawa from Olaa were the *kamaaina* with Webster. Kahaole Opunui now living in Hamakua was a *kamaaina* of Kukuau 1st.

C.X.d… [page 165]

The Ahupuaa of Olaa

District of Puna, Island of Hawaii
Boundary Commission, Hawaii Volume B:305-306

The *Ahupuaa* of ***Olaa***, District of Puna
Island of Hawaii

On this, the 8th day of October A.D. 1874, the Commission of Boundaries for the Island of Hawaii, 3d J.C. met at the Court house in Hilo, on the application of F.H. Harris, Attorney at Law for J.O. Dominis, Agent of Crown Lands for the settlement of the boundaries of ***Olaa***, situated in the District of Puna, Island of Hawaii. Due notice of hearing personally served on all owners or agents of adjoining lands, as far as known. Present: L. Kaina for all parties concerned.

For Petition see Folios 238 and 240, Book A.

Testimony

Nailima K. Sworn.
I was born at ***Olaa*** at the time of the death of Kekuakalani [1819] and lived there until about a year ago when I moved to Hilo. I am a *kamaaina* of ***Olaa*** and know the boundaries of the land. Kapuna, an old *kamaaina* of ***Olaa*** told them to me. Commencing at ***Pohakuloa*** the junction of the Hilo and Puna roads to Kilauea at the *mauka* corner of ***Olaa*** and ***Keaau*** on the boundary of ***Keauhou***; thence the boundary of ***Olaa*** runs *makai* along the old road through the edge of the *koa* grove; thence *makai* still along the road through the woods to ***Keekee*** to ***Palauhulu***, junction of the ***Panau*** and ***Hilo*** road.

Thence along the road to ***Kanekoa*** following the road through houses; thence along the road to *makai* of where the old road to Puna used to run. This point is outside of Naia's houses, where you look *makai*. Thence *makai* to the junction of ***Keaau*** road at the grove of *ohia* trees called ***Pahee***. Thence following along the Hilo road to *makai* of ***Makaulele*** to another junction of ***Keaau*** road; thence *mauka* to *Puhala* trees on an *ahua* on the Puna side of an old *kauhale* called ***Kilohana***, near some orange trees. Thence *mauka* to ***Puaaehu***, a *kauhale* on the ***Hilo*** side. Thence *mauka* to ***Kanamanu***, an old *kauhale* on the boundary covered with *ohia* trees. Thence to [page 305] ***Kaaipuaa***; thence to ***Waiaele***, a swamp in the woods; thence to ***Mawae*** junction of ***Olaa*** and ***Waiakea***; thence along ***Waiakea*** to the upper end of land.

C.X.d.

Note.
L. Kaina declines to question the witness on the boundaries between ***Olaa*** and ***Waiakea*** as the Agent of Crown Lands accepts the boundaries as surveyed by W. Webster. He also accepts the boundary of ***Olaa*** and ***Keauhou*** as given in the Decision of ***Keauhou***.

No more witnesses on hand.

Case continued until the Notes of survey are made out so that the Commissioner of Boundaries can decide the point in the woods where ***Keaau***, ***Olaa*** and ***Waiakea*** join as J.O. Dominis, Crown Agent and C.R. Bishop, on the part of owner of ***Keaau***, leave it with the Commissioner to decide so as to save the expense of looking for the point given in evidence, as <u>said point is in the middle of a dense forest and it is over forty years since the ***kamaaina*** has been there.</u>

R.A. Lyman
Commissioner of Boundaries, 3d J.C.

Notes of survey filed and Certificate of Boundaries issued January 21st A.D. 1875

See No. 60 Folio 109 Liber I… [page 306]

Ahupuaa of Olaa
Boundary Commission, Hawaii Volume C, No. 3:109-111
For Testimony of ***Olaa***
See Folio 305, Book B.
Land Boundary Commission — No. 60 Hawaii 3rd Judicial Circuit

Certificate of the boundaries of ***Olaa***,
District of Puna, island of Hawaii,
3rd J.C.

Upon the application of "J.O. Dominis,
Agent for Crown lands, and by virtue
of the authority vested in me by law
as sole Commissioner of Land
Boundaries for the island of Hawaii,
3rd J.C., I hereby decide and certify
the boundaries of the *Ahupuaa*
of ***Olaa***, situated in the District
of Puna, Island of Hawaii, to be as
hereinafter set forth.

Given under my hand at Hilo, Hawaii,
This Twenty-first day of January A.D. 1875.

R.A. Lyman
Commissioner of Boundaries, 3d J.C.

Boundaries of ***Olaa***.
Commencing at the top of a wooded
Hill known as ***Kulani*** at the West
corner of this land and running
thence along the land of ***Keauhou***,
magnetic bearings South 38º 20' East [page 109]
37,400 feet to a point on the ***Hilo***
and Volcano road at ***Pohakuloa*** *Koa*
grove about 1730 feet from the junction
of the ***Hilo*** and Puna roads. Thence
along the land of ***Keaau*** North
46º 38' East 10,230 feet; North 56º 15' East
9400 feet to **O** cut in the *pahoehoe*
on a little rise in the road, about
a mile and a quarter above the
Omao woods; North 69º 18' East 6400 feet
to **O** cut in the *pahoehoe* on the
road in the belt of woods at ***Omao***;
North 40º 42' East 13,070 feet to **K** cut
in the road at ***Kuhalau***; North
29º 12' East 12,140 feet to **A** cut in the
road at place called ***Kahooku*** where
Neneleau trees are growing and from
where the houses at ***Kanekoa*** can first
be seen in coming down from the
Volcano; North 24º 00' East 23,810 feet
to a pile of stones on a small *ahua*
by the side of the road (East side) a
little below ***Waiuli***; North 42º 10' East
12,350 feet to a pile of stones at the upper
edge of little point of *ohia* through
which the road runs; North 13º 05'
East 5600 feet to a large pile of stones at the

lower side of the road at ***Makaulele***;
North 16º 10' East 985 feet to **O** cut in the
road at the extreme East corner of this
Land. Thence still running along the
Land of ***Keaau***; South 85º 00' West
4250; South 72º 20' West 25,800 feet [page 110]
to a place where the Land of ***Keaau***
is cut off and this land joins the
Land of ***Waiakea***; South 54º 45' West
60,400 feet along the land of ***Wai-***
akea to the hill at the point of
Commencement. Containing 54,260 Acres.

R.A. Lyman
Commissioner of Boundaries, 3d J.C.

Surveyed by J.M. Lydgate… [page 111]

The Ahupuaa of Waiakea

Waiakea Ahupuaa, District of Hilo,
and Olaa Ahupuaa, District of Puna, Hawaii.
Boundary Commission Volume A No. 1 pages 238-240

Honolulu, July 7, 1873

R.A. Lyman, Esq.
Hilo

Dear Sir
Mr. F.H. Harris is authorized by the
Commissioners of Crown lands to make appli-
cation to you as Commissioner of Boundaries
to have the boundaries of all Crown lands on
the Island of Hawaii defined. He has a list of
the lands with him.

I have also authorized Mr. F.H. Harris
to make application to you for the settlement
of boundaries of all lands belonging to Est. of
His late Majesty and Her Excellency, R.
Keelikolani.

I expect to be in Kona by the trip
of the "*Kilauea*" which leaves here on the 28th
inst. Can't you make it convenient to come
round as the steamer goes to Hilo on that trip.
I wish also to apply for the settle-
ment of the boundaries of Honohina.

I remain,
Yours Respy.
Jno. O. Dominis

Honorable R.A. Lyman
Boundary Commissioner
for Island of Hawaii, Haw. Is.

The undersigned would herewith make application for the settlement of the boundaries of the following named Ahupuaas or Lands belonging to the Crown, viz.:

Waiakea in the District of Hilo bounded by *Keaau,* ***Olaa***, ***Kapapala***, ***Humuula***, Piihonua… [page 238] Humuula in the District of Hilo bounded by Kapapala, various lands in Kona and Kohala and Hamakua, and Hakalau, Makahanaloa, Papaikou, Paukaa, Piihonua and Waiakea in the District of Hilo… [page 239]

…***Olaa*** in the District of Puna, bounded by ***Keaau***, Wm. C. Lunalilo, H. M. ***Waiakea*** & ***Kapapala***…

Your Honor will therefore please appoint a day for hearing the evidence in the foregoing named lands and having decided upon the same to grant a certificate to that effect to the undersigned.

Hilo Hawaii, August 16th A.D. 1873

(Signed) Jno. O. Dominis
Crown Land Agent.
by F.H. Harris
atty. at law. [page 240]

The metes and bounds of ***Waiakea*** were decided by testimonies and surveys of adjoining lands—ʻŌlaʻa and Keaʻau, Puna; Keauhou and Kapāpala, Kaʻū; and Humuʻula on the mountain lands of Hilo; thus, no further commission proceedings were conducted under the heading of Waiākea.

The "Kulani Triangulation Station"

In the 1890s, the Government Survey Division undertook a series of surveys to map out the interior lands on the island of Hawaiʻi. Through several communications between field surveyors and W.D. Alexander, Surveyor General, we learn that Puʻu Kūlani was chosen as a triangulation station for the surveys, and of the great difficulty in reaching the location. Almost no *kamaʻāina* could be found in the early 1890s to lead the survey party to the *puʻu*.

Hilo, Hawaii
April 27, 1891
E.D. Baldwin; to Professor W.D. Alexander:
…I arrived in Hilo last Saturday night from Puakala. We have had fairly good success at Aahuwela, <u>having measured the angle between Alala and ***Kulani*** also nearly finished the angle between Halai and ***Kulani***</u> also Alala and Halai. The 8 inch is a very slow instrument to work with, there being a great deal of lost motion in setting. But by a great deal of care in setting, I believe we have managed to do very fair work with it. The measurements of the Alala Halai angle so far close the triangle within 4".

We had a very rough trip up the mountain; it raining steady all of the three days on our way to Puakala. Thrum started the day before I did and reached Hale-Loulu just at dusk; and was unable to start a fire, everything was so wet. He had a great deal of trouble with the pack animals in the woods. Two of our animals were completely used up by the trip, and I am afraid will be unfit for use any more.

I will start back early tomorrow morning. I send down any April accounts; the laborers pay roll, I will send down next month… [HSA Interior Department, Survey]

Hilo, Hawaii
May 30, 1891
E.D. Baldwin; to Professor W.D. Alexander:
…We are sharing a very tedious time of it upon the mountain; the weather has been very fair below, but the fog and clouds hang just over Aahuwela, so that for the last three weeks we have done almost nothing.

I have given up the idea of trying to see Kapoho or the other Puna stations from Aahuwela as they are always covered with a cloud, and I am afraid we will have to wait until doomsday to see them. I am going to send a heliotrope to Kaloli point – a short ways beyond Keaau, and devote myself to the large quadrilateral Aahuwela, Alala, ***Kulani*** and Kaloli, and work on through Puna from the base, ***Kulani*** to Kaloli which will form good triangles with my other Puna stations.

We hope to finish with Aahuwela soon if the weather permits, at any rate I am going to finish the topographical work around the base of the mountain to Kalaieha and a little beyond, and leave Thrum to watch at Aahuwela. We have been on Aahuwela for the last four weeks, every morning at day light, and then gone up before noon, and remained until there was no hopes of its clearing, without accomplishing any thing on the Hilo station with the exception of ***Kulani*** and ***Puu Ulaula*** which are always clear in the morning.

Kulani is just below the almost perpetual cloud line, so that I think it will not take us long there.

I have no suitable map tin to send the Hilo map down in; and think rather than run any risk of damaging the map, I will bring it down with me, as I intend to go to Honolulu on June 22nd and attend the Punahou Jubilee.

I send part of my accounts for the month of May, that is all but the labor items. Can you please turn over to H. Chamberlain $72.00 on my account.

We need all the animals we can get, but they must be strong and in fairly good condition to stand our hard trips. If the Molokai horses are in good condition, I think we had better have them up here… [HSA Interior Department, Survey]

Hilo, Hawaii
August 23, 1891
E.D. Baldwin; to Professor W.D. Alexander:
…I returned last Thursday, having stopped over a trip on Maui. Thrum saw Chamberlain's heliotrope at Kaloli, and has obtained a few angles between it and ***Kulani***, as Alala was invisible; he then came to Hilo, and notified Horace that he was *pau* with Kaloli. Horace has gone up the mountain with Thrum to help him down with camp. Also I am having Thrum fix a few points along the 1855 flow as he comes down; which will not take long and can be easily done now as we have flags on all the prominent Mauna Kea cones which he can sight to.

I expect Thrum & Chamberlain down the latter part of this week; and have everything ready to move right away to ***Kulani***. From ***Kulani*** we will move to Kaloli point, and by occupying these two points first – will fix many points along the Puna ridge. We hope before long to be well into Puna; at any rate I shall try and push the Puna work, so that we can have something to show, for the next Legislature.

The Molokai animals are doing well, so far. They have been some-what used-up by some of the trips, but seem to be tough animals and pick up readily.

The Humuula boundary case came up last Thursday, and as it will probably be referred to the Boundary Commissioner to settle upon where the line should go, I thought you would probably wish me to wait until we get his decision – before making out notes of survey from Pohaku o Hanalei to Kaupakuhale. I am now plotting up any mountain work to a scale of 2000 feet to the inch, which will take in all we have done around the base of Mauna Kea. I would like to get Lyon's location of Kaupakuhale, in Hinahina, Kaloaloa, and some of his boundary points this side of Kaloaloa station, so that I can put them on the map, and finish up the map.

I noticed that the few clear nights that we had at Aahuwela, it was also clear during the morning, but I think it will be a good idea to have the large lanterns you speak of ready, so that if necessary we can try them. Our instrument seems to have no lamp to light the cross hairs; also we will want some dark lanterns. [HSA Interior Department, Survey]

Hilo, Hawaii
September 2, 1891
E.D. Baldwin; to Professor W.D. Alexander:
…Thrum and Chamberlain arrived this evening from the mountain. I wrote to Thrum to give up locating any points below Lydgates ***Mawae*** on the 1855 flow, so that we might push on to ***Kulani***. We will make a start for ***Kulani*** next Monday. In regard to the location of those five points – I understood that you wished the notes of survey from Kaupakuhale on to Pohaku o Hanalei, and as supposed that Lyon's had located Kaupakuhale & did not relocate it again; and after receiving your letter a month ago; wrote by return steamer for Lyon's location of Kaupakuhale, so that I could get the distance and bearing from Kaupakuhale to Kole from my map. Lyon's has not as yet sent me the location of Kaupakuhale; but wrote by last steamer that he would like the coordinates of four of the points referred to Aahuwela, which I have sent him by this steamer.

We have been making up a lot of oil-skin clothes and bags, also we made a fly and tarpoling for our small tent, which accounts for the large amount of canvas duck we have been buying.

Our large tent and fly are nearly all to pieces. Can you please send us up another large tent and fly. Also I would like a lot of blank vouchers and a large calculation book.

Can you please pass H. Chamberlains pay over to W. Frear $79.85. And deposit $300.00 in the Postal Savings Bank for me, and please send the balance to me…[HSA Interior Department, Survey]

Kulani Trig. Station
November 24, 1896
J.S. Emerson; to W.D. Alexander
…After 8 ½ days of severe labor, my party of 4 strong and experienced wood cutters, yesterday completed the road through the *Koa* forest and *Pulu* jungle to this point. We started a blazing fire at 4:30 this morning. At 8:30 our party, with 5 good pack mules, left the *Kipuka* and at 10:50 we had reached the base of this noble hill. About 40 minutes of this time was spent in cutting away some obstructions in the path, leaving 1 hour and forty minutes for travelling time. While the mules are resting in an *akala* thicket at the base of the hill. My men are climbing the ascent with loads that surprise me. I found it hard work to lug a gun and overcoat, and my handwriting shows the

eddects of the exertion on my nerves and muscles. The weather continues almost perfect. We have been most fortunate in having two weeks of such unusually clear weather. I have never known it better since I began my work last July. At the moment (12:25), Mauna Kea is clouding in, while M. Loa has only two small specks of clouds just forming. Last Sunday was the finest day of the season. A heavy frost covered the ground when we awoke in the morning. My men who had never seen anything of the kind before, the guide was not among them, tasted to see if it was salt, and asked me what it was. All that day the sun shone from a cloudless sky. We went to ***Keawewai*** to bathe, and the view of the mountain and coast was wonderfully fine. I can't expect such weather to last. ***Kulani*** signal is in distress. A few tattered rags here and there all over the tripod, a bare pole with a rag or two on it, the whole surrounded by a jungle of brush 6 feet high, with a few bare trunks of *lehua* trees near by, easily mistaken for the signal, that is all. No wonder I have had trouble to see anything to sight on.

Kamaki flagged the signal as he had been taught. The system or lack of system was all wrong. Of course heliotropes have to be used to supply the defects of such signals… [HSA –Survey DAGS 6]

Travel and Access in the ʻŌlaʻa-Waiākea Forest Lands

Because of the remote nature of the ʻŌlaʻa and Waiākea forest lands which comprise the present-day Puʻu Makaʻala NAR, no government communications pertaining to historic trails or government road projects exist for the region. The Boundary Commission testimonies cited above, describe trails through the forest lands, rising from the lowlands of Waiākea, ʻŌlaʻa, Keauhou and Humuʻula. Based on the native traditions and *kamaʻāina* testimonies, as those above, it is likely that "practitioner" trails existed throughout the forest region. Features such as "*kauhale manu*" (bird-catcher's shelters), "*kahua kalaiwaa*" (canoe-makers clearings), "*oioina*" (trailside resting places and shelters), the "*ala hele*" (trails), and other features associated with traditional and customary accesses, would leave little evidence in the present-day, as the traditional features and uses generally had minimal impact on the natural landscape. Those things left behind, not cared for or maintained, were simply reabsorbed into the landscape.

We do know that by 1847, the Kingdom undertook a program of developing the *Alanui Aupuni*, or Government Road system. The "roads" were generally laid out on, or near traditional alignments, though as the system matured, and greater need for roads which could support transportation of goods evolved, new and straightened alignments were developed. One of the earliest communications documenting this process on the island of Hawaiʻi, is found in a letter from Governor Kapeau to Premier and Minister of the Interior, Keoni Ana on August 13, 1847:

Aloha oe e ka mea Hanohano –
…I have a few questions which I wish to ask you. Will the police officers be required to pay, when they do not attend the Tuesday (*Poalua*) labor days? How about parents who have several children? What about school teachers and school agents? Are they not required to work like all other people when there is Government work on the roads and highways? I believe that school agents, school teachers and parents who have several children, should only go and work on the weeks of the public, and not on the *konohiki* days…

…The roads from Kailua and down the *pali* of Kealakekua, and from Kailua to Honokohau, Kaloko, Ooma, the place where our King was cared for, and from thence to Kaelehuluhulu [at Kaulana], are now being surveyed. When I find a suitable day, I will go to Napoopoo immediately, to confer with the old timers of that place, in order to decide upon the proper place to build the highway from Napoopoo to Honaunau, and Kauhako, and thence continue on to meet the road from Kau. The road is close to the shore of Kapalilua. Also, the road that is to go *makai* of Kukalaula, below Keauhou [Kaʻū], and then continue to the shore of Puna and Hilo, will probably begin at Keaiwa.

> The width of the highways round Hawaii, is only one fathom, but, where it is suitable to widen where there is plenty of dirt, two fathoms and over would be all right. For the town of Hilo, I have appointed some road overseers, being B. Pitman, Frank W. Wood, maybe Koana [Titus Coan], Halai, Luhilea, Kaiana. Three natives and three foreigners. They get no pay for this work which has been placed upon them, they give their services free to this work because of their desire to improve the land.
>
> If the roads are put into proper condition, there are a lot of places for the strangers to visit when they come here. The Kilauea volcano, and the mountains of Maunaloa, Maunakea, Hualalai. There is only one trouble to prevent the building of a highway all around, the steep gulches at Waipio and Pololu, but this place can be left to the very last. The palis at Hilopaliku are also very bad, but another and better place has been found, it is a little *mauka* of that, that is what the old timers living at Kulaimanu say. A foreign carpenter has proposed to me that he build the bridge over Wailuku completely, all the material to be his and also the labor, and to pay him two thousand dollars. I did not pay much attention to this, because, I do not believe that it can be built for that money, it will take three thousand dollars to finish it, and maybe it will go into four thousand… [HSA Interior Department, Roads; translation modified by Maly]

As described in the preceding letter, no roads across Keauhou, the ʻŌlaʻa-Waiākea forest lands, into Humuʻula were planned. By the late 1800s, and through the 1940s, the primary users of trails in the *mauka* lands were ranchers, traveling between Humuʻula and Puʻu ʻŌʻō to Keawewai and Keauhou, and those traveling on to Kapāpala and Kahuku.

In 1932, as a part of the Land Court Application of W.H. Shipman for the land of Keaʻau, testimonies of two elder *kamaʻāina* were recorded, documenting primary routes of travel in Keaʻau, and the relationship of native residents with ʻŌlaʻa and neighboring lands. The testimony, viewed in the collection of W.H. Shipman, Limited, shares the same concepts of traditional and customary access as described in traditional texts and historical testimonies cited above.

> ***Affidavit of David Malo***
> DAVID MALO, of Keaukaha, S. Hilo, Hawaii, being first duly sworn and upon his oath, deposes and says as follows:
>
> I was born in the year 1852, at Makuu, Puna, Hawaii.
>
> I am 80 years old.
>
> I was brought up in Makuu, Puna, and lived there for many years, up to the time when my father died. I was then about 18 years old.
>
> The King Highway or Main Public Highway starts from Puumaile, Waiakea, and goes through Waiakea, Keaau, Kapoho, Kalapana along the seacoast and on Panau to the Volcano…
>
> The old Volcano Highway starts from Hilo and goes through Puuainako, Waiakea, and goes on to the present 4 mile bridge, thence it turns off to the right or *mauka* side of the 4 mile bridge and goes on till it crosses the present main public highway about 7 miles, thence it goes on till it meets again the present main public highway at 8 miles, thence it goes on to 9 miles Olaa, thence it goes on to Kuolo, and on the *pahoehoe* to Mahinaakaka, and on to Waiuli where Hawelu's Hotel was located, thence it goes on to Kalehuapua, Kapae, Kapueuhi, and on to Kekee where Shipman's cow pen is, where it meets with the present highway, thence it goes on to the Volcano. The old Volcano Highway separates Keaau from Olaa.

The people that were living in Olaa were tenants at will (*Komo Kino*) while under Queen Emma. My father was the Queen's *Konohiki*. The people that were living in Keaau paid money for living on the land. Only tenants were allowed to go on the land. The people of Waiakea were not allowed to go on Keaau without permission…

There was a big village *mauka* of Keaau in Olaa.

The only main trail or main Public Highway that was used by everybody at that time is the trail that starts from about 12 miles Olaa, and goes down to Waipahoehoe, and on to Makuu till it meets the King Highway.

There were many other trails running down to the King Highway and the beach, some of them were made by cowboys for driving cattle, and some of them were made by cows…

Subscribed and sworn to before me this 15th day of December, A.D. 1932.

Affidavit of Mai Keoki [George Mai]
MAI KEOKI, of Keaau, Puna, Hawaii, being first duly sworn and upon his oath, deposes and says as follows:

I am 64 years old.

I was born May, 1868, at Paki, Keaau, Puna, Hawaii.

I have lived in Keaau, Puna all my life time.

Only one Keaau.

When Keaau came into Mr. Shipman's possession, the people that were living in Keaau became tenants at will (*Komo Kino*).

The people of Olaa lived in Olaa and the people of Keaau lived in Keaau…

Hawelu's Hotel was on Olaa. Mr. Hawelu was Mr. Shipman's foreman.

The trail or road from Olaa to Makuu is the main road upon which the *kamaaina* and strangers travelled from Makuu to the old Volcano Road, and from Olaa to Makuu. This main trail is the road which David Malo had described.

Another small trail starts at 12 miles Olaa and goes down to Keakuamakakii, where it passes Hilo of the Stone Crusher *makai* of the Pahoa Highway, thence it goes on to Lopaiki, and on to two cocoanut trees, thence it goes on to Kaikoo where it branches off. One branch goes down to Keauhou and another branch goes down to my place. On this trail the people of Olaa came down to my place.

During Obed Spencer's time there were no tenants at will. Since the fence was put up along the Pahoa Road, this trail has not been used by anybody. Nobody has used this trail since 1910 or 1911. When the people were made tenants at will, the people have not used this trail since…

Subscribed and sworn before me this 17th day of December, A.D. 1932.

It appears that it was not until the late 1940s, that a road was cut up through the Waiākea-ʻŌlaʻa forest lands, and this in conjunction with the opening of the Kūlani Prison Farm. In the early 1950s an access road was cut from the Kūlani facility to the summit region of Mauna Loa for a weather observatory. At one point, the program manager, Tom Vance, proposed that the road be planted with the trees of the world, as a scenic drive to Mauna Loa (H. Ellis, pers comm. 2004; and HSA Series GOV 9-7).

While Mr. Vance's idea was a grand one, looking to the economic benefit of Hawaiʻi Island, we can be thankful that the plan never unfolded. The toll of an influx of alien species on the native ecosystems that are now a part of the Puʻu Makaʻala NAR would have been significant.

NĀ ULU LĀʻAU A ME NĀ KINI KINO LAU O LOKO (THE FORESTS AND MULTITUDES DWELLING THEREIN)

As discussed in earlier sections of this study, Hawaiian traditions and beliefs, shared spiritual and familial relationships with the natural resources around them. Each aspect of nature from the stars in the heavens, to the winds, clouds, rains, growth of the forests and life therein, and everything on the land and in the ocean, was believed to be alive. Indeed, every form of nature was a body-form of some god or lesser deity. As an example, in this context, and in association with lands which are part of, or adjoining the landscape of the Puʻu Makaʻala NAR, we find that the god Kū-ka-ʻōhiʻa-Laka, is represented as a deified *ʻōhiʻa*; Kū-lili-ka-ua, formed the mists and protected the forests of this upland region; and Ua-kuahine is given as the name of another goddess whose body form is that of the mists that settle on the forest. Tradition also tells us that the gods and goddesses of the forests were very protective of them. In olden times, travel through them was accompanied by prayer, and care. Many a careless traveler, or collector of resources, found themselves lost in a maze of overgrowth and dense mists, for disrespectful and careless actions. In the Hawaiian mind, such nature body forms of plant, animal, and weather, were believed to be "*kino lau*," the myriad body-forms of the gods and creative forces of nature that gave Hawaiians life.

In this context, care for each aspect of nature, the *kino lau* of the elder forms of life, was a way of life. This concept is expressed by Hawaiian *kūpuna* (elders) through the present day, and is passed on in many native families. When discussing the relationship of native families with the lands and resources around them, it is not uncommon to hear *kūpuna* express the thought — *"E mālama i ka ʻāina, a e mālama hoʻi ka ʻāina iā ʻoe! E mālama i ke kai, a e mālama hoʻi ke kai iā ʻoe!"* (Care for the land, and the land will care for you! Care for the sea, and the sea will care for you!). This concept is one that is centuries old and is rooted in the spirituality of the Hawaiian people. Importantly, the converse is that when one fails to care for, or damages nature—the *kino lau*—around them, they are in-turn punished. This is expressed in many traditional sayings, one being, *"Hana ʻino ka lima, ʻai ʻino ka waha!"* (When the hands do dirty-defiling work, the mouth eats dirty-defiled food!). In this cultural context, anything which damages the native nature of the land, forests, ocean, and *kino lau* therein, damages the integrity of the whole.

Of course, since traditional times, many things that were a part of the native Hawaiian natural and cultural landscape have disappeared—being destroyed by changes in land tenure, changes in residency and subsistence practices, and by the introduction of tens-of-thousands of alien species which have overrun the formerly balanced and fragile bio-systems that made Hawaiʻi unique.

Writing in the late 1860s and early 1870s, native historian, S.M. Kamakau, related to readers some aspects of the Hawaiian association and understanding of the mountain lands and forests. While describing traditional knowledge of the divisions of land, Kamakau wrote:

> Here are some other divisions of the islands, together with their descriptive names.
>
> Heights in the center or toward the side of a land, or island, are called *mauna*, mountains, or *kuahiwi*, "ridge backs." The highest places, which cover over with fog and have great "flanks" behind and in front (*kaha kua*, *kaha alo*)—like Mauna Kea—are called *mauna*; the place below the summit, above where the forests grow is the *kuahiwi*. The peak of the mountain is called *pane poʻo* or *piko*; if there is a sharp point on the peak it is called *puʻu pane poʻo*; if there is no hill, *puʻu*, and the peak of the mountain spreads out like the roof of a house, the mountain is described as a *kauhuhu mauna* (house ridgepole mountain); and if there is a precipitous descent, *kaolo* [from the peak] to the *kauhuhu mauna* below this is called a *kualo* ("block"). If there are deep ravines (*ʻalu haʻahaʻa*) in the sides of the mountain it is called a *kihi poʻohiwi mauna* ("shoulder edge" mountain). A place that slopes down gradually (*hamo iho ana*) is called a *hoʻokuʻu* (a "letting down"); a sheer place is called a *pali lele koaʻe* (cliff where

koa‘e birds soar), or a *holo* (“slide”), or a *waihi* (a “flowing down”). Rounded ridges that extend from the mountains or “ridge backs” or hills are called *lapa* or *kualapa* or *mo‘o*—and, if they are large, *‘olapalapa* or *‘omo‘omo‘o*. Depressions between *lapa* or *mo‘o* are *awawa*, valleys.

Here are some names for [the zones of] the mountains—the *mauna* or *kuahiwi*. A mountain is called a *kuahiwi*, but *mauna* is the overall term for the whole mountain, and there are many names applied to one, according to its delineations (*‘ano*). The part directly in back and in front of the summit [Kamakau 1976:8] proper is called the *kuamauna*, mountaintop; below the *kuamauna* is the *kuahea*, and *makai* of the *kuahea* is the *kuahiwi* proper. This is where small trees begin to grow; it is the *wao nahele*. *Makai* of this region the trees are tall, and this is the *wao lipo*. *Makai* of the *wao lipo* is the *wao ‘eiwa*, and *makai* of that the *wao ma‘ukele*. *Makai* of the *wao ma‘ukele* is the *wao akua*, and *makai* of there the *wao kanaka*, the area that people cultivate. *Makai* of the *wao kanaka* is the *‘ama‘u*, fern belt, and *makai* of the *‘ama‘u* the *‘apa‘a*, grasslands.

A solitary group of trees is a *moku la‘au* (a “stand” of trees) or an *ulu la‘au*, grove. Thickets that extend to the *kuahiwi* are *ulunahele*, wild growth. An area where *koa* trees suitable for canoes (*koa wa‘a*) grow is a *wao koa* and *mauka* of there is a *wao la‘au*, timber land. These are dry forest growths from the *‘apa‘a* up to the *kuahiwi*. The places that are “spongy” (*naele*) are found in the *wao ma‘ukele*, the wet forest.

Makai of the *‘apa‘a* are the *pahe‘e* [*pili* grass] and *‘ilima* growths and *makai* of them the *kula*, open country, and the *‘apoho* hollows near to the habitations of men. Then comes the *kahakai*, coast, the *kahaone*, sandy beach, and the *kalawa*, the curve of the seashore—right down to the *‘ae kai*, the water’s edge.

That is the way *ka po‘e kahiko* named the land from mountain peak to sea. [Kamakau 1976:9]

Among the native terms listed by Kamakau above, is one which stands out in reference to the Waiākea-‘Ōla‘a forest lands of the Pu‘u Maka‘ala NAR—this zone is the wao *akua* (zone or region of the gods and deities). The *wao akua* is so named because of the pattern of cloud cover and precipitation which settles upon the mountain slope—this covering was interpreted as concealing from view the activities of the gods and deities therein (cf. David Malo 1959:16-18; and M.K. Pukui, pers. comm. 1975).

In the traditional context above, we find that the mountain landscape, its’ native species, and the intangible components therein, are a part of a sacred Hawaiian landscape. Thus, the landscape itself is a highly valued cultural property. It’s protection, and the continued exercise of traditional and customary practices, in a traditional and customary manner, are mandated by native custom, and State and Federal Laws (as those establishing the ‘Ōla‘a and Waiākea Forest Reserves, the Pu‘u Maka‘ala Natural Area Reserve, and the Endangered Species Act).

In this discussion, protection does not mean the exclusion, or extinguishing of traditional and customary practices, it simply means that such practices are done in a manner consistent with cultural subsistence, where each form of native life is treasured and protected. *Kūpuna* express this thought in the words, *“Ho‘ohana aku, a ho‘ōla aku!”* (Use it, and let it live!).

Transitions in the Health and Value of The Hawaiian Forests Following Western Contact

We find that shortly after western contact—the introduction of alien herbivores, and financial value being placed upon resources of the forests and mountain lands—the health and integrity of the resources began to decline. After western contact, the forests were primarily evaluated in the terms of

the western economic system. While in the centuries prior to the arrival of westerners in 1778, and subsequently into the reign of Kamehameha I, the system of land tenure and management mirrored the natural landscape of the islands, later management systems focused on what, and how much could be gotten from the land.

Immediately, upon western contact, foreigners looked at the land—first as a source of provisions for ships; and second as a means for earning money, through the trade of natural resources such as *ʻiliahi* (sandalwood). In 1778, European boars, goats, rams, and ewes were introduced by Captain Cook. While offered as a "gift," one of the motivating factors was that leaving the animals behind would produce a breeding stock to supply other foreign ships (Beaglehole 1967:276, 578-579). Later, in 1793, cattle were brought to Hawaiʻi by Captain Vancouver. Given as gifts to Kamehameha I, the cattle were first let off at Kawaihae (then at Kealakekua), and were placed under a ten-year *kapu* to protect them and allow them to reproduce (Kamakau 1961:164). Between 1793 and ca. 1811, new stock was added, and the numbers of cattle had increased dramatically. The introduced cattle, goats and sheep rapidly became a problem to the native population and forests.

While the introduced animals were making their way into the higher elevations, other economic pursuits also led to the clearing of large tracts of land. In the early 1800s (ca. 1810-1829), tens-of-thousands of pounds of *ʻiliahi* (sandalwood) were cut from the forests above Waiākea and Keauhou, Kaʻū (cf. Kamakau 1961, and Ellis 1963).

Describing the collection of *ʻiliahi* in 1823, from the uplands of the Waiākea region, Ellis wrote:

In Hilo, the party was under the care of the chief Maʻalo (written Maaro), Ellis and companions offer the following narratives, describing the land there about and activities of the people, among which included hundreds of residents being required to go to the mountains above, and gather sandalwood for their chiefs:

> …we overtook Maaro, the chief of Waiakea, and three or four hundred people, returning with sandal wood, which they had been cutting in the mountains. Each man carried two or three pieces, from four to six feet long, and about three inches in diameter. [Ellis 1963:214] The bark and sap had been chipped off with small adzes, and the wood appeared lighter in colour than what is usually sold at Oahu, probably from its having been but recently cut down…. Although a plant of slow growth, it is found in abundance in all the mountainous parts of the Sandwich Islands, and is cut in great quantities by the natives, as it constitutes their primary article of exportation.
>
> It is brought down to the beach in pieces from a foot to eighteen inches in diameter, and six or eight feet long, to small sticks not more than an inch thick and a foot and a half long. It is sold by weight, and the merchants, who exchange for it articles of European or Chinese manufacture, take it to the Canton market, where it is bought by the Chinese for the purpose of preparing incense to burn in their idol temples. …Dense fogs and heavy rains are more frequent at Waiakea, and over the whole division of Hiro, than in any other part of the island... [Ellis 1963:215].

By the 1830s, the forest had been stripped of sandalwood and many other plants of the forest were impacted by the clearings made for collection and transportation of the *ʻiliahi*. Another reason that large sections of the lower forests were cleared, was to develop lands on which western-introduced food crops could be cultivated and harvested for sale to visiting ships.

In this part of the discussion, it is appropriate to note that the European boar was significantly larger, and thus stronger, than the Polynesian introduced *puaʻa*, or pig (Beaglehole 1967:579). Our review of more than 60,000 native Hawaiian land documents dating from 1846 to 1910 revealed many references to *puaʻa* (pigs), but nearly every reference was in the context of them being near-home and as being cared for (raised), not hunted. In the same review of the native Hawaiian land

documents and a large collection of writings from native authors (e.g., D. Malo, 1951; J.P. Ii, 1959, S.M. Kamakau 1961, 1964 & 1976), every reference to traditional collection or "hunting" (a word seldom used in the historical records), was in the context of native birds—those used either for food or from which feathers were collected for royal ornaments and symbolic dress.

After ca. 1815, we find that when native Hawaiians went hunting in the uplands—as described in testimonies and historical texts of the time—they were hunting bullocks, goats and other introduced grazers, and this was generally done on the demand of their landlords, and later for the growing ranches being established in the islands. The first full-scale efforts of western-style hunting in the Humu'ula-Waiākea and Keauhou (Ka'ū) region does not appear in reference until around 1840 (cf. Kamakau, 1961; Government Communications in this study). Those early outings were focused on collection of hides and tallow; and controlling wild herds of animals that were a threat to travelers, agricultural fields, residences, and forest resources.

Immergence of Hawaiian Forestry Programs

So significant was the threat of these animals to the Hawaiian landscape, that on September 19, 1876, King David Kalākaua signed into law, an Act for the Protection and Preservation of Woods and Forests. By this Act, the Minister of the Interior was authorized to set apart and protect from "damage by trespass of animals or otherwise, such woods and forest lands, the property of government…best suited for the protection of water resources…" (Hawaii Laws Chapter XXX:39). The Minister of the Interior was authorized to appoint a superintendent of woods and forests:

> …who shall, under the direction of said Minister, enforce such rules and regulations as may be established to protect and preserve such reserved woods and forest lands from trespass. Said superintendent shall have charge of the construction of fences and barriers required to protect the said woods and forest lands, and shall be responsible for their being kept in good condition… (ibid.).

The above Act was further defined by an Act of the Legislature of the Hawaiian Kingdom, approved by Queen Lili'uokalani on January 4, 1893, which established the Bureau of Agriculture and Forestry. Among the Bureau's goals was the "preservation of forests." On June 14, 1900 (then organized under the newly formed Territorial Government), the members and functions of the Bureau were absorbed by the Board of Commissioners of Agriculture and Forestry (Hawaii State Archives – Com 2, Box 11). The Board then set about the task of establishing forest reserves on all the islands; among the first being development of the Hilo Forest Reserve, which was needed to "protect the headwaters of the streams, which play so important a part in the success of the various plantations" (Wm. Hall 1904:277). On August 9, 1904, the Commissioners approved the recommendation that "all government and other lands in the district of Hilo, Island of Hawaii, lying above a line approximately 1750 feet above the sea, be set apart as a forestry reservation" (Hall 1904:282). The lands extended from Laupāhoehoe to Pi'ihonua, adjoining the land of Waiākea.

In 1905, the Board set in motion plans to set aside and protect portions of the 'Ōla'a and Waiākea forest lands, the result being establishment of a forest band around the northeastern portion of the island of Hawai'i.

Regarding the forestry movement in the islands, C.S. Judd, Superintendent of Forestry, wrote the following account of forests and forestry in the Hawaiian Islands to Governor Farrington (October 10, 1924). Eighty years later, his words still present readers with an important frame work for the on-going efforts in protection of Hawai'i's native forests:

> Forestry is practiced in the Territory of Hawaii primarily, not for timber production, but for the conservation of water. Probably in no other section of the world is the relation between a satisfactory forest cover on the mountains and the supply of water for domestic and agricultural uses better or more ably demonstrated…

The chief product, and, the most valuable, coming from the main forested and mountainous regions of the Territory, comprising about one-fourth of the total land area of the eight islands (4,099,860 acres) is water. Because of the comparatively limited terrain, short and steep water sheds, heavy rainfall in certain regions and the great need for irrigating the dry but fertile, sun-warmed lowlands, the value of this liquid product of the forest, on which domestic needs and prosperity of the community depend, is most highly appreciated and every effort is being made to conserve and maintain its sources in the forests.

Character of the Native Forest.
The forest of comparatively small trees found growing naturally on the mountain slopes is admirably suited to prevent erosion and to convert surface runoff into underground drainage, the desirederatum in water conservation. The happy combination of small trees, brushes, ferns, vines and other forms of ground cover keep the soil porous and allow the water to percolate more easily into the underground channels. The foliage of the trees breaks the force of the rain and prevents the impacting of the soil by rain drops. A considerable portion of the precipitation is let down to the ground slowly by this three-storied cover of trees, bushes, and floor plants and in this manner the rain, falling on a well-forested area, is held back and instead of rushing down to the sea rapidly in the form of destructive floods, is fed gradually to the springs and streams and to the underground artesian basins where it is held for use over a much longer interval.

Protection of the Forest.
Forest practice in the Territory of Hawaii, therefore, resolves itself into what is known as "forest protection" and the main efforts of the foresters are exerted in maintaining and build up the native forests on the mountains so that they will function to the highest degree in conserving the rainfall.

The native forest, however, is peculiarly constituted in that it is readily susceptible to damage. The shallow-rooted trees depend for proper moisture and soil conditions on the undergrowth of bushes and ferns and when the latter, the first to be attacked by stock, are injured or removed, the tree roots dry out, the trees are weakened and begin to decline, and an opening is made in the forest for the invasion of destructive insects and fungi and of the more vigorously-growing foreign grasses and other plants which choke out native growth and prevent tree reproduction. It is always dangerous for this reason to make any opening in the native forest and the only safe way to preserve it and keep it healthy and vigorous is to maintain it inviolable from all attacks and keep the ground well shaded and dark.

Damage to the Forest.
The chief damage to the native forest is done by cattle and other grazing stock which first attack the toothsome ferns and other plants which give the shallow-rooted trees the protection which is necessary to their existence.

The fencing of exposed forest boundaries to keep out stock and the extermination of wild stock where it exists in the forest constitutes an important item in forest work in the Territory…

Forest Reserves.
Forest lands devoted to the purpose of water conservation have been officially recognized under the law and set apart as forest reserves by proclamation of the Governor. In this manner during the past two decades 50 of such forest reserves have been set aside on the five largest islands of the group. These embrace a total area of 840,984 acres of which 579,905 acres or 68 per cent is land belonging to the Territory… (Hawaii State Archives – Com 2, Box 15)

Dedication of the ʻŌlaʻa and Waiākea Forest Reserves

As noted above by 1904, the Territory set in motion plans to protect Hawaiian forests by designating select tracts of land as forest reserves. While the primary perceived value of the forest reserves was economic—forests that produced water for agriculture, or forests from which wood and other natural resources could be harvested and sold—large tracts of land, upon which important Hawaiian ecosystems existed were set aside. Among these tracts were lands of the Hilo and Puna Districts, portions of which now make up the Puʻu Makaʻala NAR.

By 1905, the reports of the Board of Commissioners of Agriculture and Forestry begin describing the forests of ʻŌlaʻa, and in the following years, through the 1920s, we see the development of a system of forest reserves through ʻŌlaʻa, Waiākea, and Keauhou (the adjoining land in Kaʻū). The following narratives and notes of survey describe the nature of the reserve lands, their resources, and the thoughts behind protection and management of these unique systems. The records focus on the founding history of the reserves, and come from the collections of the Division of Forestry and Wildlife, Survey Division, and Hawaii State Archives. The records are given by land and reserve area, and date of record.

The ʻŌlaʻa Forest Lands

The following documents focus on the development of the various facets of the ʻŌlaʻa Forest Reserve, and early descriptions of the resources therein.

> ***Honolulu, T.H., April 7, 1905.***
> ***OLAA REMNANT, PUNA, HAWAII.***
>
> Committee on Forestry,
> Board of Commissioners of Agriculture and Forestry.
> Honolulu, T.H.
>
> *Gentlemen*:—On March 22 you referred to me a letter from Mr. J.W. Pratt, Commissioner of Public Lands, under the date of February 10, requesting the suggestions of the Board in regard to certain lands on the Island of Hawaii.
>
> Three of the four tracts mentioned are in Hamakua. These I expect to visit during my next trip to Hawaii, after which I shall be ready to report upon them.
>
> The other land called for I have the honor to report upon herewith. It is "that tract of land constituting the remnant of Olaa, below the surveyed part of Olaa New Tract, and between Keaau and Waiakea, forming a long narrow triangle and marked on the map of Hawaii as "Government Tract." [see *Figure 2*] The lower point of the tract comes practically to the Volcano Road, not far above the seven mile post. The upper end of the Remnant adjoins Lots 229 to 232 of the Olaa New Tract, at an elevation of about 1,600 feet.
>
> While I have not made a personal examination of this tract I am familiar with the general character of the section from visits made to the adjoining lands.
>
> This knowledge, with additional information concerning the tract obtained from Government officials and other trustworthy sources, is the basis on which I make the following report and recommendations.
>
> The greater part, if not the whole, of the Olaa Remnant is covered by old *a-a* lava, known as the Kukulu Flow. It is this flow which the Volcano Road crosses between the four and eight mile marks.

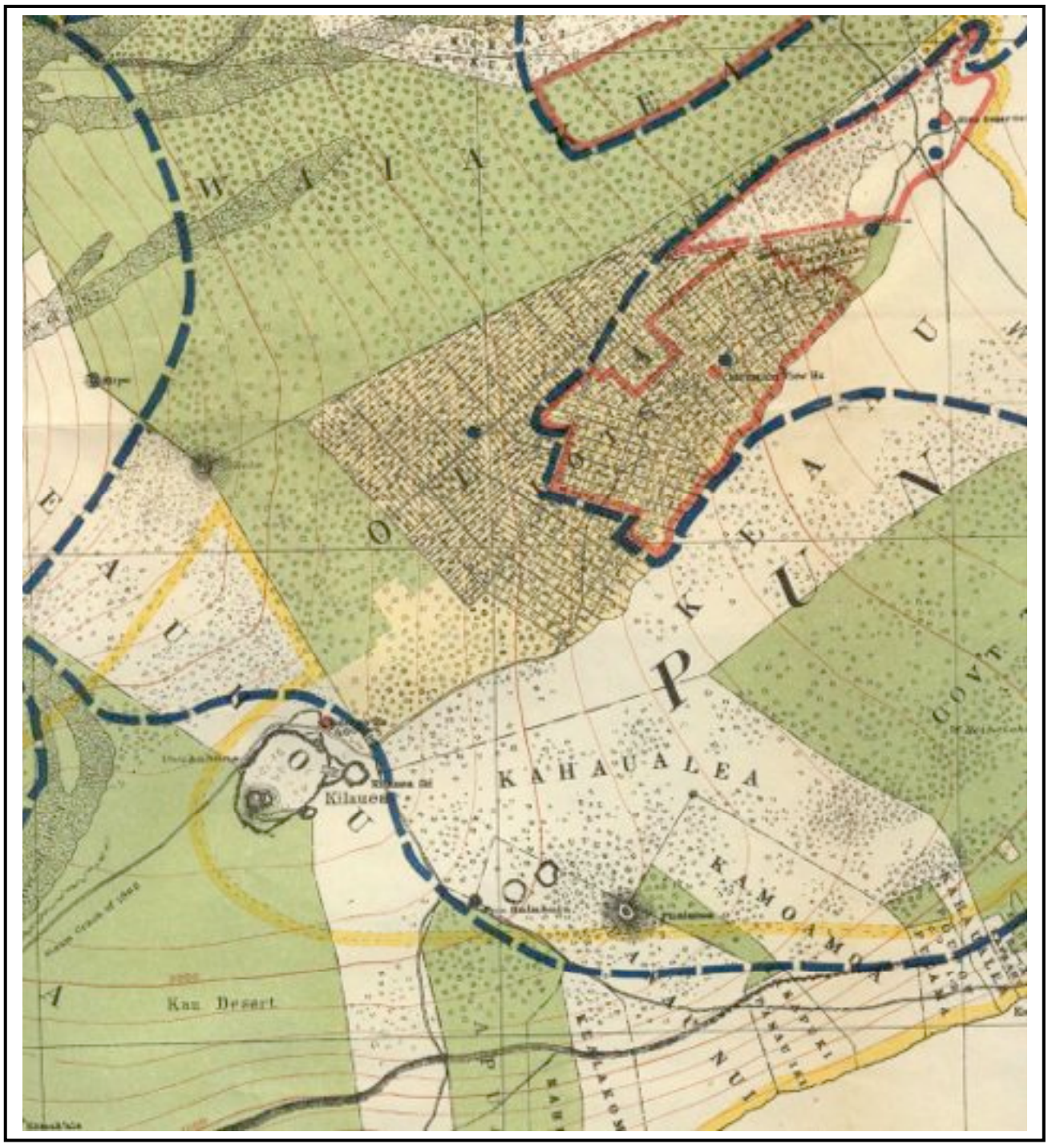


Figure 2. Detail of the ʻŌlaʻa-Waiākea Forest Lands (Hawaii Territorial Survey, 1901)

The Kukulu Flow consists of large rocks, covered in part by good soil, but the surface is too rough to admit of plowing or cultivation. The upper part of the Remnant is shown on the map of the Olaa Lots, compiled by Mr. E.D. Baldwin in 1899.

> Covering the entire Olaa Remnant is a dense forest of the same character as that on the remainder of the Olaa Tract. *Ohia Lehua* is the predominant tree with a heavy undergrowth of [page 132] tree and other ferns, climbing vines and the tangle of tropical vegetation that goes to make up the native Hawaiian forest.
>
> Were it is possible to develop the Olaa Remnant for agricultural purposes there would be no objection to clearing and opening up the land for settlement. But as the land is too rough to be cultivated, about the only profitable use to which this tract could now be put would be the cutting and marketing of the *Ohia* trees for timber, ties or fuel. Whatever value the Olaa Remnant at present possesses is largely because of the forest thereon, and unless there is a decided change in the economic conditions its greatest value in the future will be that it can produce timber trees.
>
> Provided an assured market for *Ohia* wood existed, there would be no impropriety in logging the Olaa Remnant, provided always that the work were done in such a way that the Government would receive a fair return from the wood cut and that the forest were left in good producing condition.
>
> But if a revenue is to be derived from the sale of forest products from Government land, the Government itself and not some individual should receive the chief benefit. To this end, when Government forest land is to be lumbered a special form of contract should be entered into, containing such directions and regulations as to how the work shall be done as may be deemed necessary.
>
> In the case of the Olaa Remnant it is difficult to say for what the land could be profitably used at this time unless the idea is to cut wood.
>
> I, therefore, recommend that the Board of Commissioners of Agriculture and Forestry advise the Commissioner of Public Lands not to lease the Olaa Remnant or to let it pass out of the control of the Government, until the forest on the tract can be put on the market at a fair profit or until the local economic conditions are such that the land can be used to better advantage for purposes other than that of producing timber trees.
>
> Very respectfully yours,
>
> RALPH S. HOSMER,
> Superintendent of Forestry.
> [Hawaiian Forester and Agriculturalist, 1905:133]

Eight years later, in 1913, based on a report by Territorial Forester, R.S. Hosmer, the Board set aside additional lands in the ʻŌlaʻa Tract, "The Upper ʻŌlaʻa Forest Reserve," described below:

> ***Honolulu, June 18, 1913.***
> Gentlemen:—I have the honor to submit as follows, the recommendation that the remainder of the *mauka* portion of the government land of Olaa, to the north and west of the various subdivisions of homestead lots in the district of Puna, island and county of Hawaii, be set apart as a forest reserve [see *Figure 2*]. This land all belongs to the government. It is not now under lease. The area is 92.80 acres.

Object.
The reasons for the reservation of the Olaa forest remainder are largely the same that prompted me a short time since to recommend the reservation of the adjoining forest land of Waiakea, *mauka* (see report, dated June 6, 1913). Indeed, these two tracts, forming a continuous forest, are really to be considered together. They are only reported on separately because, for purposes of description, it was found desirable to treat them as two units rather than one.

No running water comes from the Upper Olaa forest. Its reservation as a forest reserve is justified, rather, because of the fact that the question may some time arise of exploiting its timber. It is none to soon to make provision against that time. One essential reason for setting the land apart now is that it may be brought under the care and control of the Territory's forest department. [page 304]

Like Waiakea, the upper portion of Olaa bears a heavy stand of forest. *Ohia-lehua* is the predominating tree, but with it in mixture are many other species. On its western edge the Upper Olaa forest joins the Bishop Estate land of Keauhou, on which is a heavy stand of the tallest and largest *koa* in the Territory. A section of Keauhou some seven miles long by one mile in width has for 10 or 12 years been held by that estate as a private forest reserve.

The heavy *koa* forest does not extend much, if any, on to Olaa, but near the Keauhou boundary, on the government land, is a fine stand of large tree-ferns (*Cibotium*) of perhaps as large size as any to be found in the Territory. These give at least a botanical interest to this region.

Some five years ago *ohia-lehua* railroad ties were, for a time, cut on the McKenzie lots, one of the homestead subdivisions of upper Olaa. Other than this, except as certain areas of forest have been cleared on other adjoining homestead lands and sold as firewood, there has been no commercial development of the upper Olaa forest.

Description.
The official description of the proposed Upper Olaa forest reserve, prepared by the Government Survey Office as C.S.F. No. 2476, accompanies this report.

Recommendation.
For the reasons given above I do now recommend that the Board approve the setting apart of this tract as the Upper Olaa forest reserve, and that the governor be called upon to hold the hearing and thereafter to issue the proclamation incident thereto.

Very respectfully,

RALPH S. HOSMER
Superintendent of Forestry.
[Hawaiian Forester and Agriculturalist, 1913:305]

1913
Proclamation of Forest Reserves In the Districts of Hilo and Puna, Island and County of Hawaii, Territory of Hawaii.

UNDER and by virtue of the authority vested in me by the provisions of Chapter 28 of the Revised Laws of Hawaii, as amended by Act 65 of the Session Laws of 1905, and by Act 4 of the Session Laws of 1907, and of every other power me hereunto enabling, I, Ernest A. Mott-Smith, Acting Governor of Hawaii, with the approval of a majority of the Board of Commissioners of Agriculture and Forestry, having held the hearing of

which notice has been duly given as in said Acts provided, do hereby, subject to the existing leases, Set Apart as forest reserves, to be called respectively the Upper Waiakea Forest Reserve and the Upper Olaa Forest Reserve, those certain pieces of government land in the Districts of Hilo and Puna, Island and County of Hawaii, Territory of Hawaii, which may be described roughly as being the block of native forest on the lower slopes of Mauna Loa lying above the agricultural land back of Hilo and to the north and west on the various Olaa homestead subdivisions, and containing, respectively, areas of 51,800 acres and 9280 acres, more or less, more particularly described by and on a map made by the Government Survey Department of the Territory of Hawaii, which said map is now on file in the said Survey Department marked Government Survey Reg. Map No. 1808, and "Upper Waiakea" and "Upper Olaa Forest Reserves," and descriptions accompanying the same, numbered respectively C.S.F. Nos. 2430 and 2476, which said descriptions, now on file in the said Survey Department, are as follows…:

Upper Olaa Forest Reserve.
Portion of the Government Land of, Olaa, District of Puna,
Island of Hawaii.
C.S.F. No.2476.

Beginning at the Government Survey Trig. Station "Kulani" (marked by a copper bolt in a concrete post) at the intersection of the lands of Olaa, Keauhou, and Waiakea, as shown on Government Survey Reg. Map No. 1808, and running by true azimuths:

1. 243° 20' 12,694.0 feet along the land of Waiakea;
2. 318° 32' 30" 26,210.0 feet along the Southwest side of Cross Road No. 8 to a point on the Northwest boundary of Lot IV of the Otto Rose Settlement Association Lots;
3. 59° 31' 4492.0 feet along Lots IV and V of the Otto Rose Settlement Association Lots; 4. 149° 31' 3000.0 feet along Lot V of the 27 ½ Mile Tract;
5. 59° 31' 5858.0 feet along Lots V and VI of the 27 ½ Mile Tract;
6. 329° 31' 6000.0 feet along Lots VI and VII of the 27 ½ Mile Tract ;
7. 59° 31' 2950.0 feet along Lots VII, VI and V of the Kilauea Settlement Association Lots and across Wright Road;
8. 329° 31' 1000.0 feet along the Southwest side of Wright Road to the North corner. of Lot IV of the Kilauea Settlement Association Lots;
9. 59° 31' 4356.0 feet along Lots IV, III, II and I of the Kilauea Settlement Association Lots;
10. 149° 31' 30,575.0 feet along the land of Keauhou to the point of beginning.
    Area, 9,280 acres.

In Witness Whereof, I have hereunto set my hand and caused the Great Seal of (the Territory of Hawaii to be affixed. (Seal)

DONE at the Capitol in Honolulu, this 13th day of October, A. D. 1913.

E. A. MOTT-SMITH,
Acting Governor of Hawaii.
[Hawaiian Forester and Agriculturalist, 1913:333]

1914
Olaa Forest Park.

REPORT OF THE SUPERINTENDENT OF FORESTRY.

Honolulu, Hawaii July 15, 1914.

Board of Commissioners of Agriculture and Forestry, Honolulu.

Gentlemen:—I have to recommend as follows the creation of a small forest reserve in the Olaa section, Puna district, Hawaii, to be known as the "Olaa Forest Park Reserve."

The purpose of this project is to preserve for its beauty, its scenic interest and its scientific value the last remaining strip of the heavy native Hawaiian forest along the Volcano road, together with a grove of *koa* trees facing the road at 29 Miles. The former area consists of the untaken Olaa homestead lots bordering the Volcano road, *mauka* of Glenwood, between the twenty-three and the twenty-five mile posts. It is the one place in the Territory where without effort or exertion the visitor to the Islands can still see the dense native forest in its primitive condition.

The Glenwood Forest.
The area proposed to be set apart consists essentially of lots Nos. 363, 364, 277 to 380, and 389 to 391 of the original Olaa Tract homestead subdivision, a total of 374 acres. All of these lots still vest in the government. The majority of them were never taken up. Those that were have since reverted to the Territory. All are covered with heavy forest, consisting of a stand made up principally of large *ohia lehua* trees with a dense undergrowth of ferns, vines and shrubs. The lots named form a solid block across which runs the Volcano road. Adjoining this block are a number of privately-owned lots, on which the forest cover is of like character. It is the intention of the owners of these lots to continue to protect the forest on them. In effect this increases the size of the proposed reserve and insures the perpetuation of a block of forest large enough to maintain itself. [page 278]

The government lots, especially those to the south of the road, are said to be extremely rocky, so that their value for agriculture would at best be but small. On the other hand the forest on these lots makes them, because of their location, of unique value to the Territory.

Ever since the Volcano road was first built, the Hawaiian forest along its course has been one of the most exploited features of the Island of Hawaii. With increasing attention to building up the tourist trade in the Territory it is strictly a business proposition to preserve and develop all places of special scenic attraction. From the tourist point of view the drive from Glenwood to the Volcano is a distinct asset.

"But this forest is not alone of interest from the superficial standpoint of the passing tourist. With the opening up of the surrounding country, it will have increasing scientific interest from a botanical standpoint, while it may also well serve as a refuge for some of the remaining Hawaiian birds."

These being the objects of the reservation, it is to be regarded as a forest park rather than as a regular forest reserve. But for purposes of administration it can best be handled if set apart under the Board of Agriculture and Forestry.

"The second area proposed to be included in the reserve is located further up the road at 29 Miles, a small block of forest, of seven and a half acres, that I believe should also

be reserved, say as Section B of the Olaa forest park. This is the stand of *koa* trees nearly opposite Mr. W.H. Shipman's mountain place, that was held out of the "Olaa Summer Lots" subdivision as a special "*koa* reserve." This *koa* grove is an interesting feature of the Volcano road. As the trees grow older it will be of interesting value as a part of the park.

Volcano Road Strips.
While this matter is under consideration by the board, I should like to bring forward one more suggestion which may result in increasing the area of the proposed forest park. I bring it up separately, as it involves a question of policy.

When the original Olaa tract was laid out, narrow strips of forest were reserved along the Volcano road between the twelve and the twenty-four mile posts, with the idea of preserving the forest, just as is now proposed on a smaller scale. Unfortunately the strips were not made wide enough. When the land behind them was opened up many of the trees on the strips died. The result was that below about the eighteen-mile post the former "forest reserve" strips are now merely remnants of open land, which are now and for years have been subject to trespass; sources of annoyance to all concerned.

Mauka of the "Peck Road" at eighteen miles there is still a fair [page 279] stand of forest on some of the strips, increasing in density toward and above Glenwood. But even where the native trees have pretty much gone there exists here, should the board deem it wise to take advantage of it, good opportunity for the planting in their stead of introduced trees of suitable species.

At present the government probably has no funds that it would care to use for such work, but in time conditions may so change as to make such planting possible. For this reason it seems to me desirable that these remnants be added to and set apart as portions of the Olaa forest park.

The Board of Agriculture and Forestry has, of course, no authority or control over these strips, nor voice as to their disposition, other than as a matter of general government policy. As concerns those below eighteen miles, my personal recommendation as superintendent of forestry is that they no longer be held for forest purposes, but disposed of under the law, as the Department of Public Lands may see fit, as agricultural land. Below eighteen miles the original forest is gone. The strips there can in my judgment be used to better advantage for agriculture than for tree planting.

I believe it would be good business for the government to clean up in this way what is now an unsatisfactory land muddle.

For the reason set forth I do therefore now recommend that the board approve the project of setting apart as the Olaa forest park reserve the three sections of government land above described, and that the board request the Governor to take the necessary steps to have the lands so set apart.

Very respectfully,

RALPH S. HOSMER,
Superintendent of Forestry.
[Hawaiian Forester and Agriculturalist, 1914:280]

1914
Proclamation of Forest Reserve In the District of Puna, Island and County of Hawaii, Territory of Hawaii.

Under and by virtue of the authority vested in me by the provisions of Chapter 28 of the Revised Laws of Hawaii, as amended by Act 65 of the Session Laws of 1905, and by Act 4 of the Session Laws of 1907, and of every other power me hereunto enabling, I, Lucius E. Pinkham, Governor of Hawaii, with the approval of a majority of the Board of Commissioners of Agriculture and Forestry, having held the hearing of which notice has been duly given as in said Acts provided, do hereby set apart as a forest reserve to be called the Olaa Forest Park Reserve, those certain pieces of government land in the District of Puna, Island and County of Hawaii, Territory of Hawaii, which may be roughly described as the remaining area of government land along the Volcano Road under a stand of heavy Hawaiian forest, and containing an area of 531 acres, more or less, more particularly described by and on maps made by the government survey department of the Territory of Hawaii, which said maps are now on file in the said survey department marked Government Survey Reg. Maps Nos. 2250, 2411 and 2577 and "Olaa Forest Park Reserve," Sections A, B, and C respectively, and descriptions accompanying the same in two parts numbered C.S.F. 2538 and 2544 (the description of Section C, the road strips, appearing directly on Map No. [page 282] 2577), which said descriptions now on file in the said Survey Office are as follows:

OLAA FOREST PARK RESERVE.
Olaa, Puna, Hawaii.

Section A.
Including Lots 363, 364, 377, 378, 389, 390, 391, and portions of Lots 379 and 380, of the Olaa Reservation Lots.

C.S.F. No. 2538.
Beginning at the East corner of Lot 365 of the Olaa Reservation Lots (Grant 4345 to E.G. Hitchcock) at the junction of 30-foot side road with the Volcano Road, the coordinates of which point are 47,311.24 feet South and 37,490.65 feet West of Government Survey Trig. Station "Olaa," as shown on Government Survey Registered Map No. 2250, and running by true azimuths:

1. 304º 12' 2975.0 feet more or less across Volcano Road and along the Southwest side of a 30-foot road to a point in middle of old Volcano Road;

   Thence along the land of Keaau along the middle of the old Volcano Road, the direct azimuths and distances being:

2. 55º 15' 2720.0 feet more or less;
3. 39º 20' 1477.0 feet more or less;
4. 63º 00' 930.0 feet more or less;
5. 124º 12' 4905.0 feet more or less along the Northeast side of a 30-foot side road, across the Volcano Road to the West corner of Lot 389 of the Olaa Reservation Lots;
6. 214º 12' 1200.0 feet along Lot 1 of the Brughelli Settlement Association lots;
7. 304º 12' 561.0 feet along Right of Purchase Lease No. 155 to Mrs. B. Bergstrom (Olaa Reservation Lots);
8. 249º 45' 976.0 feet along Right of Purchase Lease No. 155 to Mrs. B. Bergstrom (Olaa Reservation Lots);

9. 304º 12’ 2689.0 feet along Right of Purchase Lease No. 155 to Mrs. B. Bergstrom (Olaa Reservation Lots) to the Volcano Road;
10. 211º 49’ 430.0 feet along the Northwest side of the Volcano Road to the North corner of the Volcano Road and a 30-foot side road;
11. 124º 12’ 150.0 feet along the Northeast side of a 30-foot side road to the South corner of Grant 4547;
12. 211º 49’ 601.0 feet along Grant 4547 to Mrs. J.C. McStay;
13. 304º 12’ 150.0 feet along Grant 4547 to Mrs. J.C. McStay;
14. 211º 49’ 400.0 feet along Grant 4547 to Mrs. J.C. McStay along the Northwest side of Volcano Road;
15. 124º 12’ 150.0 feet along Grant 4547 to Mrs. J.C. McStay;
16. 211º 49’ 200.0 feet along Grant 4547 to Mrs. J.C. McStay;
17. 124º 12’ 309.0 feet along Grant 4547 to Mrs. J.C. McStay to the South corner of Grant 4345 to E.G. Hitchcock;
18. 214º 12’ 801.0 feet along Grant 4345 to E.G. Hitchcock;
19. 204º 12’ 213.0 feet along Grant 4345 to E.G. Hitchcock;
20. 211º 50’ 400.0 feet along Grant 4345 to E.G. Hitchcock to the point of beginning; Area, 380 acres, more or less.

Excepting and reserving there from that portion of the Volcano Road passing through this tract (area, 6 acres), leaving a net area of 374 acres, more or less.

SECTION B.
Being the *Koa* Grove Reservation in the Olaa Summer Lots Subdivision.

C.S.F. No. 2544
Beginning at the West corner of the Volcano Road and Kalanikoa Road, [page 283] the coordinates of which point referred to Government Survey Trig. Station “Kulani” are 34,351.6 feet South and 20,278.6 feet East, as shown on Government Survey Registered Map No. 2411, and running by true azimuths:

1. 50º 98’ 310.0 feet along new line of the Volcano Road;
2. 33º 04’ 245.8 feet along new line of the Volcano Road;
3. 149º 31’ 707.7 feet along the land of Keauhou to an *ohia* post;
4. 239º 31’ 525.9 feet along Lot 2, Block C, of the Olaa Summer Lots (Grant 5645 to Thos. E. Cook), to an *ohia* post;
5. 329º 31’ 547.6 feet along Kalanikoa Road to the point of beginning.
   Area, 7 32/100 acres.

AREAS.

Section A-	374	acres
Section B-	7.32	acres
Section C-	150	acres
	531.32	acres

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Great Seal of the Territory of Hawaii to be affixed. Done at the Capitol in Honolulu this 20th day of August, A.D. 1914.

Lucius E. Pinkham
Governor of Hawaii… [Hawaiian Forester and Agriculturalist, 1913:284]

1918
Olaa Forest Reserve.

Honolulu, Hawaii, Nov. 26, 1918.
Board of Commissioners of Agriculture and Forestry, Honolulu.

GENTLEMEN :
I have the honor to recommend the setting apart as a forest reserve of a portion of the government land of Olaa, Puna, Hawaii, consisting of 20,030 acres, more or less, as shown on the attached blueprint map.

The whole area is covered with a heavy forest of native trees such as the *ohia, olapa, koa, loulu* palm and tree ferns with their accompaniment of a heavy undergrowth of ferns and vines and is situated between the Upper Waiakea Forest Reserve on the north, the Upper Olaa Forest Reserve on the west, and Section A of the Olaa Forest Park Reserve and homestead lots on the south. It includes a vast wilderness of heavy forest, situated between the elevations of 1700 and 3800 feet, which is impenetrable except for the roads and trails which have been cut through it.

Over fifteen years ago the tract was surveyed into homestead lots with the idea that they would be settled upon by coffee planters. Coffee cultivation was a failure here owing to the [page 492] shallowness of the soil and other unfavorable factors, and although homesteads have repeatedly been taken up in this region and a lot of money spent in improving them, no one has' been successful in raising any crops.

With this demonstration in view, and with the idea of making some use of the land, four leases have been made during the past two years by the Land Office of a part of the land at the lower or *makai* end, consisting of a total of 8,886 acres, at nominal rentals, with the idea that cattle could be raised on the land. All of these leases are held by Japanese, who are about the only people who will live in this wet region. In connection with one of these leases, the largest, consisting of 8589 acres, portions of the land have been subleased to four other Japanese. These men are making an unsuccessful attempt at raising a few head of scrubby cattle in the forest. At the time the first lease was assigned to a second party in April, 1918. 175 head of cattle were supposed to have been turned over with the lease, but on account of the heavy growth of forest the assignees have been able to find only 100 head.

Recently an application was made for a lease of the balance of this forest land for grazing purposes, but at my request the application has been held up. If further extended grazing is permitted on the land it will, in time, become similar to adjacent lands *makai*—a useless waste of dead trees, fallen logs and Hilo grass. Such a large stretch of forest cannot help but exert a favorable influence on the surrounding climate, and this is of importance to the Olaa Sugar Plantation just below, which suffered from the effects of drought two summers ago.

As stated above, the soil throughout the region for the most part is shallow and is best suited to forest growth. Continued grazing in the region on any scale will in time reduce the forest to a useless waste.

Sufficient land has been left out of the area recommended to be set aside to provide for the need of additional homesteads at the *makai* or lower end where soil conditions are more favorable, and a sufficient area at the high elevation near the upper end, not far from the Volcano House, has been reserved for additional summer lots.

For the reasons above set forth, I recommend that the Board approve the project of creating the Olaa Forest Reserve, as described above, and that the Governor be requested to take the necessary steps toward this end.

Respectfully submitted,
C. S. JUDD,
Superintendent of Forestry. [Hawaiian Forester and Agriculturalist, 1918:493]

Withdrawal of Land From Olaa Forest Park Reserve.
Honolulu, Hawaii, Nov. 27, 1918.
Board of Commissioners of Agriculture and Forestry, Honolulu.

GENTLEMEN:
I have the honor to submit, as follows, a report recommending the withdrawal of 30,000 square feet or 0.69 acres of land from a part of Section C of the Olaa Forest Park Reserve on the Volcano Road above Glenwood, in Olaa, Puna, Hawaii, for the purpose of exchange with Mr. F. G. Snow for an equal area of privately owned forest land in the immediate vicinity which it is desired to include in the above reserve. The two areas, each 200 feet by 150 feet in size, are shown on the attached maps.

This section of the Olaa Forest Park Reserve, which was set aside on August 20, 1914, consists of narrow strips of land, only 150 feet deep, fronting on both sides of the Volcano Road. On some of the homestead lots these reserve strips occupy most of the frontage and in some cases have caused great inconvenience.

In this case, the piece desired by Mr. Snow is opposite his frontage area across the road, and he desires to use it as a driveway between his two opposite lots. There is only a scant covering of dying tree ferns and dead *ohia* trees on this piece, whereas on the piece of equal size which he desires to give the government in exchange, and which is already protected by a fence, there is a heavy forest of *ohia* and tree ferns in good condition.

The government will thus benefit by the exchange and, for this reason, I recommend that the Board approve the withdrawal of the 30,000 square feet and that the Governor be requested to take the necessary further action to perfect the exchange.

Respectfully submitted,
C. S. JUDD, Superintendent of Forestry. [Hawaiian Forester and Agriculturalist, 1918:494]

Proclamations of Forest Reserve in the District of Puna,
Island and County of Hawaii, Territory of Hawaii.

Under and by virtue of the authority vested in be by the provisions of Chapter 37 of the Revised Laws of Hawaii of 1915, and of every other power me hereunto enabling, I C.J. McCarthy, Governor of Hawaii, with the approval of a majority of the Board of Commissioners of Agriculture and Forestry, having held the hearing of which notice has been duly given as in said laws provided, do hereby set apart as a forest reserve to be called the Olaa Forest Reserve, subject to existing rights, a portion of that certain piece of government land called Olaa, in the District of Puna, Island and County

of Hawaii, Territory of Hawaii, containing an area of 20,030 acres, more or less, more particularly described by and on maps made by the Government Survey Department of the Territory of Hawaii, which said maps are now on file in the said Survey Department marked Government Survey Reg. Map No. 2250 and "Olaa Forest Reserve" and description accompanying the same number C.S.F. 3026, which said description now on file in said Survey Department, is as follows:

Olaa Forest Reserve.
Portion of the Government Land of Olaa, Olaa, Puna, Hawaii.
C.S.F. 3026

Beginning at the West corner of this reserve, and the North corner of UPPER OLAA FOREST RESERVE, the true azimuth and distance from Government Survey Trig. Station "Kulani" being 243º 20' 12,694 feet, as shown on Government Survey Registered Map No. 2250, and running by true azimuths:

1. 243º 20' 50,151.7 feet along WAIAKEA FOREST RESERVE;
2. 318º 39' 30" 1848.9 feet along government land;
3. 48º 39' 30" 12,070.0 feet along Lots 229 to 214 inclusive, Olaa New Tract, to the West corner of Lot 214;
4. 38º 41' 50.5 feet across Road No. 2, to the North corner of Lot 213, Olaa New Tract;
5. 48º 32' 30" 3010.9 feet along Lots 213 to 210 inclusive, Olaa New Tract, to the West corner of Lot 210;
6. 138º 32' 30" 724.9 feet along Lot 264, Olaa New Tract;
7. 48º 32' 30" 3055.0 feet along Lot 264, Olaa New Tract, and across Road No. 3, to the North corner of Lot 265, Olaa New Tract;
8. 318º 32' 30" 6583.2 feet along West side of Road No. 3 to the North corner of Lot 119A, Olaa New Tract;
9. 48º 32' 33" 18,130.0 feet along Lots 119A, 118, 117, 116, 115, 120, 121, 129 and 130, Olaa New Tract, and across Road No. 6, to the East corner of Lot 53, Olaa New Tract;
10. 318º 32' 30" 3.6 feet along Southwest side of Road No. 6:
11. 302º 21' 5759.2 feet along Southwest side of Road No. 6, to the North corner of Lot 99, Olaa New Tract;
12. 34º 08' 30" 11,016.5 feet along Lots 99 to 85 inclusive, Olaa New Tract;
13. 318º 32' 30" 2998.0 feet along Lot 85, Olaa New Tract;
14. 34º 08' 30" 384.0 feet, more or less, along Northwest side of a road;
15. 304º 12' 5539.0 feet, more or less, across road, and along the Southwest side of a 30-foot road;
16. 214º 12' 1230.0 feet across a 30-foot road, and along Lot 387, Olaa Reservation Lots; [page 505]
17. 304º 12' 2069.0 feet along Lots 380 and 381, Olaa Reservation Lots;
18. 34º 12' 1230.0 feet along OLAA FOREST PARK RESERVE and across a 30-foot road;
19. 304º 12' 3930.0 feet, more or less, along Southwest side of a 30-foot road, to the West corner of said 30-foot road and Volcano Road;

20. Thence along the Northwest side of Volcano Road, the direct azimuth and distance being: 45º 10' 1644.0 feet, more or less;
21. 149º 16' 602.7 feet along government land;
22. 88º 00' 573.7 feet along same;
23. 117º 47' 1244.6 feet along same;
24. 134º 18' 507.3 feet along same;
25. 69º 01' 860.7 feet along same;
26. 87º 39' 911.9 feet along same;
27. 87º 35' 421.9 feet along same;
28. 87º 55' 400.2 feet along same;
29. 57º 22' 424.1 feet along same;
30. 160º 31' 30" 213.3 feet along same, and across Kilauea Road to the South corner of Lot 2B, Brughelli Settlement Association;
31. 59º 31' 13,218.0 feet along the Northwest side of Kilauea Road, to the North corner of said Kilauea and Hinano Roads;
32. 149º 31' 15,000.0 feet along the Northeast side of Hinano Road, and along the Kilauea Settlement Association Lots and UPPER OLAA FOREST RESERVE;
33. 239º 31' 5858.0 feet along UPPER OLAA FOREST RESERVE;
34. 329º 31' 3000.0 feet along same;
35. 239º 31' 4492.0 feet along same;
36. 138º 32' 30" 26,210.0 feet along UPPER OLAA FOREST RESERVE, to the point of beginning.

    Area, 20,030.0 acres, more or less.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Great Seal of the Territory of Hawaii to be affixed.

Done at the Capitol in Honolulu, this 31st day of December, A.D. 1918.

C.J. McCarthy
Governor of Hawaii.
By the Governor:

Curtis P. Iaukea,
Secretary of Hawaii. [Hawaiian Forester and Agriculturalist, 1918:506]

Proclamation of Withdrawal of Certain Land From the Olaa Forest Park Reserve, District of Puna, Island and County Of Hawaii, Territory Of Hawaii.

UNDER and by virtue of the authority vested in me by the provisions of Chapter 37 of the Revised Laws of Hawaii of 1915, and of every other power me hereunto enabling I, C.J. McCarthy, Governor of Hawaii, with the approval of a majority of the Board of Commissioners of Agriculture and Forestry, having held the hearing of which notice has been duly given all as in said laws provided, do hereby withdraw and eliminate from Section C of the Olaa Forest Park Reserve, in the District of Puna, Island and County of Hawaii, Territory of Hawaii, created and set apart by the Proclamation of the Governor of Hawaii on August 20, 1914, that certain portion of the government land called Olaa, containing 30,000 square feet, in the District of Puna, Island and County of

Hawaii, [page 506] Territory of Hawaii, more particularly described by and on maps made by the Government Survey Department of the Territory of Hawaii, which said maps are now on file in the said Survey Department marked Government Survey Reg. Map No. 2577 and "Territory of Hawaii to F.G. Snow, Portion of the Forest Reserve Between the Volcano Road and Lot 328 of the Olaa Reservation Lots," and a description accompanying the same numbered C.S.F. 3027, which said description now on file in the said Survey Department is as follows:

TERRITORY OF HAWAII TO F.G. SNOW,

Portion of the Forest Reserve between the Volcano Road and Lot 328, of the Olaa Reservation Lots, Olaa, Puna, Hawaii.

C.S.F. 3027.

Beginning at the South corner of this piece, on the Northwest side of Volcano Road, said point being 214º 12' 660.8 feet from the North corner of Volcano Road and a 30-foot side road, the coordinates of said point of beginning referred to Government Survey Trig. Station "Olaa" being 42,654.0 feet South and 34,468.3 feet West, as shown on Government Survey Registered Map No. 2577, and running by true azimuths:

1. 124º 12' 150.0 feet along Forest Reserve (government land);
2. 214º 12' 200.0 feet along Lot 328, Olaa Reservation Lots;
3. 304º 12' 150.0 feet along Forest Reserve (government land);
4. 34º 12' 200.0 feet along Volcano Road to the point of beginning.
   Area, 30,000 square feet.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Great Seal of the Territory of Hawaii to be affixed.

Done at the Capitol in Honolulu, this 31st day of December, A.D. 1918.

C.J. McCarthy
Governor of Hawaii.

By the Governor:
Curtis P. Iaukea,
Secretary of Hawaii. [Hawaiian Forester and Agriculturalist, 1918:507]

Pu'u Kūlani and Vicinity Described in 1919

Botanist, Joseph Rock described the make up of the forest around Pu'u Kūlani, as it existed in 1919. Interestingly, at that time, he called for fencing as a means of protecting the unique biological system from depredation of wild cattle and pigs:

One Government Forest
Reserve Lands at Kulani, Hawaii, Described.
By Joseph F. Rock, Consulting Botanist.

The whole forest reserve area at Kulani, Hawaii, is covered with a decidedly uniform and, geologically speaking, rather young forest. The border below 29 Miles contains more of a mixture of trees than the area further up toward Kulani proper. Near 29 Miles we find that trees are more numerous, especially *ohia* lehuas with occasional *mana* [*maua*] trees, *Xylosma Hillebrandii*, of which the writer encountered large individuals.

Dispersed throughout that region is a very beautiful native fan palm with large orbicular fruits described by the writer as a new species under the name of *Pritchardia Beccariana*. *Olapa*, *Cheirodendron*, *Gaudichaudii*; an occasional *aiea*, *Nothocestrum*; *kopiko*, *Straussia*; *olomea*, *Perrottetia*; *pilo*, *Coprosma*; and *manono*, *Gouldia*, form the rest of the arborescent growth.

The forest is, however, mainly a tree-fern forest interspersed with an occasional tree of the species mentioned. An acre of this forest land may contain perhaps five or six mature trees, of which four may belong to the genus *Metrosideros* (*ohia lehua*). The remainder is all tree ferns composed of the two common types—*Cibotium Chamissoi* and *Cibotium Menziesii*. Undergrowth is mainly composed of *Cyrtandrae*, *Broussaisia*, [page 39] *Cyanea tritomantha*, *Cyanea pilosa*, *Rubus*, *Phyllostegia*, etc. Ferns are of course very numerous. The whole forest is in splendid condition, but the undergrowth is much disturbed by the ravages of wild pigs. The uniformity of the forest makes exploring rather uninteresting for a botanist.

Kulani proper is a densely wooded volcanic cone, the forest being exceedingly uniform and of the rain forest type. Palms are entirely absent. A gap was cut at the summit to permit a view of the surrounding region. The land toward Keauhou lies considerably lower than that over which Kulani was approached, or, in other words, the slopes of Kulani towards Keauhou are rather steep, giving the cone quite a formidable appearance both in height and size. The summit appears as two cones, but in fact the central valley or ridge, densely wooded, is nothing but an ancient volcanic fissure dividing the cone in two. The ground is covered with fallen trunks of both trees and tree-ferns which are covered with numerous epiphytes such as ferns *Stenogyne*, *Clermontia parviflora*, *Astelia veratroides*, *Selagruella*, *Lycopodium*, etc. The soil is mostly black loam, and the ground quite hummocky, which, besides fallen trunks and the absence of a trail, made progress quite slow. If properly fenced and protected from cattle and wild hogs, this forest reserve is certainly one of the finest on Hawaii, and deserves protection from cattle and hogs. [Hawaiian Forester and Agriculturalist, 1919:40]

The Waiākea Forest Lands

Following the development of the Hilo Forest Reserve in 1904, and the addition of portions of the ʻŌlaʻa Tract to the reserve system in 1905 and 1913, the board also set aside the upland portions of Waiākea as a reserve. Thus, making a contiguous line of forest across the Hilo District, and adjoining the Puna District. The following documents are among those recorded as a part of the dedication of the Waiākea forest lands to the reserve system.

Honolulu, June 6, 1913.
The Upper Waiakea Forest Reserve.
Reports of the Superintendent of Forestry.

Gentlemen:—
I have the honor to submit as follows the recommendation that a forest reserve be created to cover the central forested portion of the government land of Waiakea, district of Hilo, island and county of Hawaii:

Location, Object and Area.
Waiakea is a large government land stretching from the sea at Hilo bay well up on the slopes of Mauna Loa. Much of the lower portion is in cane; the extreme upper part is more or less open grazing land, crossed by lava flows. Between is a section of heavy forest. The present recommendation is that the forested portion be set apart as a forest reserve, with the objects (1) of bringing the land under the management of the department of the Territory especially equipped to care for it, so that (2) it may be

wisely administered in any way not inconsistent with its maintenance as a forest that may in the future be deemed best. [page 302]

Owing to the geological formation of the island of Hawaii there are no running streams south of the 1855 and 1881 lava flows that come down the side of Mauna Loa back of Hilo town on lands lying immediately to the north of Waiakea. It is quite possible that springs and water holes may later be discovered in the Waiakea forest; for at present almost nothing is known accurately about the interior of this tract; but there are no running streams coming from it.

The question of stream protection does not, therefore, figure on Waiakea, but there are other reasons why it is important that existing areas of forest should receive the care and protection of the government. Until many more scientific data than are now available have been collected, it is impossible to tell how far-reaching may be the influence exerted on the country immediately surrounding large bodies of continuous forest, but it is evident that such influence does exist and that it is beneficial. Particularly is this true in the tropics and sub-tropics.

Further, on Waiakea it may happen that in time the question may arise of devoting portions of this forest to commercial utilization. To safeguard the interests of the government in all these ways and to be ready for any sort of development that may come about, it is desirable that the Waiakea forest become the Waiakea forest reserve.

The area proposed to be set apart is 51,800 acres. Of this 600 acres is a part of the land of Piihonua, a remnant mainly covered with lava, between the boundaries of the Hilo forest reserve and Waiakea. Piihonua is now under lease No. 103 to Hon. John T. Baker, expiring on March 21, 1921.

At the present time all of the land of Waiakea is under an expiring 30-year lease to the Waiakea Mill Co. (No. 124) that runs out on June 1, 1918. No use is at present made of the forest. Beyond the general clause against waste, common to the leases of that time, the lessees are not obligated to protect the forest.

The forest on Waiakea is practically unexplored region. It is a dense stand of the rain-forest type. *Ohia-lehua* is the predominating tree. Along its lower side, where the forest is crossed by the Olaa flume, are numerous groups of *loulu* palms, growing in company with great tree ferns. And throughout, so far as the interior is known, there is a dense stand of the undergrowth characteristic of this type of Hawaiian forest.

Boundaries.
The upper and lower boundaries of the proposed Upper Waiakea forest reserve have been somewhat arbitrarily fixed by drawing lines across the land from known points on the outside boundaries, but it is believed that they serve the purpose at this time as well as if they had been run out on the ground. The *makai* line very nearly parallels the flume constructed to carry water [page 303] from upper Kaumana to the Olaa plantation. The upper line leaves out of the reserve the area suitable for grazing above the native forest.

The elevation of the *makai* boundary is approximately 1800 feet; that of the *mauka* line varies from 5000 feet at Puu Kulani to 4500 feet at the 1855 lava flow, where the proposed reserve joins and forms a continuation of the existing Hilo forest reserve.

Description.
A technical description of the boundary, prepared by the Government Survey Office as C.S.F. 2430, accompanies this report.

Recommendations.
For the reasons above set forth I do now recommend that the Board approve this project and call upon the governor of the Territory to set apart this government land as a forest reserve to be known as the Upper Waiakea forest reserve.

Very respectfully,

RALPH S. HOSMER
Superintendent of Forestry. [Hawaiian Forester and Agriculturalist, 1913:304]

1913
Proclamation of Forest Reserves in the Districts of
Hilo and Puna, Island and County of Hawaii, Territory Of Hawaii.

UNDER and by virtue of the authority vested in me by the provisions of Chapter 28 of the Revised Laws of Hawaii, as amended by Act 65 of the Session Laws of 1905, and by Act 4 of the Session Laws of 1907, and of every other power me hereunto enabling, I, Ernest A. Mott-Smith, Acting Governor of Hawaii, with the approval of a majority of the Board of Commissioners of Agriculture and Forestry, having held the hearing of which notice has been duly given as in said Acts provided, do hereby, subject to the existing leases, SET APART as forest reserves, to be called respectively the Upper Waiakea Forest Reserve and the Upper Olaa Forest Reserve, those certain pieces of government land in the Districts of Hilo and Puna, Island and County of Hawaii, Territory of Hawaii, which may be described roughly as being the block of native forest on the lower slopes of Mauna Loa lying above the agricultural land back of Hilo and to the north and west on the various Olaa homestead subdivisions, and containing, respectively, areas of 51,800 acres and 9280 acres, more or less, more particularly described by and on a map made by the Government Survey Department of the Territory of Hawaii, which said map is now on file in the said Survey Department marked Government Survey Reg. Map No. 1808, and "Upper Waiakea" and "Upper Olaa Forest Reserves," and descriptions accompanying the same, numbered respectively C.S.F. Nos. 2430 and 2476, which said descriptions, now on file in the said Survey Department, are as follows:

UPPER WAIAKEA FOREST RESERVE
Portions of the Government lands of Piihonua and Waiakea,
District of Hilo, Island of Hawaii.
C.S.F. No. 2430.

Beginning at the Government Survey Trig. Station "Kulani" at the intersection of the lands of Olaa, Keauhou, and Waiakea, as shown on Government Survey Reg. Map No.1808, and running by true azimuths:

1. 162° 58' 56,790 feet, more or less, along the land of Waiakea to a point at lower Mawae, near a small island in lava flow; [page 332]
2. Thence along the HILO FOREST RESERVE along edge of lava flow of 1855 to the Northwest corner of the Land of Punahoa 2nd, the direct azimuth and distance being: 256° 27' 33,580.0 feet, more or less;
3. 341º 00' 7000 feet, more or less, along the land of Punahoa 2nd;
4. 93º 20' 5230.0 feet, more or less, along the land of Kaumana;
5. 1º 00' 640.0 feet, more or less, along the land of Kaumana;
6. 29° 30' 2750 feet, more or less, along the land of Kukuau 2nd;

7. 350° 00’ 1150 feet, more or less, along the land of Kukuau 1st to a point a little South of the lower end of a small branch of the lava flow of 1855 at a place called Kapualei;
8. 285° 30’ 24,500 feet, more or less, along the land of Kukuau 1st;
9. 309 ° 21’ 26,710.0 feet, more or less, across the land of Waiakea to the North corner of Lot 232 of the Olaa New Tract Lots ;
10. 63° 20’ 62,845.7 feet, more or less, along the Olaa New Tract Lots, and the Land of Olaa to the point of beginning.

Area, Waiakea, 51,200 acres; Piihonua, 600 acres. Total area, 51,800 acres… [Hawaiian Forester and Agriculturalist, 1913:333]

In 1923, the boundaries of the Upper Waiakea Forest Reserve were modified, by survey of 1922, and recorded in C.S.F. 3876:

C.S.F. 3876
Upper Waiakea Forest Reserve,
South Hilo, Hawaii.
(revised)

June 13, 1922

Including the upper portion of the land of Waiakea [see *Figure 3*].

Beginning at “Kulani”, a Government Survey Triangulation Station, at the South corner of the land of Waiakea and the Northwest corner of the land of Olaa, and on the East boundary of the land of Keauhou, and running by true azimuths:–

1. 133º 18’ 05” 19346.9 feet along the land of Keauhou to a spike in large upright stone near Kipu Hill;
2. 159º 33’ 17” 49478.2 feet along the lands of Keauhou and Humuula to “Kahiliku Boundary” Point;
3. 288º 24’ 33” 15744.0 feet along the land of Piihonua to “Mawae” Trig. Station;
4. 271º 41’ 28484.0 feet along same;
5. 4º 33’ 30” 535.0 feet along the land of Kaumana;
6. 52º 30’ 2750.0 feet along the land of Kukuau 2nd;
7. 340º 25’ 1150.0 feet along the land of Kukuau 1st;
8. 284º 51’ 27258.0 feet along same;
9. 308º 23’ 24802.0 feet along Waiakea Forest Reserve;
10. 63º 20’ 62845.7 feet along Olaa and Upper Olaa Forest Reserves to the point of beginning.
    Area 63,150 Acres.

Excepting and Reserving there from the following Tracts or parcels of land, to-wit:–

Part 1, Portion of Waiakea. Beginning at a point called “Kahiliku Boundary”, on the boundary of Humuula, Waiakea and Piihonua, the direct azimuth and distance of said point of beginning from Government Survey Trig. Station “Puu Oo” being 355º 40’ 55” 16092.7 feet, and running by true azimuths:-

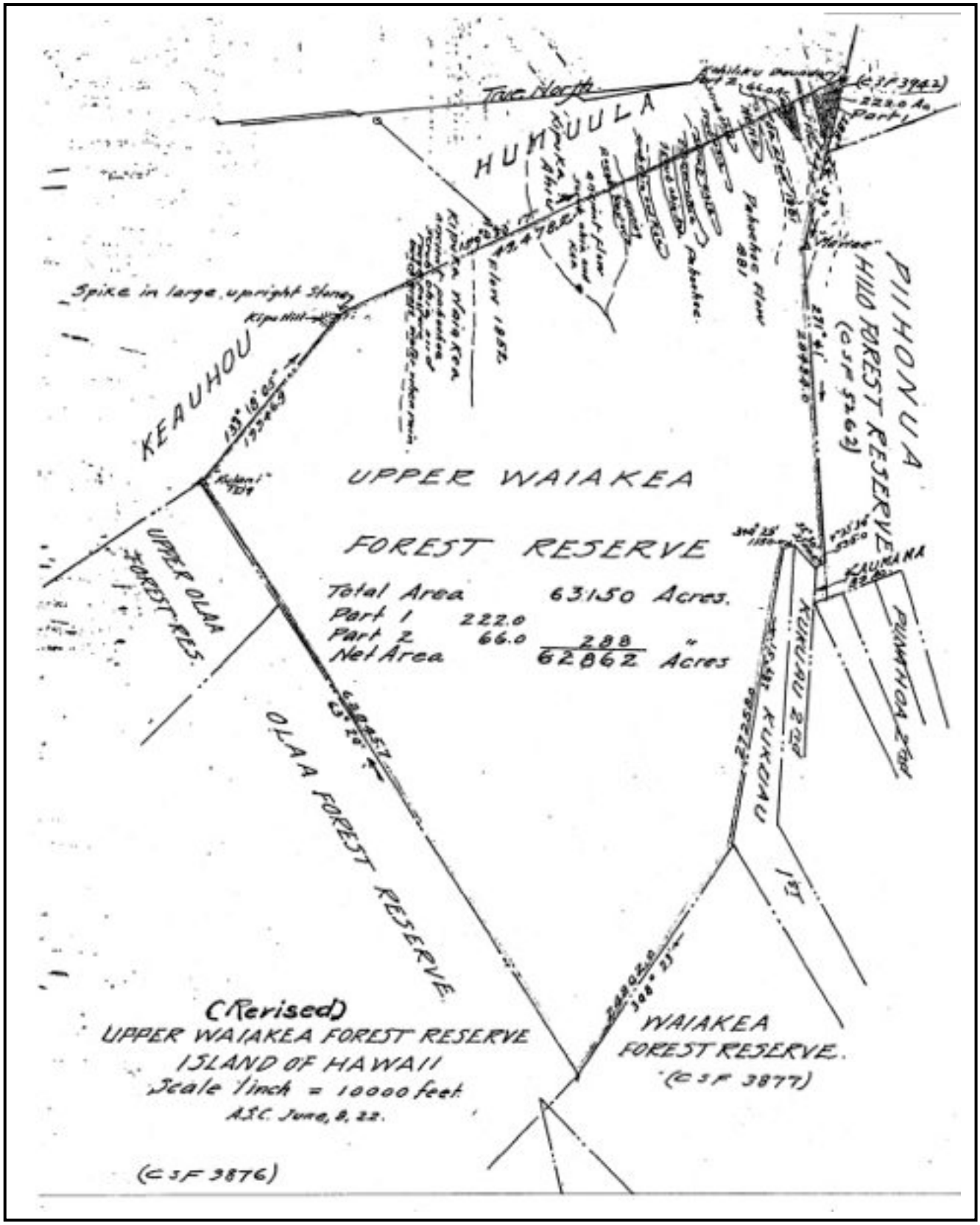


Figure 3. Plan of the Upper Waiakea Forest Reserve; C.S.F. 3876 Hawaii Territorial Survey, 1922)

1. 288º 24’ 33” 7500.0 feet along Piihonua;
2. 83º 00’ 6005.0 feet;
3. 159º 33’ 17” 3309.0 feet along Humuula-Waiakea boundary to the point of beginning.

Area 222-00/100 Acres.

Part 2. Portion of Aina Hou Kipuka in Waiakea. Beginning at a point on the Humuula-Waiakea boundary, the coordinates of said point of beginning referred to Government Survey Trig. Station “Puu Oo” being 21021.4 feet South and 3081.3 feet East, and running by true azimuths:–

1. 268º 00’ 3500.0 feet;
2. 59º 00’ 3370.0 feet;
3. 159º 17’ 33” 1725.0 feet to the point of beginning.

Area 66-00/100 Acres.

LEAVING A NET AREA OF 62,862 ACRES.

Compiled from Gov’t. Survey Records & Survey of E.W. Hockley, by A.S. Chaney, Assistant Government Surveyor. [State Survey Division]

[See also Plat 788; R.M. 2682, Dated Jan. 3, 1923; and C.S.F. 2430, 3942, 9193, 16633, 21210-21213.]

The Hawaii National Park, taking in portions of Keauhou and neighboring lands in Puna, was established on August 1st, 1916. In 1926, an addition to the park, connected the Kīlauea and Mauna Loa Sections of the park (C.S.F. 4625, State Survey Division). In 1928, the Kilauea Forest Reserve, comprised of a portion of Keauhou, adjoining the ‘Ōla‘a and Waiākea Forest Reserve lands was established, thus extending the forest reserve tracts from Hilo, through Puna, and into Ka‘ū (C.S.F. 4842) (*Figure 4*). While the land of Keauhou had been leased out to ranching interests since 1860, some control over the cattle had been maintained. The leases specifically stipulated that care would be taken of the forest resources (Bureau of Conveyances Liber 13:56-57). Apparently, based on the early records of the reserve, only minimal intrusion by wild stock into the denser ‘Ōla‘a-Waiākea forests occurred.

Following establishment of the ‘Ōla‘a, Waiākea and Kīlauea Forest Reserves, management of the lands and forest resources fell under the jurisdiction of the Territory, and then the State of Hawai‘i. During the years from establishment of the reserves to the 1950s, little work occurred within the deep reserves. Some fencing along leasehold boundaries occurred, and cattle continued to be moved on the upper Humu‘ula and Keauhou sections of the adjoining lands. Hunting wild cattle and pigs in the reserve lands and neighboring ranch lands was almost entirely limited to ranch hands, territorial game wardens and personnel, and the occasional poacher. It was not until after World War II ended that the Territorial Fish and Game Division began a program of conducting guided hunting trips, and developing camps from which hunters could access the public lands for hunting pigs in the region—this being a way to control damage done to the forest reserve resources.

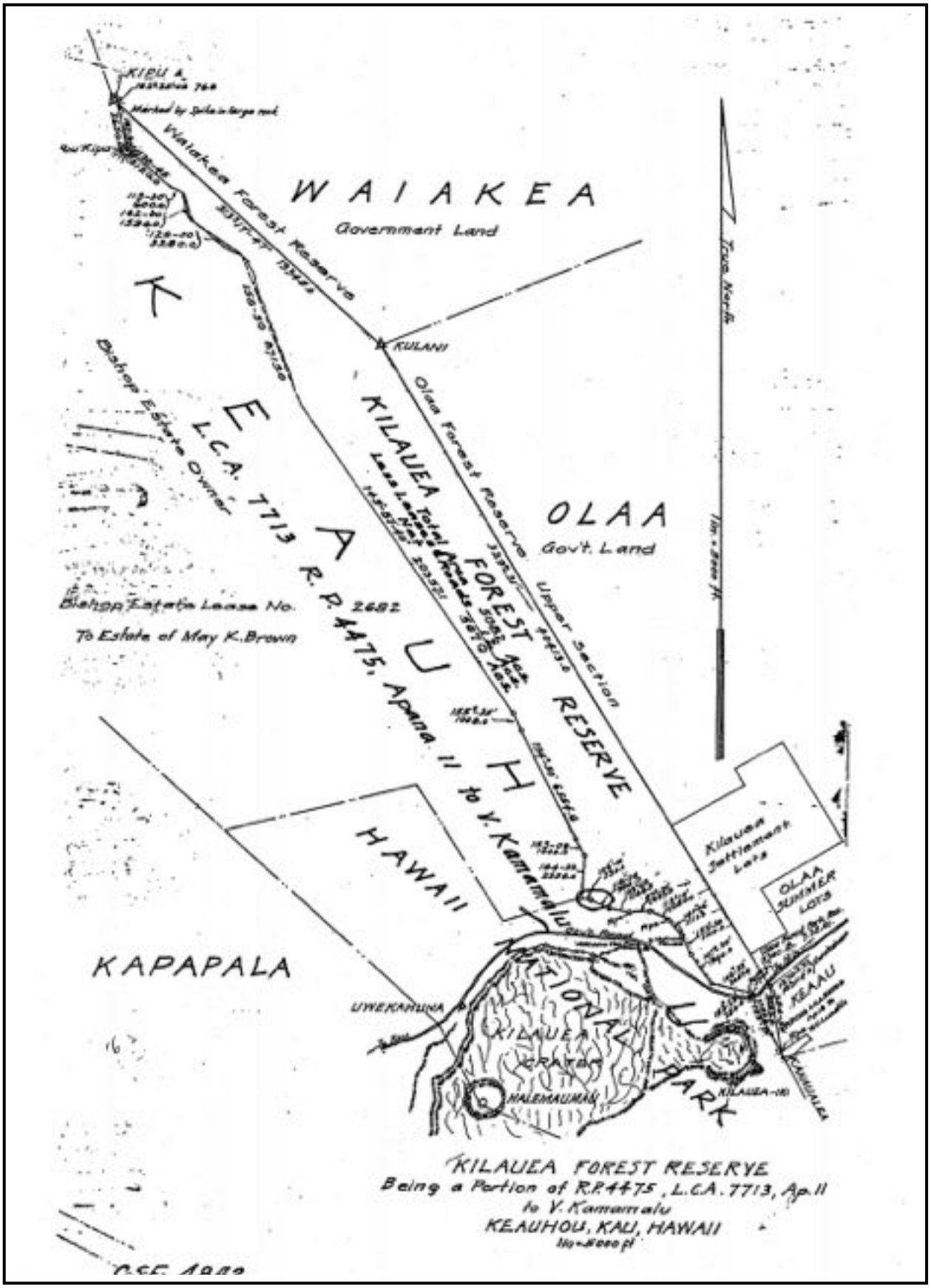


Figure 4. Plan of Kilauea Forest Reserve; C.S.F. 4842 (Hawaii Territorial Survey, 1927)

The "Kulani Prison Farm"

One additional activity began in the forest lands in the 1940s, in the vicinity of what is now the Pu'u Maka'ala NAR. This was the relocation of the Waiakea Prison Camp from the Hilo Airport to the remote, Kūlani site. Howard Ellis, former employee and manager of the Mauna Loa Weather Station, began working on Mauna Loa in 1961. During the early years on Mauna Loa, Mr. Ellis was close friends with Tom Vance, who opened the Kūlani Prison Farm (later, the Kulani Honor Camp); the access roadway (Stainback Higway); and the Mauna Loa Observatory.

Government survey records document that on January 8, 1948, the lands for the Kulani Prison Site were confirmed by the survey below (*Figure 5*):

> ***C.S.F. 10,543***
> ***Jaunary 8, 1948***
> ***Kulani Prison Site***
> ***South Hilo and Puna Island of Hawaii***
> Being protions of Upper Waiakea Forest Reserve and Upper Olaa Forest Reserve to be withdrawn by Governor's Executive Order and set aside under the control of the Board of Institutions as a prison site.
>
> Being portions of the Government (Crown) lands of Waiakea and Olaa.
>
> Beginning at the Government Triangulation Station "Kulani" and on the common boundary of the lands of Keauhou, Waiakea and Olaa as shown on Government Survey Registered Map 2765, and running by azimuths measured clockwise from True South:-
>
> 1. 133º 18' 05" 5000.00 feet along the land of Keauhou;
> 2. 180º 00' 7500.00 feet along portion of the Upper waiakea Forest Reserve;
> 3. 90º 00' 3400.00 feet along the Upper Waiakea Forest Reserve;
> 4. 159º 33' 30" 9600.00 feet along Upper Waiakea Forest Reserve;
> 5. 105º 40' 4500.00 feet along Upper Waiakea Forest Reserve;
> 6. 156º 10' 6410.70 feet along Upper Waiakea Forest Reserve;
> 7. 249º 33' 3247.00 feet along Upper Waiakea Forest Reserve;
> 8. 336º 10' 3849.20 feet along Upper Waiakea Forest Reserve;
> 9. 285º 40' 7500.00 feet along Upper Waiakea Forest Reserve;
> 10. 339º 33' 30' 5500.00 feet along Upper Waiakea Forest Reserve;
> 11. 285º 52' 11493.30 feet along Upper Waiakea Forest Reserve;
> 12. 360º 00' 800.00 feet along Upper Waiakea Forest Reserve;
> 13. 56º 11' 30" feet along Upper Waiakea Forest Reserve;
> 14. 360º00 19300.00 feet along portions of the Upper Waiakea and Upper Olaa Forest Reserves;
> 15. 149º 31' 9000.00 feet along the land of Keauhou to the point of beginnig.
>
> Area 5,600 Acres. [State Survey Division]

Governor Ingram M. Stainback, issued Executive Order No. 1224 on March 4th, 1948, formally removing the Kulani Prison site lands from the Upper Waiakea and Olaa Forest Reserves, and setting aside the land for use by the Department of Institutions for the Kulani Prison Farm (Governor's Executive Order No. 1224).

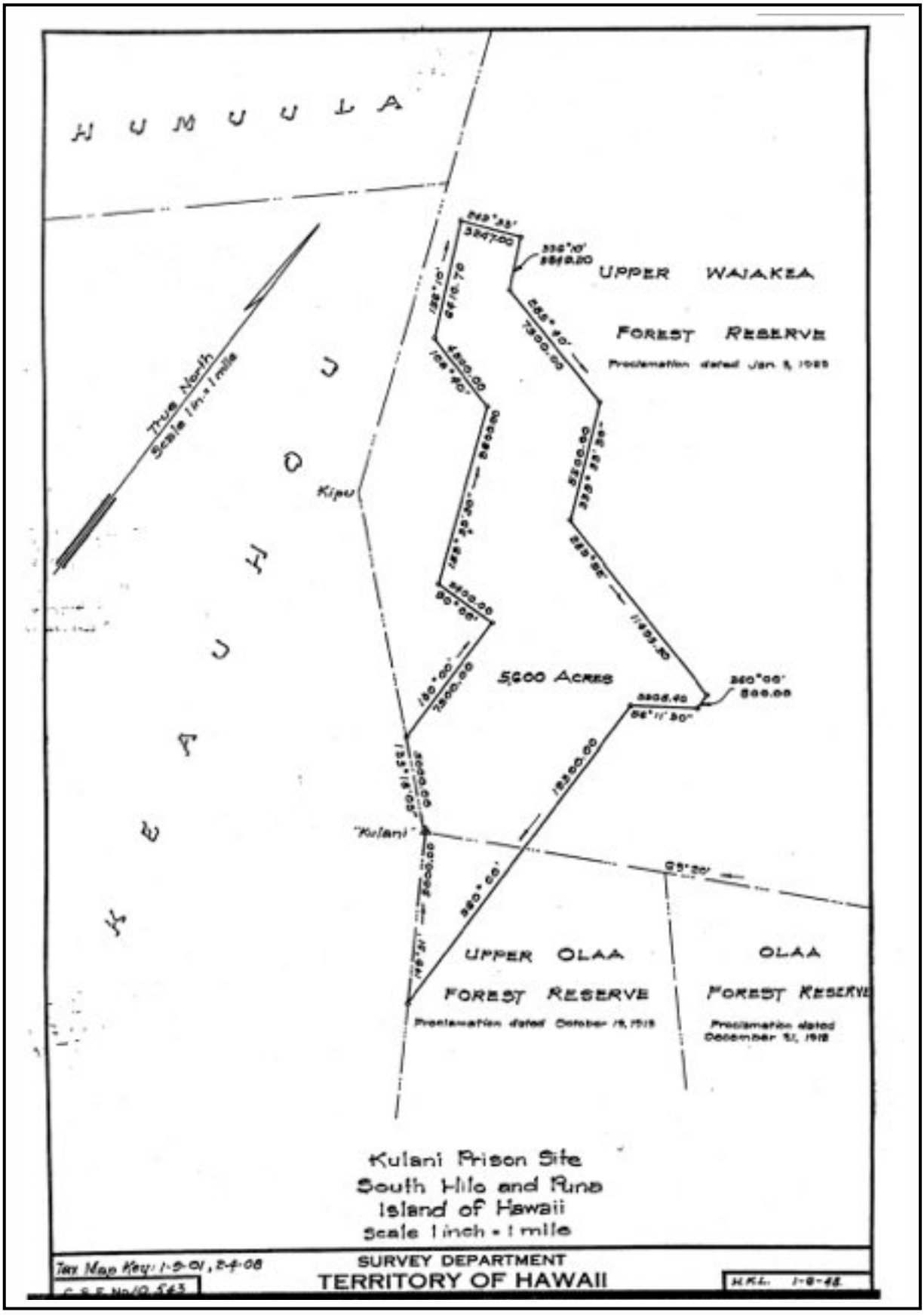


Figure 5. C.S.F. Map No. 10,543; The Kulani Prison Site (January 8, 1948)

In 1952, the Kulani Prison Farm site was modified, taking in an additional 4,461.99 acres of forest land from the Upper Waiakea and Olaa Forest Reserves. C.S.F. No. 11,550 lays out the mete and bounds and map of the addition (see *Figure 6*). Governor, S.W. King. Siged Executive Order No. 1588, on October 16th, 1953, setting asside the additional land for the facility and support programs.

From Tom Vance, Howard Ellis learned first-hand accounts about the Kūlani facility and access across the forest lands in the 1940s to 1950s (pers comm. H. Ellis, 2004). *Figure 7*, HTS Plat No. 788-A (A.S. Chaney, surveyor, dated 1922); with additions to 1956, provides the locations of sites and facilities described by Mr. Ellis, who wrote of his recollections in 1988:

> In 1951, a weather station was set up by the Weather Bureau (WB) near the summit of Mauna Loa… An instrumented building was dedicated there as the Mauna Loa Observatory on December 12. [page 1] On June 28, 1956, a larger building at 11,150 feet was dedicated as the Mauna Loa Slope Observatory, which in time became known as the Mauna Loa Observatory…
>
> Mr. Tom Vance came… to Hawaii to teach school in the 1930s… On an early hike over the trail from Puu O'o across the lower slopes of Mauna Loa on the Hilo side to the Volcano area, he dreamed that some day he would be in a position to cause the great resources he found along the trail to be utilized. He found "great ash [page 2] deposits of deep fertile soil and beautiful stands of *koa* trees, many of which were falling to the ground and slowly rotting away."
>
> Mr. Ingram M. Stainback, a prominent attorney in the islands…helped Mr. Vance establish the Waiakea Prison Camp near Hilo for the purpose of forming an airstrip by hand labor using only picks, shovels and wheelbarrows.
>
> When the war started, the military took over this airstrip, expanding it, making it a Navy Air Station only to realize that virtually in its center there was a prison camp… [page 3] With concern for their safety and with his philosophy that if any person is to be retrained to function in society he must be given constructive work and a chance to learn a trade, he set his sights up the slope in the direction of the summit of Mauna Loa to that area where he had seen that rich soil and huge *koa* trees. It was a long way off and partly through a rainforest. They started out packing in with each cutting the trail with a cane knife.
>
> [Mr. Vance] …said that people thought him crazy to do this… They finally made it to the base of the Kulani Cone where the Territorial Board of Agriculture had come in from the other side, up the Puu O'o trail from the Volcano area, and built a pig hunter's cabin to encourage the reduction of damage to the forest by pigs.
>
> Mr. Vance had found that the territorial government's half million acres in the area they had cut through were ideal not only for forests, which could foster a lumber and furniture industry, but the mile high area provided a climate ideal for temperate zone agriculture.
>
> He felt that as soon as the prison industry was thought to be competitive with private industry, there would be a legislation that would be passed to stop the activity. However, they [page 4] might be safe in their isolation up there, he thought. There were 17 miles of road to be built through dense jungle with little likelihood of special appropriations since it was during war time.
>
> He began by sledding in supplies a short distance, establishing camp, working the road back down, and repeating these steps over again. Mr. Stainback had now been appointed Governor of the Territory and when the commander of the U.S. Navy

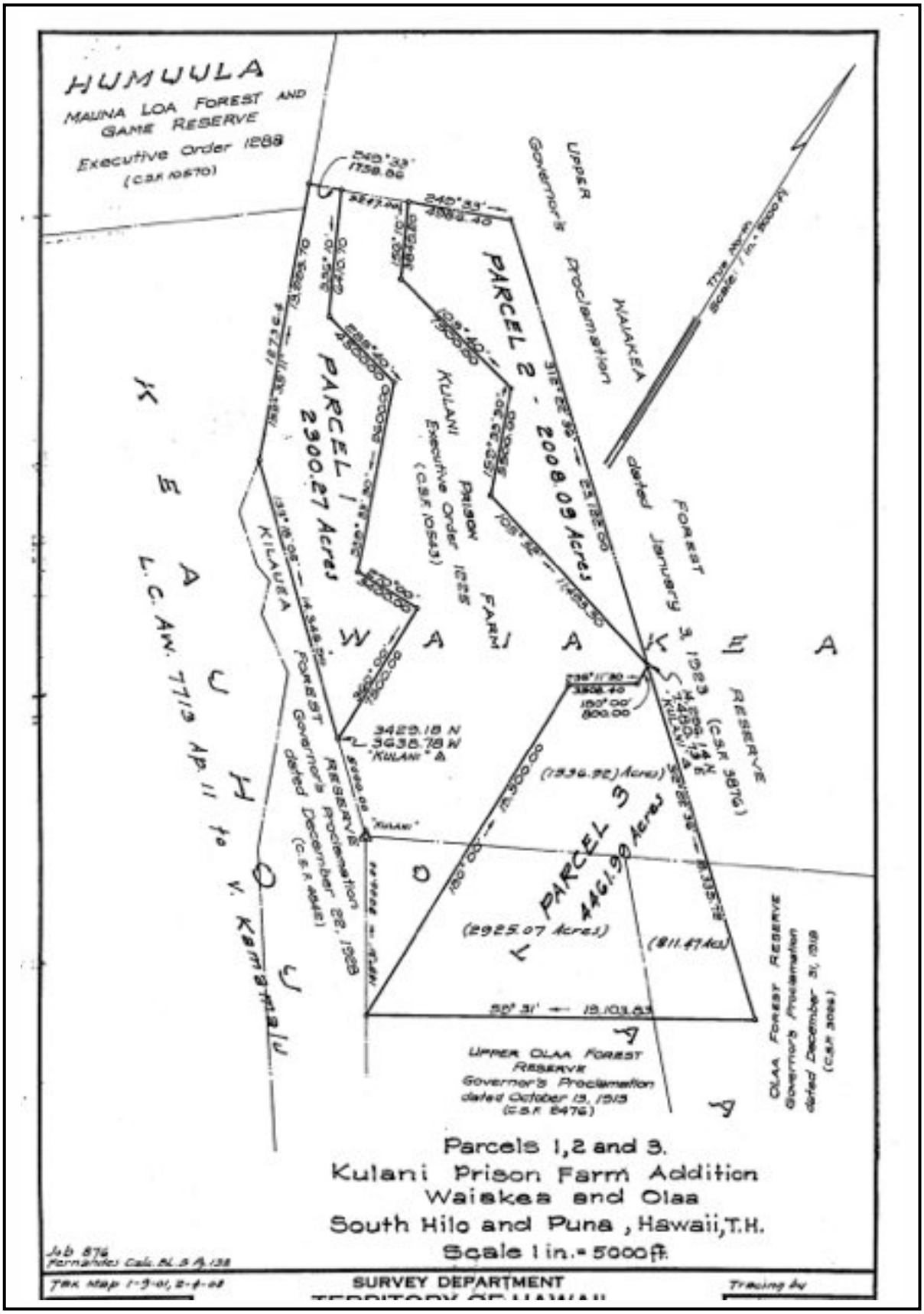


Figure 6. C.S.F. Map No. 11,550; Addition to the Kulani Prison Site (October 16th, 1953)

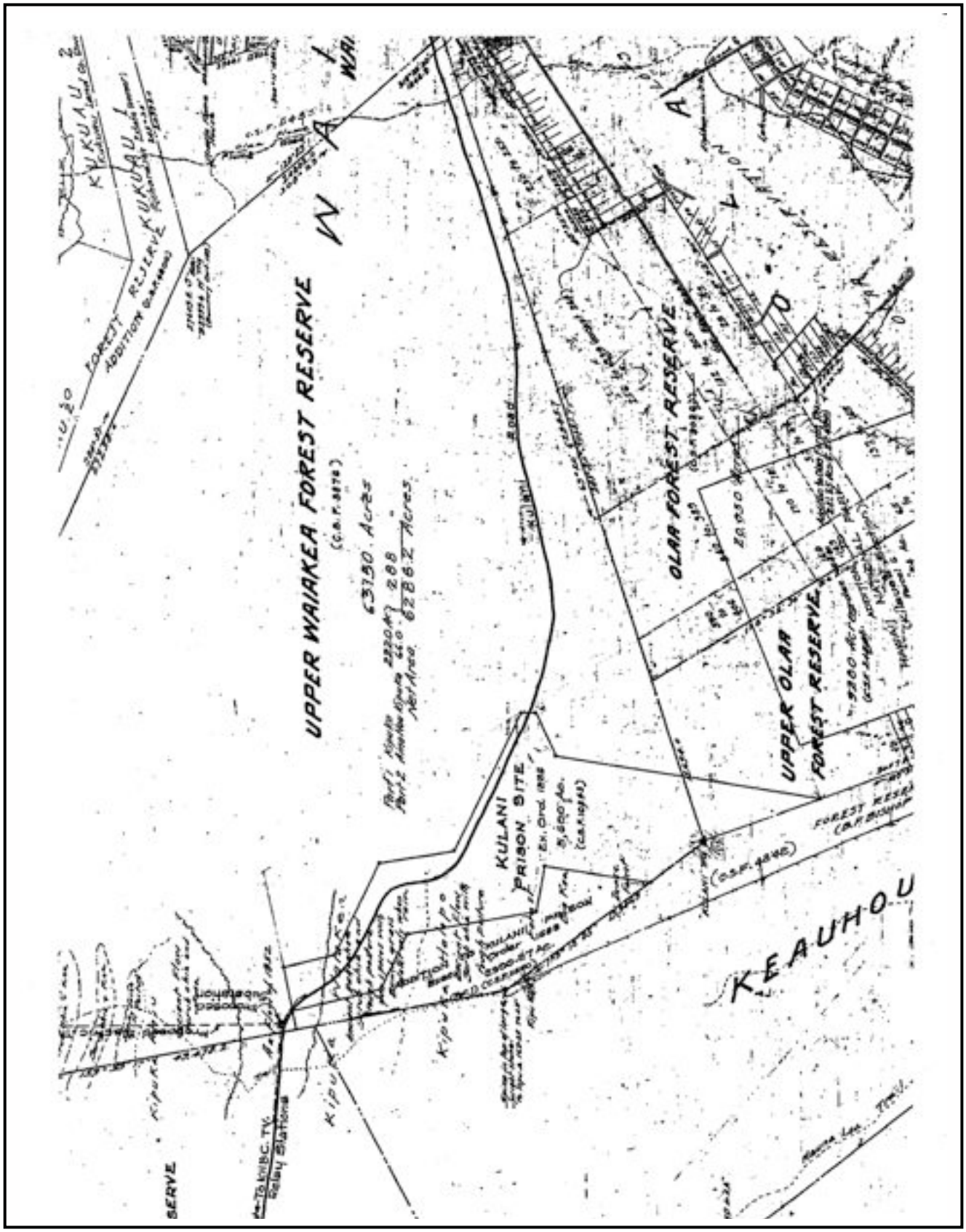


Figure 7. Portion of HTS Plat No. 788-A, Depicting Features and Boundaries of the Kulani Prison Site (A.S Chaney, 1922; additions to 1956)

> Seabees requested the use of land for practice in road building to be soon used in the war on Pacific islands and in jungles, he knew just where to send them.
>
> Things were going great for about three miles when a big *ohia* tree fell on a bulldozer operator. He might have died but the prisoners quickly wrested the big trunk away. The Seabees gave up, but Mr. Vance didn't.
>
> When the immediate threat of enemy landings on the island subsided, some portable barracks that had been used by guard units at various places around the island were left surplus. Mr. Vance obtained and used some of these for his camps as he continued to push up further toward Kulani.
>
> He had many plans and tried to tie them all together. He planned a road all the way to the summit of Mauna Loa with a median strip where he thought all the plants of the world could [page 5] find a supporting climate[3]. It was to be called the "Gardens of the World." The road was named "Stainback Highway," leaving it open for later jokes about "Strainback Highway."
>
> The reason Mr. Vance gave for choosing Mauna Loa was the resources of the Kulani area. Since Mauna Kea, at any given elevation above 6,000 feet is about five times smaller in area than Mauna Loa, and being of almost equal height, it is easier to see. With great pride, he pointed out how he had laid out the road in several places above Kulani so as to frame Mauna Kea with his great *koa* trees on both sides of the road. His pride was indeed justified because such an effect accentuated the majesty [page 6] of Mauna Kea and with a snow-covered top the view was truly breathtaking.
>
> Mauna Loa, with it's almost constant and gentle slope all the way from Hilo to the summit, made road building alluring. Drainage ditches along the roadside were not required in the lava fields since there was good natural drainage.
>
> The fact that Mauna Loa had erupted about every ten years since records had begun and that there was no record, legend, or evidence obvious to the average person that Mauna Kea had ever erupted did not disfavor the selection of Mauna Loa. Indeed, providing public access for viewing future eruptions was an added attraction… [H. Ellis, 1988:7]

Ellis' narrative also describe the further development of the road from Kūlani to Mauna Loa. By 1949, the road extended nine miles above Kūlani. Mr. Vance's lead man on the project was the late Henry Auwae (a noted Hawaiian healer), who at the time, was employed at Kūlani as an instructor (Ellis 1988: 11). The Kūlani-Mauna Loa was completed by late 1949, and was used as the route of access to the Mauna Loa summit region until 1963 (Ellis, 1988:15).

Another important part of the program at the Kūlani facility has been its' wood workshop and sales venture. For years, inmates have collected native hardwoods from lands around the facility, and turned it into art and utilitarian items for sale. A part of the income goes to the benefit of the inmates themselves, and provides them with a trade skill.

The 1942 Lava Flow Natural Area Reserve

In 1972, Governor Ariyoshi signed Executive Order No. 2720, establishing one of the early Natural Area Reserves in the islands, it being the 1942 Lava Flow Natural Area Reserve. Land for the 640 acre reserve was withdrawn from the older Waiakea Forest Reserve (by Executive Order No. 2719), and described as:

> ***C.S.F. 16,634***
> ***May 26, 1972***
>
> ***1942 LAVA FLOW NATURAL AREA RESERVE***
>
> Waiakea, South Hilo, Island of Hawaii, Hawaii
>
> Being a portion of the Government (Crown) Land of Waiakea.
>
> Beginning at the west corner of this parcel of land, the direct azimuth and distance from Government Survey Triangulation Station "E 1942 FLOW" being 149º 15' 2035.00 feet, and the coordinates of said point of beginning referred to Government Survey Triangulation Station "KULANI" being 41,481.42 feet North and 18,229.29 feet East, thence running by azimuths measured clockwise from True South:–
>
> 1. 228º 46' 5,280.00 feet along Upper Waiakea Forest Reserve, Governor's Proclamation dated January 3, 1923;
> 2. 318º 46' 5,280.00 feet along Upper Waiakea Forest Reserve, Governor's Proclamation dated January 3, 1923;
> 3. 48º 46' 5,280.00 feet along Upper Waiakea Forest Reserve, Governor's Proclamation dated January 3, 1923;
> 4. 138º 46' 5,280.00 feet along Upper Waiakea Forest Reserve, Governor's Proclamation dated January 3, 1923 to the point of beginning and containing an AREA OF 640 ACRES…

The formal designation of the 640 acre reserve was authorized by Governor's Executive Order No. 2720, dated December 2nd, 1974.

The Puʻu Makaʻala Natural Area Reserve

The Puʻu Makaʻala Natural Area Reserve is made up of lands that were originally set aside in the early 1900s as a part of the territorial government's resource conservation program. In 1970, Hawaiʻi became one of the first states in the country to designate unique natural resources as a part of a system of Natural Area Reserves. In accordance with State Law, the NARS are mandated to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaii" (HRS 195-1).

In 1981, as a part of the ongoing program to designate unique natural systems as Natural Area Reserves, selected lands of the ʻŌlaʻa Forest Reserve were withdrawn from reserve. Those lands are described in the following notes of survey:

C.S.F. 18,636
WITHDRAWAL
PORTION OF OLAA FOREST RESERVE [Figure 8]
(Governor's Proclamation dated December 31, 1918)
Olaa, Puna, Island of Hawaii, Hawaii
Withdrawn by E.O. 3095 dated Nov. 2, 1981
(E.O. Folder 67-A)

STATE OF HAWAII
SURVEY DIVISION
DEPT. OF ACCOUNTING AND GENERAL SERVICES
HONOLULU
May 4, 1979

WITHDRAWAL
PORTION OF OLAA FOREST RESERVE
(Governor's Proclamation dated December 31, 1918)
Olaa, Puna, Island of Hawaii, Hawaii

Being portion of the Government (Crown) Land of Olaa.

Beginning at the west corner of this parcel of land, on the boundary between the lands of Waiakea and Olaa, the coordinates of said point of beginning referred to Government Survey Triangulation Station "KULANI" being 5,697.06 feet North and 11,343.77 feet East, thence running by azimuths measured clockwise from True South:–

1. 243º 20' 24,906.00 feet along Upper Waiakea Forest Reserve (Governor's Proclamation dated January 3, 1923), along the boundary between the lands of Waiakea and Olaa.
2. Thence along the contour line 3000 feet above mean sea level, along the remainder of Olaa Forest Reserve (Governor's Proclamation dated December 31, 1918), the direct azimuth and distance being: 353º 48' 52" 15,913.31 feet;
3. 302º 21' 10" 1100.00 feet along the remainder of Olaa Forest Reserve (Governor's Proclamation dated December 31, 1918);
4. 302º 21' 10" 4257.80 feet along Lots 129, 128, 127, 126 and 125, Olaa New Tract Lots;
5. 48º 32' 30" 3057.06 feet along Lot 135-B, Olaa New Tract Lots and along the northwest end of Roadway (50.00 feet wide);
6. 302º 21' 10" 1506.52 feet along the southwest side of Roadway (50.00 feet wide);
7. 34º 08' 30" 7462.10 feet along Lots 99, 98, 97, 96, 95, 94, 93, 92, 91, 90-B and 90-A, Olaa New Tract Lots;
8. 149º 31' 17,853.54 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor's Executive Order 1540);
9. 59º 31' 10,104.01 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor's Executive Order 1540);
10. 138º 32' 30" 8347.71 feet along upper Olaa Forest Reserve (Governor's Proclamation dated October 13, 1913) to the point of beginning and containing an AREA OF 6871 ACRES, MORE OR LESS…

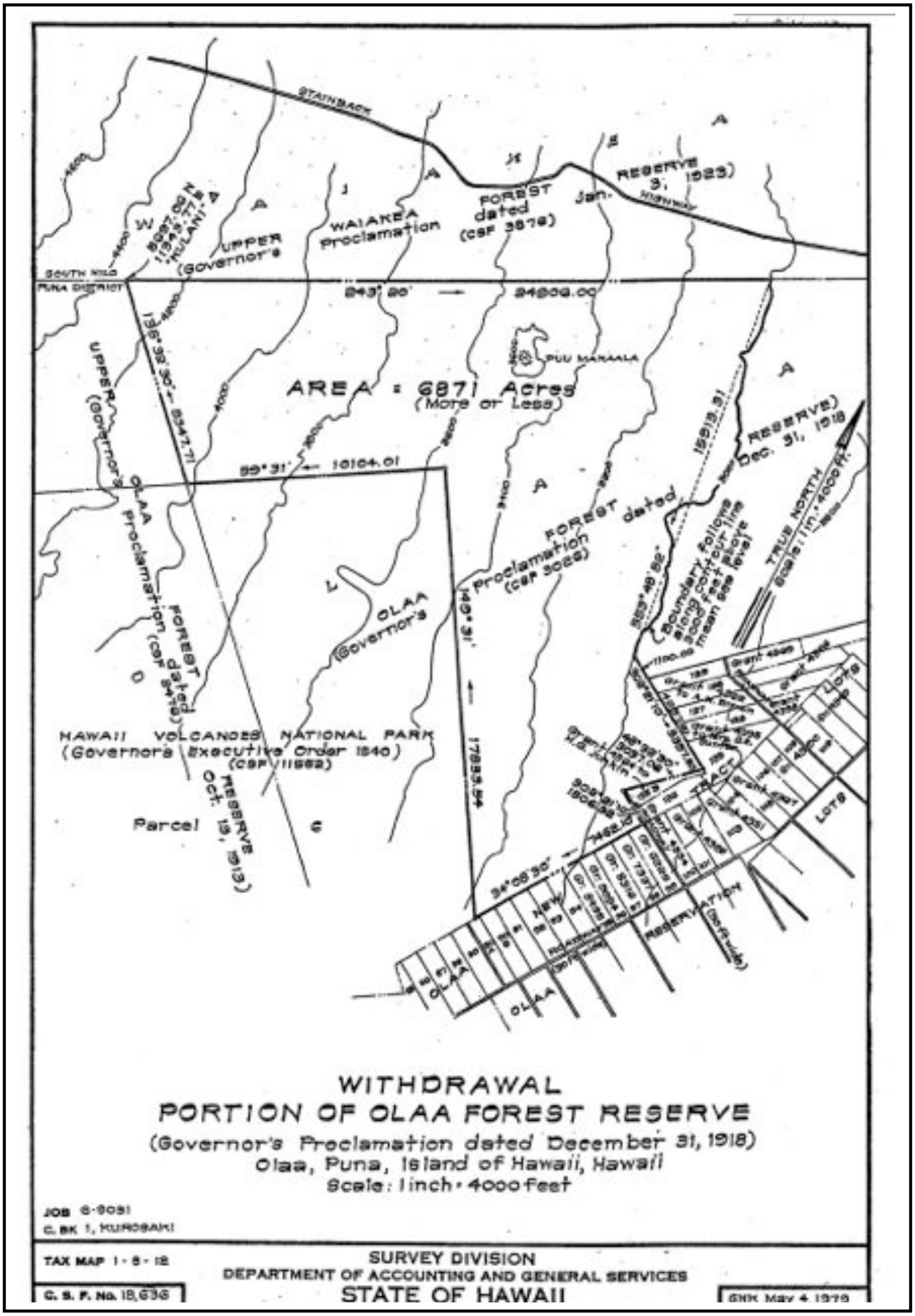


Figure 8. Location of Land Withdrawn From ʻŌlaʻa Forest Reserve; Puʻu Makaʻala NAR Section (Hawaii State Survey, 1979)

Compiled from data furnished
by N.A.R.S., U.S.G.S. Map,
& Govt. Survey Records. [State Survey Division]

Executive Order No. 3094
November 2nd, 1981
Withdrawal of Land from the Operation of
Governor's Proclamation of Forest Reserves Dated October 13, 1913.
Whereas, by Governnor's Proclamation of Forest Reserves in the Districts of Hilo and Puna, Island of Hawaii, Hawaii, dated October 13, 1913, Certain lands situate in the District of Puna, Island of Hawaii, Hawaii, were set aside for Upper Olaa Forest Reserve, to be under the control and management of the Board of Commissioners of Agriculture and Forestry; and

Whereas, portions of said lands were recommended by the Natural Area Reserves System Commission as Natural Area Reserves; and

Whereas, the Board of Land and natural Resoruces, at its meeting of November 9, 1978, approved the withdrawal.

Now, Therefore, I, George R. Ariyoshi, Governor of the State of Hawaii, by virtue of the authority vested in me under Section 171-11, Hawaii Revised Statues, do hereby order that the following described land, more particularly described in Exhibit "A" and delineated on Exhibit "B…" be and the same is hereby withdrawn from the operation of Governor's Proclamation of Forest Reserves dated October 13, 1913… [In Collection of State Survey Division]

C.S.F. 18,635
WITHDRAWAL
PORTION OF UPPER OLAA FOREST RESERVE
(Governor's Proclamation dated October 13, 1913)
Olaa, Puna, Island of Hawaii, Hawaii

Withdrawn by E.O. 3094 dated Nov. 2, 1981
(E.O. Folder 67-A)
STATE OF HAWAII
SURVEY DIVISION
DEPT. OF ACCOUNTING AND GENERAL SERVICES
HONOLULU

May 4, 1979

WITHDRAWAL
PORTION OF UPPER OLAA FOREST RESERVE
(Governor's Proclamation dated October 13, 1913)
Olaa, Puna, Island of Hawaii, Hawaii

Being portion of the Government (Crown Land of Olaa).

Beginning at the west corner of this parcel of land, on the boundary between the lands of Waiakea and Olaa, the coordinates of said point of beginning referred to Government Survey Triangulation Station "KULANI" being 2292.92 feet North and 4565.59 feet East, thence running by azimuths measured clockwise from True South:-

1. 243º 20’ 7584.98 feet along Upper Waiakea Forest Reserve (Governor’s Proclamation dated January 3, 1923), along the boundary between the lands of Waiakea and Olaa.
2. 318º 32’ 30” 8347.71 feet along Olaa Forest Reserve (Governor’s Proclamation dated December 31, 1918);
3. 59º 31’ 9895.99 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor’s Executive Order 1540);
4. 329º 31’ 7976.25 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor’s Executive Order 1540);
5. 59º 31’ 4359.10 feet along Lots 16 and 17, Volcano Farm Lots and along the northwest end of Roadway (50.00 ft. wide);
6. 149º 31’ 8016.25 feet along Kilauea Forest Reserve (Governor’s Proclamation dated December 22, 1928), along boundary between the lands of Keauhou and Olaa;
7. 180º 00’ 10,048.92 feet along Kulani Prison Site (Governor’s Executive Order 1225) to the point of beginning and containing an AREA OF 2926.76 ACRES.

Compiled from data furnished
by N.A.R.S & Govt. Survey Records. [State Survey Division]

In 1981, portions of the Waiākea and ‘Ōla‘a Forest Reserve lands were dedicated to the Pu‘u Maka‘ala Natural Area Reserve by Governor Waihe‘e, in Executive Order No. 3102. The Executive Order provides the following description and purpose of the lands in the NARS:

Executive Order No. 3102
Setting Aside Land for Public Purposes
November 16, 1981

FOR NATURAL AREA RESERVE, to be under the control and management of the Department of Land and Natural Resources, State of Hawaii, being the lands situate at Waiakea, South Hilo and Olaa, Puna, Island of Hawaii, Hawaii, and designated as PUU MAKAALA NATURAL AREA RESERVE, containing an area of 12,106 acres, more or less, all more particularly described in Exhibit “A” and delineated on Exhibit “B” , both of which are attached hereto and made a part hereof, said exhibits being a survey description designated as C.S.F. No. 18,646 dated May 4, 1979, and a survey map designated as H.S.S. Plat 933, both prepared by the Survey Division, Department of Accounting and General Services, State of Hawaii…

Exhibit A
C.S.F. 18,646
May 4, 1979

PUU MAKAALA NATURAL AREA RESERVE
Waiakea, South Hilo and Olaa, Puna
Island of Hawaii, Hawaii

Being portions of the Government (Crown) Lands of Waiakea and Olaa.

Beginning at the Government Survey Triangulation Station “KULANI” on the common corner of the lands of Keauhou, Waiakea and Olaa, as shown on Government Survey Registered H.S.S. Plat 933 [*Figure 9*], thence running by azimuths measured clockwise from True South:-

1. 133º 18’ 05” 1000.00 feet along Kilauea Forest Reserve (Governor’s Proclamation dated December 22, 1928), along the boundary between the lands of Keauhou and Waiakea;

   Thence along the south side of Roadway, along the remainder of Kulani Prison Site (Governor’s Executive Order 1225) for the next five (5) courses, the direct azimuths and distances between points along said south side of roadway being:

2. 180º 30’ 1260.00 feet;
3. 244º 45’ 1310.00 feet;
4. 275º 00’ 880.00 feet;
5. 293º 40’ 1088.17 feet;
6. 318º 25’ 753.90 feet to the boundary between the lands of Olaa and Waiakea;
7. 243º 20’ 16,520.00 feet along the remainder of Upper Waiakea Forest Reserve (Governor’s Proclamation dated January 3, 1923), along the boundary between the lands of Olaa and Waiakea;
8. Thence along the contour line 4000 feet above mean sea level, along the remainder of Upper Waiakea Forest Reserve (Governor’s Proclamation dated January 3, 1923), the direct azimuth and distance being:

   167º 09’ 12” 6808.36 feet to the south side of Stainback Highway;

9. Thence along the south side of Stainback Highway, along the remainder of Upper Waiakea Forest Reserve (Governor’s Proclamation dated January 3, 1923), the direct azimuth and distance being:

   259º 50’ 03” 17,874.62 feet;

10. Thence along the contour line 3000 feet above mean sea level, along the remainder of Upper Waiakea Forest Reserve (Governor’s Proclamation dated January 3, 1923), the direct azimuth and distance being:

    2º 44’ 24” 1761.32 feet to the boundary between the lands of Olaa and Waiakea;

11. Thence along the contour line 3000 feet above mean sea level, along the remainder of Olaa Forest Reserve (Governor’s Proclamation dated December 31, 1918), the direct azimuth and distance being:

    353º 48’ 52” 15,913.31 feet;

12. 302º 21’ 10” 1100.00 feet along the remainder of Olaa Forest Reserve (Governor’s Proclamation dated December 31, 1918);
13. 302º 21’ 10” 4257.80 feet along Lots 129, 128, 127, 126 and 125, Olaa New Tract Lots;
14. 48º 32’ 30” 3057.06 feet along Lot 135-B, Olaa New Tract Lots and along the northwest end of Roadway (50.00 ft. wide);
15. 302º 21’ 10” 1506.52 feet along the southwest side of Roadway (50.00 ft. wide);
16. 34º 08’ 30” 7462.10 feet along Lots 99, 98, 97, 96, 95, 94, 93, 92, 91, 90-B and 90-A, Olaa New Tract Lots;
17. 149º 31’ 17,853.54 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor’s Executive Order 1540);
18. 59º 31’ 20,000.00 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor’s Executive Order 1540);
19. 329º 31’ 7976.25 feet along Hawaii Volcanoes National Park, Parcel 6 (Governor’s Executive Order 1540);

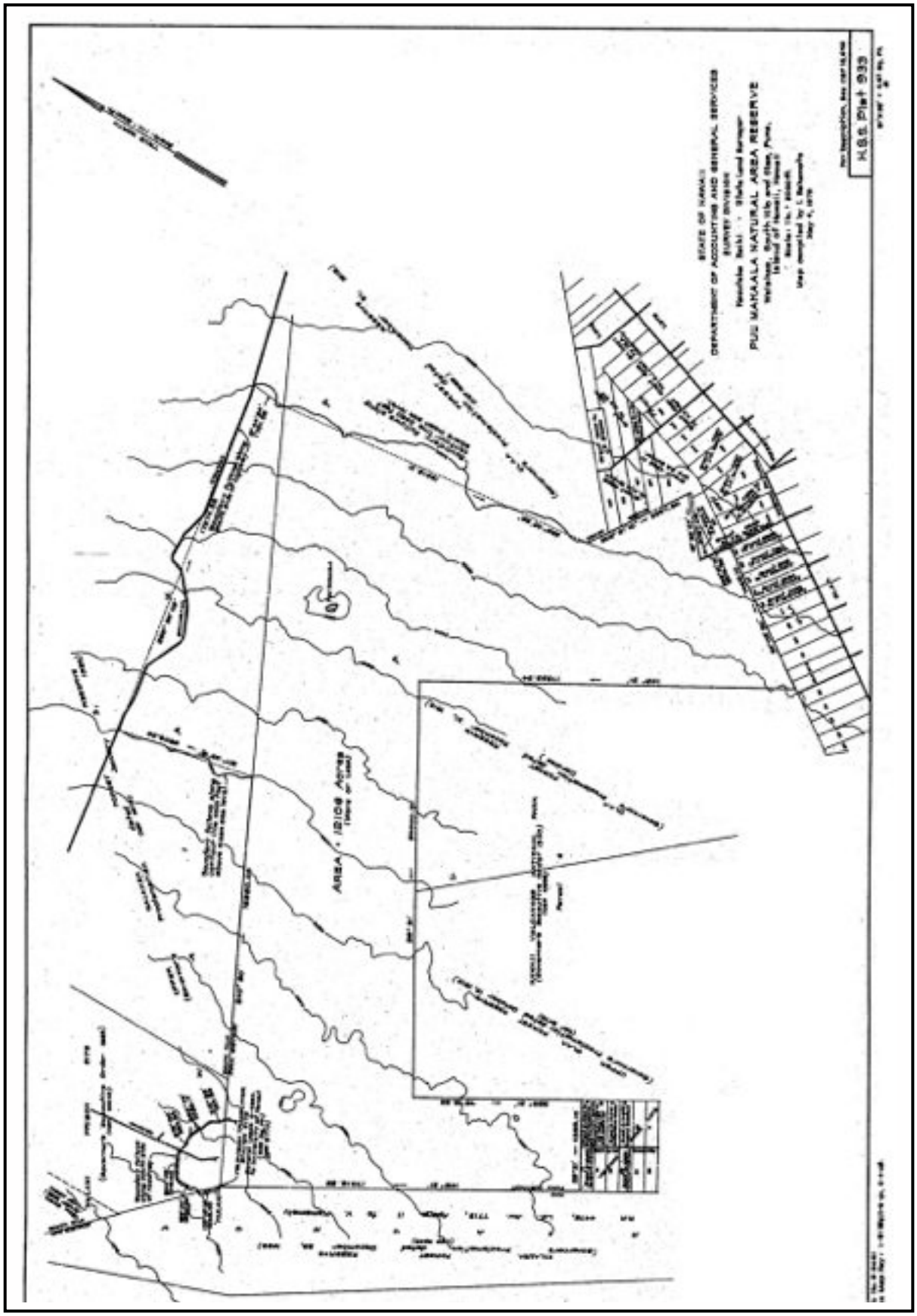


Figure 9. Redcution of Plan of the Pu‘u Maka‘ala Natural Area Reserve; Plat Map No. 933 (Hawaii State Survey, 1979)

20. 59º 31' 4359.10 feet along Lots 16 and 17, Volcano Farm Lots and along the northwest end of Roadway (50.00 ft. wide);
21. 149º 31' 17,016.25 feet along Kilauea Forest Reserve (Governor's Proclamation dated December 22, 1928), along the boundary between the lands of Keauhou and Olaa to the point of beginning and containing an AREA OF 12106 ACRES, MORE OR LESS.

The above-described PUU MAKAALA NATURAL AREA RESERVE is subject, however, to the following as shown on plan attached hereto and made a part hereof.

1. Television Translator Station Site covered by General Lease S-4234 to University of Hawaii.

Overview of Resources and Management Objectives for the Pu'u Maka'ala NAR

In 1989, the Department of Land and Natural Resources, Natural Area Reserves System office prepared a management plan for the Pu'u Maka'ala NAR. The following narratives describe resources of the Pu'u Maka'ala NAR and program objectives:

A. General Setting

Puu Makaala Natural Area Reserve occupies 12,106 acres in the Puna and South Hilo districts on the island of Hawaii. Elevations range from 2,800-5,500 feet and the average annual rainfall is 100-175 inches (DLNR 1986). Landmarks include Kulani Cone and Puu Makaala. The reserve is bordered by the Upper Waiakea Forest Reserve on the north, the Kilauea Forest on the west, Olaa Forest Reserve on the east, and the Olaa Tract of Hawaii Volcanoes Park (HAVO) on the south. Kulani Correctional Facility lies just outside the reserve's northwest corner. Access to portions of the reserve is generally good via Wright Road and jeep trails, although public access to the reserve's northern boundary via Stainback Highway is restricted by regulations of the correctional facility.

Regionally, the Puu Makaala reserve represents an important conservation parcel. It provides a link between the lower elevation HAVO Olaa Tract and the higher elevation *'ohia* (*Metrosideros polymorpha*)/*koa* (*Acacia koa*) forests of Kilauea, Kulani and Upper Waiakea, protecting the transition between the *'ohi'a* and *koa* forest types. These forest areas contain a full mosaic of different-aged *'ohi'a* stands… [DLNR 1989]

B. FLora

Puu Makaala reserve encompasses some of the Big Island's best wet native forest. Four natural communities occur in the reserve; three are dominated by native species.

'Ohi'a/Hapu'u (*Cibotium spp.*) Montane Wet Forest occupied the majority (11,200 acres or 92%) of the Puu Makaala reserve, meeting with the *koa/'ohi'a* forest near the western reserve's boundary, and extending east of the reserve. A variety of substrate types, including cinder, *'a'a* and *pahoehoe* flows of variable age, result in a mosaic of different-age stands of *'ohi'a/hapu'u* forest. The closed *'ohi'a* canopies can exceed 75 feet in height. Other sections of the *'ohi'a/hapu'u* forest were in various stages of dieback, ranging from a few senescent trees to sections where all trees are dead and fallen, with only a few snags standing over a 15 to 30 foot canopy dominated by *hapu'u* and an association of native trees.

The *hapu'u*, or tree fern layer in this *'ohi'a/hapu'u* wet forest is dominated by *Cibotium glaucum*, but *C. chamissoi* and *C. hawaiienses* can be locally abundant. The native

tree association below the *ʻohiʻa* canopy commonly included *ʻolapa* (*Cheirodendron trigynum*); *kawaʻu* (*Ilex anomala*); *pilo* (*Coprosma* spp.); *kolea* (*Myrsine lessertiana*); smaller stature *ʻohiʻa*; and occasionally included *naio* (*Myoparum sandwicense*); *manono* (*Hedyotis affinis*); *loulu* (*Pritchardia beccariana*); and *ʻohe* (*Tetraplasandra* spp.). The vegetation under the *hapuʻu* layer consisted of a mix of native ferns such as *Thelypteris sandwicensis*, *hoʻiʻo* (*Athyrium sandwichianum*), *ʻamaʻu* (*Sadleria* spp.) and *Dryopteris* spp.; native shrubs such as *puʻahanui* (*Broussaisia arguta*), *ʻohawai* (*Clermontia* spp.), *haʻiwale* or *kanawao keʻokeʻo* (*Cyrtandra* spp.), *Cyanea* spp., *maile* (*Alyxia oliviformis*), *alani* (*Pelea* spp.), and *ʻohelo* (*Vaccinium* spp.); seedlings of *ʻolapa*, *ʻohiʻa*, *kawaʻu*, *kolea* and *pilo*; and herbs such as *paʻiniu* (*Astelia menziesiana*) and ʻ*alaʻalawainui* (*Peperomia* spp.). Sedges such as *Carex alligata* and *Uncinia uncinata* were infrequent components of the ground cover. Epiphytic mosses, ferns, herbs and shrubs were present, and occasionally abundant.

Koa/ʻOhiʻa Montane Wet Forest occupied the northwestern edge of the Puu Makaala reserve on cinder and ash substrate. This community encompasses just 460 acres or 3.8 percent of the reserve. The forest type stretched into the reserve's Kulani Cone area from the adjacent Kilauea Forest. Scattered individual *koa* trees, from 60 to 120 feet in height, emerge from a layer of *ʻohiʻa* 30 to 90 feet in height. Under the *koa* and *ʻohiʻa* canopy is an association of native trees that commonly included *kolea*, *kawaʻu*, *ʻolapa*, *pilo* and young *ʻohiʻa*, but may also include *naio* and *ʻohe*.

The *ʻohiʻa/hapuʻu* and *koa/ʻohiʻa* wet forests share many of the same component species. The former, however, had an overall higher diversity by virtue of the greater area and elevational range it occupies. Some genera in Puu Makaala, such as *Pritchardia, Trematolobelia,* and *Claoxylon,* as well as species such as *anini* (*Eurya sandwicensis*) and *Cyanea tritomantha*, seem restricted to the *ʻohiʻa/hapuʻu* forest.

Carex Alligata Montane Wet Grasslands are scattered throughout the reserve as small but distinct patches occupying low lying water-saturated areas such as cinder cone pits or depressions in the forest. Only a few of the *Carex* grasslands were encountered on the ground survey but many examples were seen during helicopter reconnaissance. This grassland may consist entirely of *Carex* but may also include scattered shrubs of *ʻohiʻa* and patches of *wawaeʻiole* (*Lycopodium* spp.), especially in ecotones with surrounding forest. Often associated with standing water, this sedge forms a wide margin around a pond. As the pond ages, the basin may become dominated by *Carex.* The largest examples occupy cinder cone craters on ***Kulani*** and ***Na Lua Mahoe***.

Along the eastern boundary, 360 acres of tropical ash (*Fraxinus uhdei*) plantations constitute the reserve's only non-native dominated community. Amidst the scattered ash trees are elements of the surrounding *ʻohiʻa/hapuʻu* forest, as well as a variety of non-native plants. At this time, the ash is not invading adjacent native forest in the reserve. There were many non-native plants found within these four natural communities… [DLNR 1989]

C. Fauna.

Systematic circular plots were used to sample birds along transects 4 and 6; and incidental bird observations were made on all other transects. Only two native birds were commonly seen in the reserve during this survey. The *Apapane* (*Himatione sanguinea*) was abundant throughout, except in areas of extensive *ʻohiʻa* dieback. The Hawaiian Thrush, or *ʻOmaʻo* (*Myadestes obscurus*) was less abundant, but ubiquitous, being recorded on nearly all stations.

Two other native forest birds, *ʻiʻiwi* (*Vestiaria coccinea*) and *ʻelepaio* (*Chasiempis sandwichensis ridgewayi*) were uncommon. The non-native Japanese White-eye

(*Zosterops japonicus*) occurred in low numbers at most stations, whereas Redbilled Leiothrix (*Leiothrix lutea*) were heard at only a few stations. These findings are similar to those of previous surveys except that densities of *ʻIʻiwi, ʻelepaio*, White-eye, and Leiothrix were lower (Pratt 1988).

Four endangered bird species have been reported from the Puu Makaala reserve, but only one, the *ʻio* (*Buteo solitarius*, Hawaiian Hawk), was seen during the survey. An *ʻio* was seen carrying nesting materials near ***Na Lua Mahoe***, and another was seen during transect 6**.**

The *ʻoʻu* (*Psittirostra psittacea*) is extremely rare and localized on the Big Island and Kauai. ***Olaa Tract*** and kipukas of ***Upper Waiakea Forest Reserve***, above Stainback Highway are thought to be primary habitat for *ʻoʻu* on the Big Island. *ʻOʻu* were last seen in the southwestern portion of the reserve in 1986.

ʻAkiapolaʻau (*Hemingnathus munroi*) exist only on the Big Island, with the largest population on the windward side (Scott et al. 1986). Generally observed in *koa/ʻohiʻa* forests in this area, *ʻAkiapolaʻau* sightings are reported from west of the reserve in the Kilauea Forest, and north of ***Kulani Cone***. Observed periodically in the reserve's Disappointment Road area, one record also exists from the western edge of the reserve below Kulani Cone.

Hawaii Creeper (*Oreomystis mana*), known from the Big Island's Kona, Kau and windward areas, is one of Hawaii' s more abundant endangered forest birds. Creepers have been reported from the reserve's Disappointment Road complex, and the western area near ***Kulani Cone*** and ***Na Lua Mahoe***, as well as south in ***Olaa Tract***, and west of the reserve near ***Puu Lalaau***.

Hawaii *ʻAkepa* (*Loxops coccineus*) is an uncommon bird on the Big Island. On the windward side, populations are known from the upper slopes of Mauna Kea and Mauna Loa, preferring closed canopy *koa/ʻohiʻa* forests (USFWS 1982). Though *ʻAkepa* have not been reported within the reserve, sightings of this rare bird are recorded from outside the reserve's western boundary in the Kilauea Forest as recently as 1987.

Although native invertebrates were only incidentally noted, a high diversity of representative native insects, spiders and snails (particularly *Succinea* spp.) was observed in all of the natural communities sampled and on all transects. The general richness of native invertebrates suggests that the native communities of the reserve are generally intact, and that major disruptive factors, such as competition with non-native species, have not greatly affected the native invertebrate biota. A lava tube was found and further study may reveal native cave invertebrates of interest.

Non-native fauna such as pigs (*Sus scrofa*) were seen throughout the Reserve and are specifically discussed in the Ungulate Control program. Other non-native mammals, such as rats (*Rattus rattus*) and mongoose (*Herpestes auropunctatus*) have been reported in the Reserve… [DLNR 1989]

Key Management Concerns

The overall management goal is to protect and maintain the reserve's native character.

Some of the key considerations behind the management programs proposed to achieve this are as follows:

(1) ***Puu Makaala*** is a very large reserve. At this time it is not economically realistic to intensively manage the entire reserve. Intensive management of key areas are proposed and prioritized based on the biological resources they contain, the extent of current disturbance, the nature of the other biological threats within and near the area, and the feasibility of management (e.g. topography and access).

(2) Pigs constitute the most severe threat currently affecting the reserve. Their rooting and wallowing destroy native plants and the ground cover on the forest floor. Such damage limits effective regeneration of native plants, and creates conditions favorable for mosquitoes and certain non-native weeds throughout the reserve. This in turn degrades the quality and integrity of native plant communities, threatening the existence of species that rely on the forest for survival.

Control of the feral pig population is the essential first step in the restoration and maintenance of native plant communities in the reserve. Strategic fencing to create smaller pig control units and an aggressive ungulate control program are critical for effective long term reduction of the pig population.

Portions of the reserve are utilized for recreational hunting, which should continue to be encouraged year round. This helps reduce pig densities in certain areas. However, as the number of pigs decrease in priority management areas, public hunting becomes less effective as hunters move to areas with more chance of success, and pig control by staff will be necessary. If incentives can be developed for public hunters to continue to hunt in areas where pig numbers are low, then expensive fence construction and staff hunting may not be necessary.

(3) *ʻOhiʻa* dieback continues to have an impact in the reserve, especially in the lower elevations. Dieback is a natural successional phenomenon in which older stands die synchronously, leaving gaps in the forest canopy. Dieback itself is not a "threat" as these gaps provide openings for subsequent *ʻohiʻa* regeneration. The management concern in the dieback areas is the invasion of aggressive non-native weeds, accelerated by feral pigs, which hampers native plant regeneration. Aerial photographs indicate over one-third of the *ʻohiʻa* forests in the reserve have undergone relatively recent dieback.

(4) Many non-native plants observed in the reserve are shade intolerant and pose no major problem as long as the native canopy and ground cover remain intact. There are non-native weed species in the reserve which form monotypic stands and displace native vegetation over large areas, making them priority weeds for management. Weed control activities will focus on these invasive weeds within key management areas, and in localized populations of priority weed species. Biological control efforts for widespread weed species should be supported.

(5) Signs of marijuana cultivation were seen in the reserve. This illegal activity creates a hazard for people in the reserve. Growers destroy native plants clearing patches for cultivation, introducing new weeds to the forest and spreading others.

Management Programs

The following four management programs outline the long-term goals for the reserve. The management activities within each program lay essential foundations for effective protection of the reserve's natural resources. A six-year implementation schedule is recommended. Although the programs are listed by priority, they fit together to form an integrated management package.

Ungulate Control Program (PUM-RM-01) - Priority #1

GOAL: Reduce impact of pigs to a level that prevents further degradation of the reserve's native species and allows the greatest possible recovery of the reserve's native character.

Statement of the Problem: Techniques available for pig control in the reserve include hunting with or without dogs, snaring, baiting and trapping. Current pig control research recommends use of passive control (e.g. snares and traps) before actively controlling with dogs when possible,' unless hunting is already established. There is less investment initially, less upkeep, less chance of the program being overly oriented to hunting, and it is more cost effective in remote areas. Hunting can be alternated with snaring, but snares must be removed from areas prior to hunting to avoid catching dogs. Radio transmitters on lead hunting dogs has improved hunting efficiency and trapping can be useful for the first vulnerable animals in an area.

Reduction is the necessary first phase of a control effort. Long-term funding for fence construction, pig control and fence maintenance are needed. Attempts to reduce pig populations to remnant levels in similar terrain without the use of any fences have not been effective due to unimpeded ingress of animals into areas where population densities were reduced. Funds spent on feral pig control will be ineffective unless pig numbers are reduced to remnant populations and not allowed to build back up to damaging levels.

Alternative Actions and Probable Impacts:

1) No action. Accept the continuing deterioration of Puu Makaala's native resources. Pigs destroy native plants, alter the structure of native vegetation, and contribute to the spread of non-native plants. Without control, pigs can be expected to degrade native communities, converting most of the reserve to less diverse assemblages of native plants with non-native weeds.
2) Attempt control of feral animals without installation of any fences. Damaging impacts of feral pigs under this alternative will probably be roughly the same as alternative #1, except for portions of the reserve where increased hunting activity may protect small areas of forest. Management resources used for control will be less effective without any fences to keep new pig populations from moving into the reserve.
3) Control feral pigs with the aid of fences. This method has proven successful in both HAVO and Haleakala National Park. Initial cost is high, but benefits in preservation of native ecosystems are great. Recovery of native vegetation can occur if feral animals are controlled. The advance of non-native weed species can be slowed and at times reversed. Native plant species surviving only as epiphytes because of feral pig disturbance can become reestablished on the forest floor.

Recommended Action: Alternative #3 is recommended. The two large management zones proposed for intensive pig control and fencing in this plan comprise only one-third of the reserve. Public hunting access is essential and encouraged to control pig populations in the rest of the reserve. However, the goal for the Disappointment Road and Kulani Cone Zones is clearly reduction of the pig population to remnant levels, not sustained yield hunting. Three projects are proposed to carry out this alternative:

Project (1) - Construction of a strategic network of 20.3 miles of barrier fences to create five management zones. Goals of the fencing project are to cut off pig access routes

into priority areas and to direct predictable pig movements within intensive control areas. An aggressive snaring and hunting project is essential in conjunction with the fencing project to take advantage of induced pig movements and to avoid creation of "pig pens."

Although there are eight smaller management units within the Disappointment Road and Kulani Cone Zones, they will not be fenced immediately. A progressive fencing strategy will be used. The outside of the management zones will be fenced before individual management units are closed off. This will allow pig control efforts to begin over a larger area. In addition, success of pig control efforts and monitoring of subsequent vegetation recovery may determine that fences to close off the smaller management units may be unnecessary. The fence system will share 2.3 miles of HAVO fence along the Olaa Tract boundary. Cooperative agreements to share maintenance costs of this fence section will be pursued.

Pig control fences will consist of 39 inch high galvanized woven-wire supplemented along the ground surface by one strand of barbwire stretched tightly across the ground. Woven wire and barbwire will be secured to steel posts placed no more than 10 feet apart. Concreted galvanized pipes may be required to secure the fence line at certain corners. Helicopter transport of fencing materials will be required for remote units…

Strict procedures for clearing fence line will be established to minimize disturbance. Does not include personnel costs for fence line layout and assessment, contract preparation and monitoring. A botanist will walk the flagged fence route to search for rare plants to be avoided by the brushing crew.[9]

Project (2) **-** Monthly inspection and maintenance of all fence lines (and after major storms). Inspections will be done in conjunction with other resource management activities such as monitoring and non-native plant control along fence corridors…

Project (3) - Initiate an active pig control program using hunting, trapping, snaring, and other methods as required in the Disappointment Road and Kulani Cone Zones. The goal is to reduce feral pig populations to remnant levels in 4,560 acres of the reserve. Pig control should begin before fence closure in order to chase out populations within the area.

Snares are recommended for the Kulani Cone Zone, where public access is restricted. Snare numbers will increase over time to continue to catch pigs as their densities decrease. The greatest effort is initially setting up the snare groups. These snare groups are left in place, as pigs habitually return to previously used areas. When new areas are found with fresh sign, additional snare groups are set out. Snares in rain forests last six months to a year. Accumulating data on health, sex, and age of captured pigs provides important data in the effectiveness of the snaring program.

Staff hunting is recommended rather than snaring in the Disappointment Road Zone. This will allow time to incorporate interested public hunters into the program. The major limitation with using public hunters is the lack of incentive for hunting an area when the chances of a successful hunt is low. An effective pig control program demands constant hunting pressure, even when pig populations decrease. Incentives such as

9 While it is recognized that the natural landscape is a Hawaiian cultural resource, it is recommended as a part of this study, that DLNR-NARS staff and contractors meet with State Historic Preservation staff as a part of the program to plan for the fencing of the Pu'u Maka'ala NAR. The focus of such a meeting should be to discuss types of traditional cultural sites that may be encountered in the field; and to review the laws and protocols for notification and treatment of inadvertent finds of cultural resources.

> improved access, contests, and logistical support for volunteer hunters will be offered to maintain public hunter pressure in the Disappointment Road Zone. Contracting out public hunters is also a possibility. If monitoring indicates vegetative recovery from these pig control efforts, snaring will not be used. The use of snares would necessitate closing the area to the public… [DLNR-NARS, 1989]

This study has been undertaken to provide resource managers and the public with important background information, documenting the wide range of cultural values, practices, and knowledge of resources of the Waiākea and ʻŌlaʻa forest lands. An understanding of the cultural environment will help resource managers and the public ensure that the unique qualities of the Puʻu Makaʻala NAR, remain a healthy and resilient part of the cultural landscape through future generations.

REFERENCES CITED

ACHP (Advisory Council on Historic Preservation)

1985 Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review. Washington, D.C.: Advisory Council on Historic Preservation. (Draft report, August)

Alexander, W.D.

1891 *A Brief History of Land Titles in the Hawaiian Kingdom*. Hawaiian Almanac and Annual for 1891. Honolulu. T.G. Thrum.

Beckwith, M.

1970 *Hawaiian Mythology*. Honolulu: University of Hawaii Press.

Bingham, H.

1969 A residence of Twenty-one Years in the Sandwich Islands. Praeger Publishers, New York, Washington & London (Reprint of 1855 edition).

Boundary Commission Testimony

1873-1891 Hawaii State Archives (Digitized copy in collection of Kumu Pono Associates).

Department of Land and Natural Resources

1986 Rainfall Atlas of Hawaii. Water Resources Research Center/Department of Meteorology, University of Hawaii at Manoa. State of Hawaii, DLNR, Division of Water and Land Development, Report R76. Honolulu, Hawaii.

1989 Puu Makaala Natural Area Reserve Management Plan. Natural Area Reserves System, State of Hawaii. (January 1989)

Ellis, W.

1963 *Journal of William Ellis*. Honolulu: Advertiser Publishing Co., Ltd.

Fornander, A.

1917-1919 Fornander Collection of Hawaiian Antiquities and Folklore. (9 vols.). Honolulu: Bishop Museum Press.

l973 *An Account of the Polynesian Race: Its Origin and Migrations*. Tokyo: Charles E. Tuttle Co., Inc.

Handy, E.S.C., E.G. Handy, with M.K. Pukui

1972 Native Planters in Old Hawaii, Their Life, Lore, and Environment. B.P. Bishop Museum Bulletin 233. B.P. Bishop Museum Press.

Ii, J.P.

l959 Fragments of Hawaiian History. Honolulu: Bishop Museum Press.

Kamakau, S.M.

1961 Ruling Chiefs of Hawaii. Honolulu: Kamehameha Schools Press.

Kingdom of Hawai'i

1850 *Kanawai Hoopai Karaima no ko Hawaii Pae Aina* [Penal Code].

Lyons, C.J.

1875 Land Matters in Hawaii. *Islander*, Honolulu.

Malo, D.
1951 Hawaiian Antiquities. Honolulu, B.P. Bishop Museum.

Maly, Kepā (translator)
ms. *He Kaao no Pikoiakaalala, ke Keiki Akamai i ka Pana*. Published in the Hawaiian Newspaper, *Ku Okoa*: December 16th, 1865 to March 10th, 1866, by S.M. Kaui

ms. *Kaʻao Hoʻoniua Puʻuwai no Ka-Miki* (The Heart Stirring Story of Ka-Miki). Published in the Hawaiian Newspaper, *Ka Hoku o Hawaii*; January 8, 1914 - December 6, 1917, by John Wise and J.W.H.I. Kihe, et al.

Menzies, A
1920 Hawaii Nei 128 Years Ago. Honolulu, Hawaii.

OEQC (Office of Environmental Quality Control, State of Hawaiʻi)
1997 Guidelines for Assessing Cultural Impacts. Adopted by the Environmental Council; November 17, 1997.

Parker, P.L., and T.F. King
1990 Guidelines for Evaluating and Documenting Traditional Cultural Properties. *National Register Bulletin 38*. U.S. Department of the Interior, National Park Service, Washington D.C.

Pratt, T.
1988 Puu Makaala Bird Survey. Report on file at DLNR. (Unpublished)

Pukui, M.K., and A.L. Korn
1973 *The Echo of Our Song*. Chants and Poems of the Hawaiians. Honolulu: University Press of Hawaii.

Scott, M. & S. Mountainspring, F. L. Ramsey, and C. B. Kepler.
1986 Forest Bird Communities of the Hawaiian Islands: their Dynamics, Ecology, and Conservation. Studies in Avian Biology No **9,** Cooper Ornithological Society. Allen Press, Lawrence, Kansas.

State of Hawaiʻi
Ms. Files cited in text from the collections of the:
Bureau of Conveyances
Division of Forestry and Wildlife (Hilo)
Hawaiʻi State Archives
Land Division
Natural Area Reserves System Office (Honolulu)
State Survey Division

U.S. Fish and Wildlife Service
1982 The Hawaii Forest Bird Recovery Plan. Prepared in cooperation with the Hawaii Forest Bird Recovery Team.

Whitney, H.M.
1875 Hawaiian Guide Book. Published by Henry M. Whitney; White and Bauer, Washington St.

Wilkes, C.

1970 *Narrative of the United States Exploring Expedition During the Years 1838-1842*, Under the Command of C. Wilkes, U.S.N. Vol. 4. Philadelphia: Loa and Blanchard. (original date of publication, 1845)

June 9, 2004
Telephone interview with:

Ralph Daehler

The name "Puʻu Makaʻala" was given to the *puʻu* and forest area in 1961 or 1962, when Ralph Daehler was working on the Board of Agriculture and Forestry's Reforestation Program. Mr. Daehler recalled that at the tiem, he was working with old quad maps and aerial photos, identifying areas in which reforestation projects could be developed, and through the photos—the *puʻu* did not appear on old quad maps—he noticed this *puʻu*, which looked very interesting to him. From the photo, it appeared to him that the hill would offer anyone who traveled to it, a great view of all the surrounding lands, and out to the coast of Hilo and Puna.

Mr. Daehler looked around for *kamaʻāina* to see if anyone knew the name of the *puʻu*, but could find no one familiar with it. During this time, L.W. Bryan had been the Forester, and was just retiring, and Max Landgraf took over. Max's nick name was *Maka* (eye), because he could see things all over. Mr. Daehler found that the word *ala* with *maka*, could mean wide open or imply a lookout point, so he settled on naming the site Puʻu Makaʻala (interpreted as Lookout Hill).

Shortly thereafter, USGS was updating its' quads and contacted him about the region in which the *puʻu* is situated. He explained that he had found no name for the *puʻu*, but that he had called it Puʻu Makaʻala for the forestry program. He recalled being surprised later, to find that on the next quadrangle, the name Puʻu Makaʻala appeared in print.

Mr. Daehler never had the opportunity to actual travel to the *puʻu*, as he was transferred to Kauaʻi a shoret while later. It had been his goal to establish a trail to the *puʻu*, which he believed would be of interest, and provide travelers with a great view of the region. In his review of the maps and photos, he had determined a couple of possible approaches to the *puʻu*. One of the approaches being from the old Olaa Back Road—which was all overgrown—and which ran out of the old Olaa Homesteads. He recalled also, that while researching the area, he had been surprised to learn that so much of ʻŌlaʻa had been subdivided into homestead lots, and that many of the homesteaders had been of Galician origin.

Mr. Daehler also recalled that in those early years, the Board of Agriculture and Forestry had a strong component of land development for agricultural purposes. At the time the Board's Reforestation Program began, a number of people had been calling for the Panaʻewa-ʻŌlaʻa forest lands to be cleared for agricultural purposes. The early reforestation program, through planting a number of fast growing introduced species, helped to save much of the area for present-day and future conservation programs and public interest.

Appendix F: Final Plan for Archaeological Inventory Survey Waiākea Timber Management Area (Haun and Associates)

Rec'd 12/31/14
HRA 958

HISTORIC PRESERVATION DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

601 Kamokila Boulevard, Suite 555
Kapolei, HI 96806

December 22, 2014

Alan Haun, Ph. D., Principal Investigator
Haun and Associates
73-1168 Kahuna A'o Road
Kailua Kona, Hawai'i 96740

LOG NO: 2014.01730
DOC NO: 1412SN20
Archaeology
History and Culture

Dear Dr. Haun:

SUBJECT: **Chapter 6E-8 Historic Preservation Review –**
Draft Archaeological Inventory Survey for the Waiākea Timber Management Area
Waiākea and Ola'a Ahupua'a, South Hilo District, Island of Hawai'i
TMK: (3) 1-8-012:001 (por); 2-4-008:001, 006, 010, and 020 (por)

Thank you for the opportunity to review the report titled *Archaeological Inventory Survey Waiākea Timber Management Area Waiākea and 'Ōla'a Ahupua'a, South Hilo and Puna Districts, Island of Hawai'i TMK: (3) 1-8-012:001 (por); 2-4-008:001, 006, 010, and 020 (por)* (A. Haun and D. Henry April 2014). This document was received by our office on April 15, 2014. We apologize for the delayed review and thank you for your patience. The fieldwork consisted of a 5% sample (550-acres) survey of the 12,506-acre project area as agreed upon through consultation and an archaeological inventory survey plan (AISP) with SHPD (*Log No. 2013.5274 Doc. No. 1309SN26*). In addition to the sample survey, a total of 6.49-acres were surveyed in order to re-locate a previously identified burial cave (SIHP Site 50-10-35-18697).

Two historic properties were identified during the survey: Site 50-10-34-20870 is a remnant of the 'Ōla'a Flume water transportation/diversion system and is assessed as significant under Hawaii Administrative Rule (HAR) §13-275-6 Criteria A and D. SIHP 50-10-34-30088, the historic road associated with the 'Ōla'a house lots established for homesteading in 1895, has been paved and is still in use as Ihope Road (back road); this site is assessed as significant under HAR §13-275 Criterion D. Sites, 20870 and 30088 have been adequately documented and are recommended for no further work. SIHP Site 18697, the previously identified burial cave, was identified by Mr. George Yokoyama and examined by DLNR archaeologist Wendall Kam in 1985. Efforts were made during the current survey to relocate the cave using information from the previous documentation; the exact location could not be ascertained and the cave entrance is thought to have since been sealed by natural processes. A general location for the cave has been determined.

We concur with the proposed significance assessments and treatment recommendations for Sites 20870 and 30088. For Site 18697, the report recommends that a 500 square meter (61.7 acre) area centered on the reported location of the site and oriented parallel to Stainback Highway be established. Should future land alteration occur in this area, an archaeological monitoring plan pursuant to HAR §13-279 should be submitted to SHPD for review and approval to ensure that the burial is protected if discovered. In consultation with the SHPD-History and Culture Branch, we believe that this provision will provide ample mitigation procedures in the event that the burial is relocated during any future land modification.

This report meets the requirements of Hawaii Administrative Rule (HAR) §13-276 and is accepted by SHPD. Please send one hardcopy of the document, clearly marked **FINAL**, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office. In the event of ground disturbance in the area of Site 18697, we look forward to the opportunity to review an archaeological monitoring plan. Please contact Sean Naleimaile at (808) 933-7651or Sean.P.Naleimaile@Hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

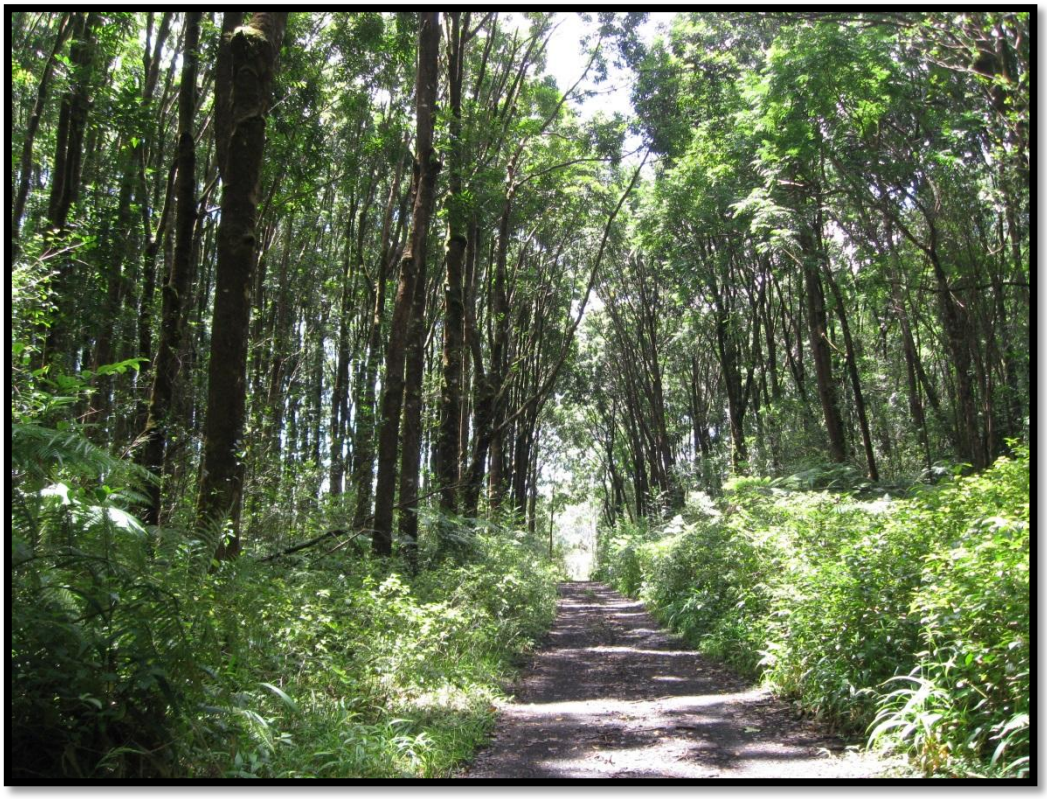
Theresa K. Donham, Archaeology Branch Chief

Haun & Associates Report 938-090413

FINAL

PLAN FOR ARCHAEOLOGICAL INVENTORY SURVEY

WAIĀKEA TIMBER MANAGEMENT AREA



WAIĀKEA AND ʻŌLAʻA AHUPUAʻA

SOUTH HILO AND PUNA DISTRICTS, ISLAND OF HAWAIʻI

TMK: (3) 1-8-012: POR 001; 2-4-008: POR 001, 006, 010 AND 022

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FINAL

PLAN FOR ARCHAEOLOGICAL INVENTORY SURVEY

WAIĀKEA TIMBER MANAGEMENT AREA

WAIĀKEA AND ʻŌLAʻA AHUPUAʻA

SOUTH HILO AND PUNA DISTRICTS

ISLAND OF HAWAIʻI

TMK: (3) 1-8-012: POR 001; 2-4-008: POR 001, 006, 010 AND 022

By:
Alan E. Haun, Ph.D.
and
Dave Henry, B.S.

For:
Department of Land and Natural Resources (DLNR),
Division of Forestry and Wildlife
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Honolulu, HI 96813

September 2013

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SUMMARY

At the request of the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Haun & Associates prepared this plan for an Archaeological Inventory Survey (AIS) of the 12,506 acre Waiākea Timber Management Area located in Waiākea and ʻŌlaʻa Ahupuaʻa, South Hilo and Puna Districts, Island of Hawaiʻi (TMK: [3] 1-8-012: portion of 001; 2-4-008: portions of 001, 006, 010, and 022). This plan was prepared in advance of the AIS, in accordance with the State Historic Preservation Division (SHPD) requirements for an archaeological inventory survey plan detailed in Hawai'i Administrative Rules (HAR) §13-13-284-5(c) and §13-13-276-5 (a) and (b).

The project will be potentially licensed as part of the Commercial Harvest and Reforestation Project under the auspices of the Forestry Program, Division of Forestry and Wildlife (DOFAW). The DOFAW proposes to harvest non-native timber and non-timber forest products from the Waiākea Timber Management Area and to subsequently reforest the harvested areas with commercial tree species. The project is being undertaken to fulfill DOFAW's requirements to comply with the state historic preservation law, Chapter 6E, 7 and 8, Hawai'i Revised Statutes (HRS), and it's implementing administrative rules, Chapters 13-275 and 13-276, Hawai'i Administrative Rules (HAR).

The proposed AIS fieldwork will consist of documenting previously identified sites and a 5% sample survey of the project area. The proposed AIS sample is a judgmental quadrat design that is based on obtaining a representative sample of three primary environmental variables: elevation, soil type, and lava flow age. The proposed AIS sample also includes areas that were mechanically cleared for planting and areas cleared by other means. The project area spans three elevation-based traditional Hawaiian settlement zones (Upland Agricultural, Lower Forest, and Rainforest) as defined by McEldowney (1979). The proposed survey sample consists of 20 sample survey blocks that range in area from 10-40 acres and will yield a representative sample of the settlement zones and environmental variables.

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INTRODUCTION

At the request of the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Haun & Associates prepared this plan for an Archaeological Inventory Survey (AIS) of the 12,506 acre Waiākea Timber Management Area located in Waiākea and ʻŌlaʻa Ahupuaʻa, South Hilo and Puna Districts, Island of Hawaiʻi (TMK: [3] 1-8-012: portions of 001; 2-4-008: portions of 001, 006, 010, and 022 - *Figures 1, 2* and *3*). This plan was prepared in advance of the AIS, in accordance with the requirements for an archaeological inventory survey plan detailed in Hawaiʻi Administrative Rules (HAR) §13-13-284-5(c) and §13-13-276-5 (a) and (b).

The project will be potentially licensed as part of the Commercial Harvest and Reforestation Project under the auspices of the Forestry Program, Division of Forestry and Wildlife (DOFAW). The project is being undertaken to fulfill DOFAW's requirements to comply with the state historic preservation law, Chapter 6E, 7 and 8, Hawaiʻi Revised Statutes (HRS), and it's implementing administrative rules, Chapters 13-275 and 13-276, Hawaiʻi Administrative Rules (HAR).

This plan describes the Waiākea Timber Management Area and presents the results of historical documentary and archaeological background research for the area. The plan also provides a research design with a methodology to guide the proposed AIS work. This plan also discusses proposed consultation with agencies and local knowledgeable individuals.

THE WAIĀKEA TIMBER MANAGEMENT AREA

The DOFAW is the largest land management department in the State of Hawaiʻi, overseeing the management of approximately 800,000 acres of State owned lands. The majority of these lands (700,000 acres+) are located on Hawaiʻi Island with more than 400,000 acres situated within the forest reserve system. The 12,506 acre Waiākea Timber Management Area (WTMA) is situated within the Upper Waiākea, the Waiākea and the ʻŌlaʻa Forest Reserves. According to Maly and Maly, the forest reserves in the area were established between 1904 and 1913:

> Following the development of the Hilo Forest Reserve in 1904, and the addition of portions of the ʻŌlaʻa Tract to the reserve system in 1905 and 1913, the board also set aside the upland portions of Waiākea as a reserve. Thus, making a contiguous line of forest across the Hilo District, and adjoining the Puna District (2004:91).

The WTMA is bisected by the Stainback Highway that extends inland from Highway 11 (*Figure 4*). Large portions of the area are accessed by a series of main primary roads and a grid work of mostly overgrown secondary roads (*Figure 4*). The primary roads are oriented in a northwest by southeast direction and are labeled Roads A-D and G-R. According to DOFAW, "Approximately 130 miles of unimproved access roads grid the WTMA tree planting area into 40 acre blocks. These roads provide access to the public and DOFAW for hunting, recreation, non-timber forest product gathering, forest protection and timber management" (State of Hawaiʻi 1998:5). According to DOFAW, the road grid forms 245 40-acres lots, 237 lots of which were mechanically grubbed to varying degrees between 1959 and 1968 to prepare the lots for planting with commercial timber species.

The WTMA was established to provide a supply of wood for the State of Hawaiʻi's timber products industry (State of Hawaiʻi 1998:4). In 1956, the Waiākea Arboretum was created by the Hawaiʻi Forestry Division on a 20 acre parcel of land on the north side of Stainback Highway, 3.1 miles southwest of Highway 11 (Richmond 1963:1). The arboretum was established to test the productive viability of 84 tree species. The test results were used to select the timber species to be planted in the WTMA. The first planting at the arboretum occurred in 1956, with subsequent plantings in 1957, 1959 and 1960.

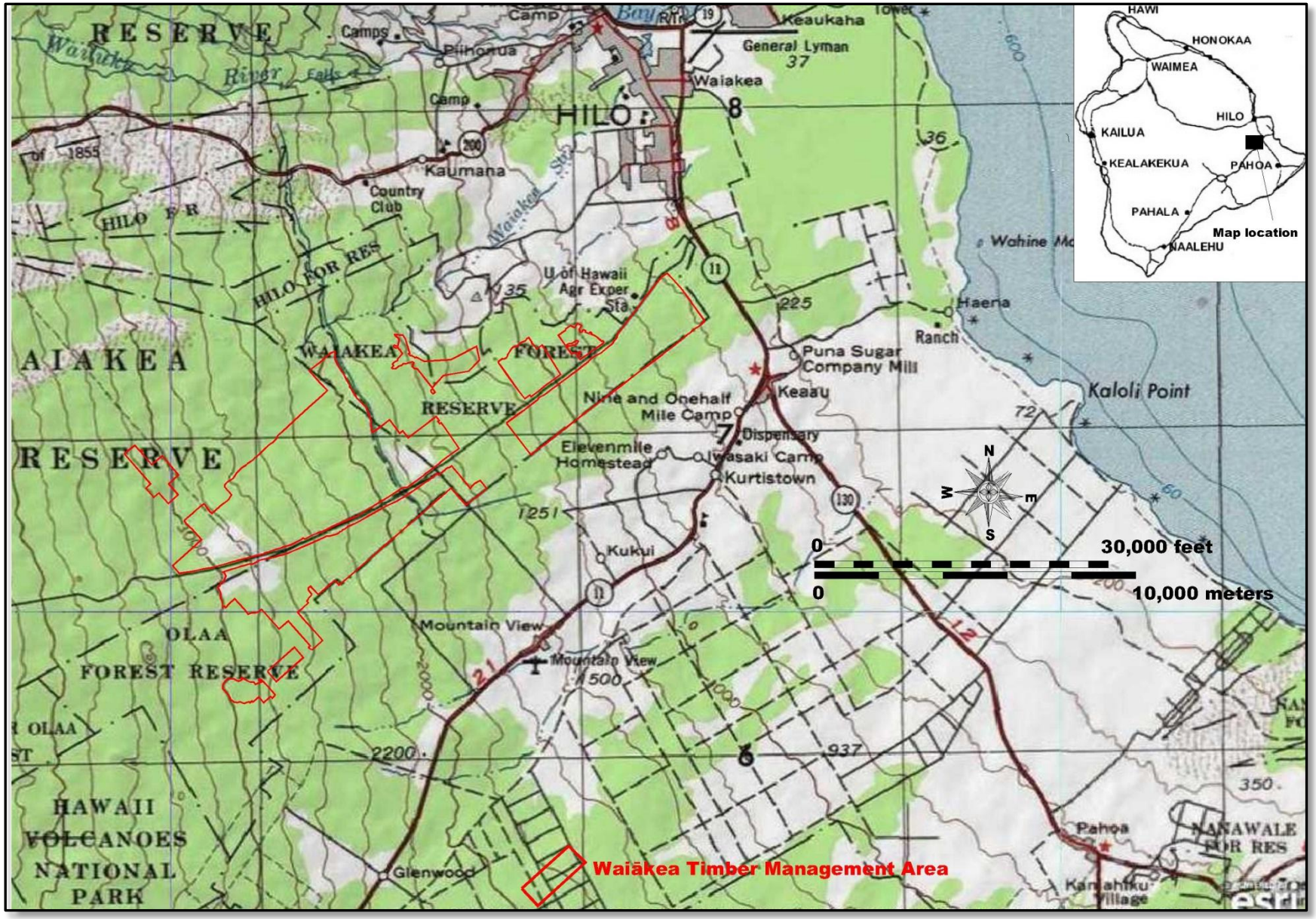

Figure 1. Portion of USGS 7.5' Hilo (1995), Mountain View (1981) and Puu Makaala (1981) quadrangles showing the Waiākea Timber Management Area

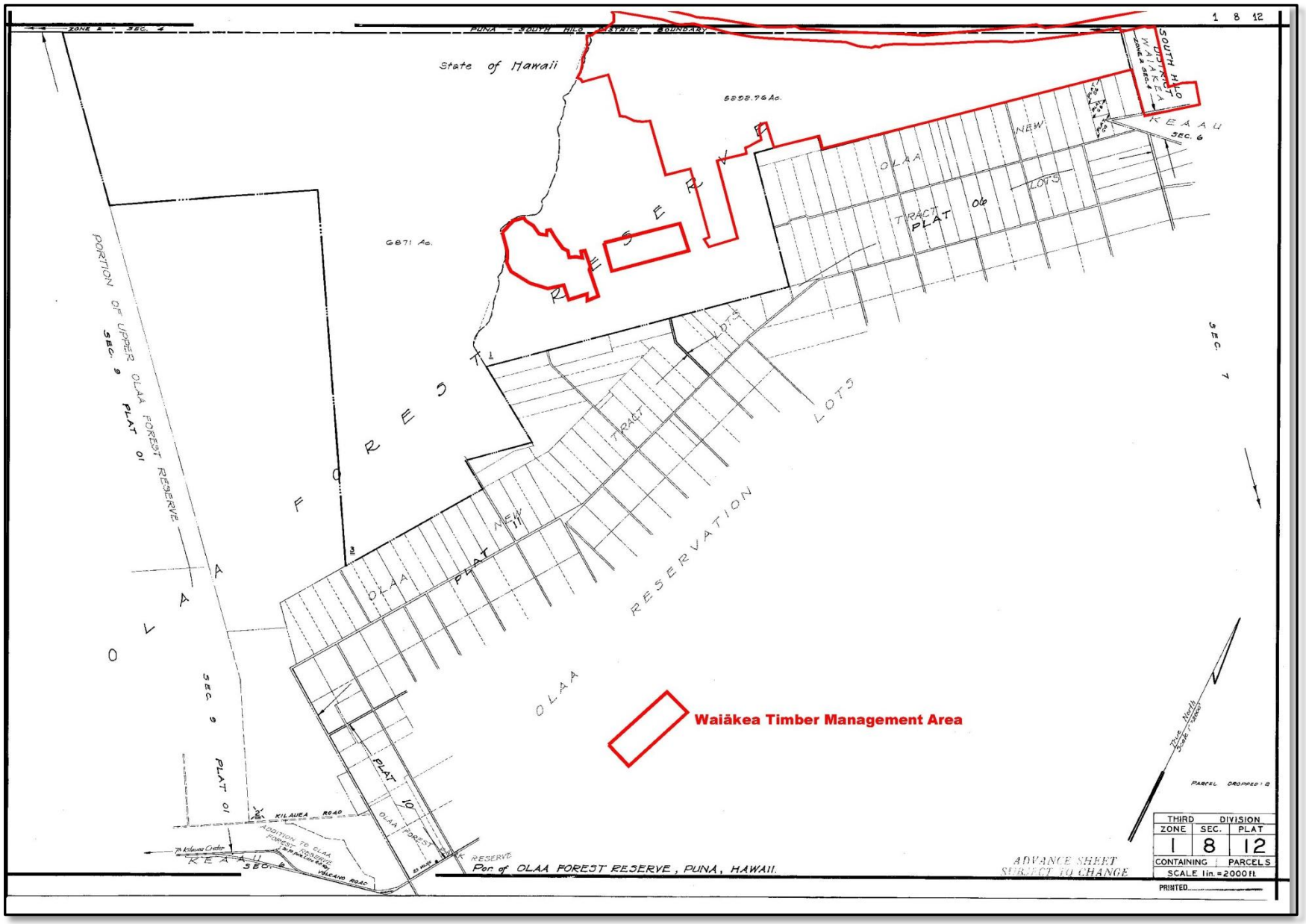

Figure 2. Tax Map Key (3) 1-8-012 showing Waiākea Timber Management Area

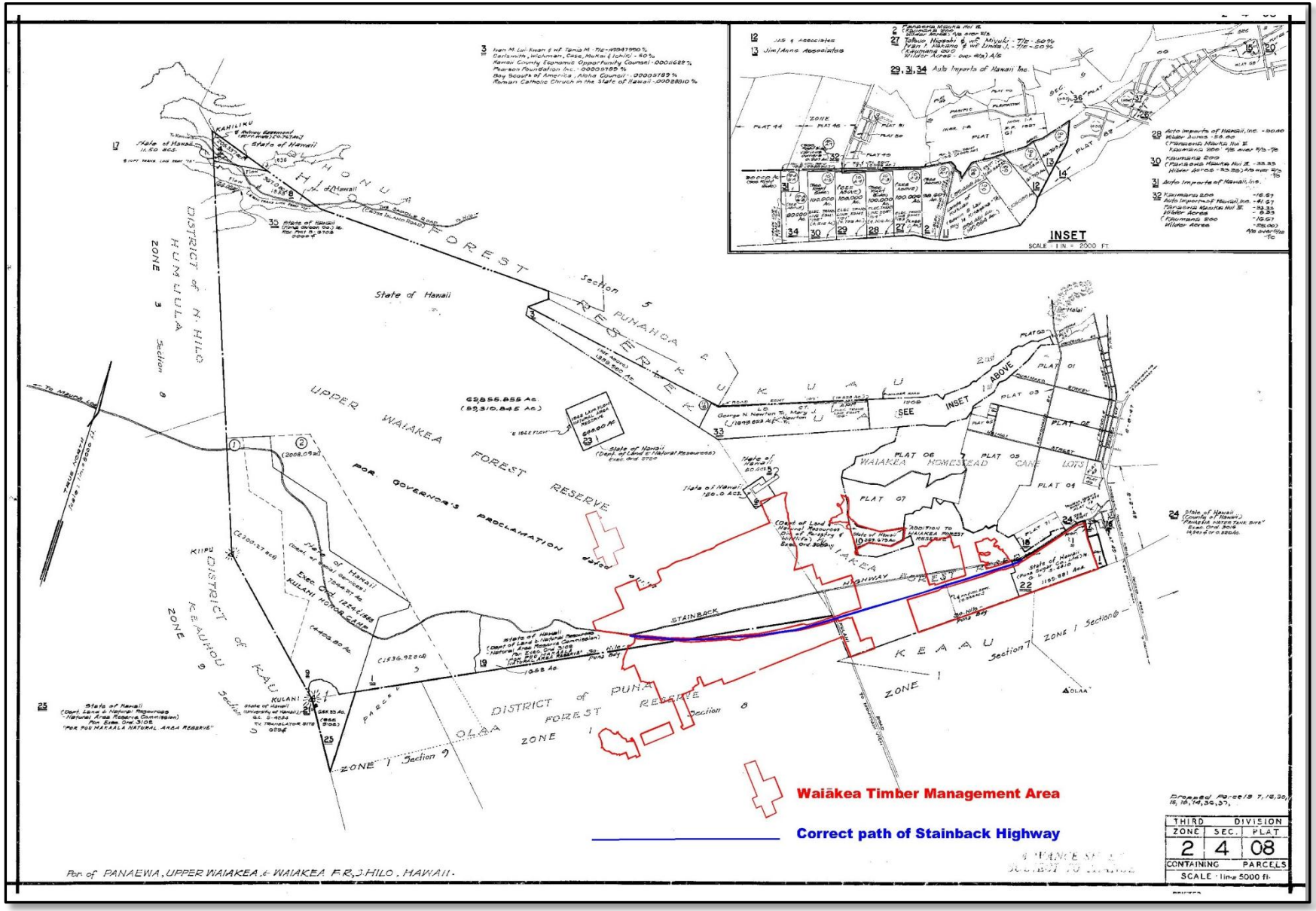

Figure 3. Tax Map Key (3) 1-8-012 showing Waiākea Timber Management Area

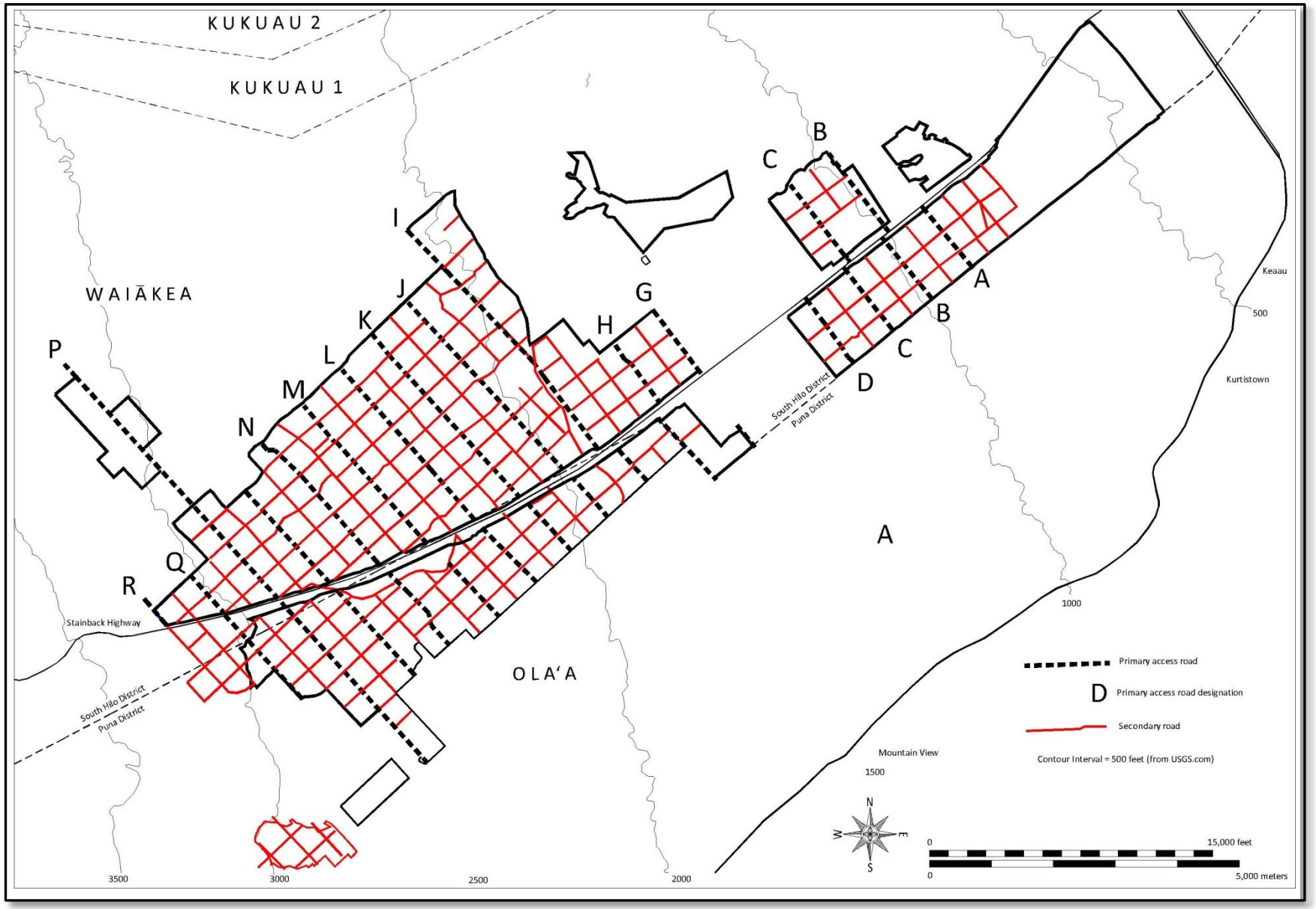

Figure 4. Roads within the Waiākea Timber Management Area

Richmond summarizes the creation of the arboretum. According to his account:

> Wild vegetation was cleared from planting sites shortly before planting. The Kulani prison project of the Hawai'i Department of Social Services cleared the land with bulldozers in preparation for tree planting. Much of the soil overlying the shallow pahoehoe was pushed into natural depressions which are common within the area (1963:2).

Portions of the WTMA were subjected to major plantings beginning in 1959 and continuing through 1968, with additional plantings continued into the mid-1970s. The development of the area is summarized as follows:

> Some WTMA plantation units were weeded or fertilized in the early years, but the majority was allowed to grow without any timber stand improvement (TSI) activity… During initial land clearing operations, large native trees such as ohi`a lehua (*Metrosideros polymorpha*), koa (*Acacia koa*), and loulu (*Pritchardia spp*.) were left undisturbed. Today, these plants are intermixed with non-native timber species. Primary understory species include hapuu (*Cibotium spp*.), guava (*Psidium spp*.), uluhe (*Dicranopteris spp.*), palm grass (*Setaria palmifolia*), *Melastoma spp*. and scattered native Hawaiian understory shrub species (State of Hawai'i 1998:5).

Tree ferns or hapuu (*Cibotium spp*.), were harvested from the WTMA in the early 1970s. Approximately 1,600 cubic feet of *hapuu* logs were harvested to supply the landscape and flower industry (State of Hawai'i 1998:5). Between 1985 and 1988, the Puna Sugar Company, in an agreement with the State of Hawai'i, harvested eucalyptus from 2000 acres of the WTMA and turned the trees into wood chips that were subsequently used to generator electricity at a local power plant (*Ibid.* 1998:5).

In 1961, the first of three Five-Year Planting Plans were created to develop and sustain Hawai'i's timber industry. These plans covered the fiscal years 1962-1966, 1967-1971 and 1972-1976 and guided proposed plantings on Hawai'i, Oahu, Maui, Kauai and Molokai Islands (Division of Forestry 1961, 1966, 1971). The timber grown on Hawai'i Island was intended primarily for wood product harvesting, while on Oahu it was designed to cover erosion scars and protect watersheds. On Maui, Kauai and Molokai, the plantings were for watershed protection and to create recreational areas.

Limited information is presented in the Fiscal Year 1962 to 1966 Planting Plan, although more comprehensive planting data is provided in the subsequent plans. This initial plan called for planting 2,850 acres per year on each of the five islands, with 1,300 acres to be planted on Hawai'i Island. All of the Hawai'i plantings during the first five years occurred in the Waiākea Forest Reserve, consisting of 31% located in the Upper Waiākea Forest cleared and planted by prisoners from the Kulani Prison, 31% in the Upper Waiākea Forest cleared and planted by contract labor, and 38% in the Waiākea Forest Waiākea Forest also done by contract labor (*Table 1*).

Figure 5 depicts the extent of the plantings between 1962 and 1966. As indicated in this figure, the area to be planted in the Upper Waiākea Forest by Kulani Prison personnel is located outside the boundary of the WTMA. During the 1967-1971 plan, the plantings were expanded to include the Hilo-Manowaialee Working Circle (*Figure 6*), followed by the Hilo-Hamakua Working Circle in 1972-1976 (*Figure 7*). As indicated in these figures, the WTMA is situated in an area referred to as the Waiākea-Olaa Working Circle.

Table 2 summarizes all of the available planting data presented in the three Five-Year Planting Plans. According to the data, more than 16,600 acres were planted in the Waiākea-Olaa Working Circle between 1962 and 1976, with more than 9,200 acres located within the WTMA. More than 7.5 million trees were planted during this period, with nearly 2.3 million planted within the WTMA.

Figure 8 is a compilation map that shows the plantings that occurred in the Waiākea-Olaa Working Circle between 1967 and 1976. The data from 1962 through 1966 has been excluded from this figure as it only depicts general

Table 1. Five Year Planting Plan – Fiscal Years 1962-1966 (Division of Forestry 1961)

FIVE-YEAR PLANTING PLAN
Fiscal Years 1962-66

Island Hawaii
District South Hilo
Forest Reserve Waiakea

Planting Area (Land Name)	Sched. FY	Key No. on map	Acres	Est. Costs Clearing/Planting	Est. Costs Other	Total	Species	Thousands trees	Remarks
*Waiakea, Upper	1962	1	400	--		--	F.uhdei T.ciliata	180 315	Machine clear. & hand plant.- Kulani prison
Waiakea, Upper	1962	2	400	34,000		34,000	F.brayleyana E.saligna	30 30	Contract machine clear. & hand plant.
Waiakea	1962	3	500	42,500		42,500	E.pilularis	30	" " " "
	FY Total		1,300	76,500		76,500		585	
Waiakea	1963	4-6	1,300	76,500		76,500		585	
"	1964	7-9	"	"		"		"	
"	1965	10-12	"	"		"		"	
"	1966	13-15	"	"		"		"	
5-year Total			6,500	382,500		382,500		2,925	

Note: Program to be continued at same level for 5-year period. 30,000 acres in this area in need of commercial reforestation.

* In order to continue this planting project for 5 years with Kulani Prison they will need a new crawler type tractor w/bulldozer blade--approx. cost $45,000.

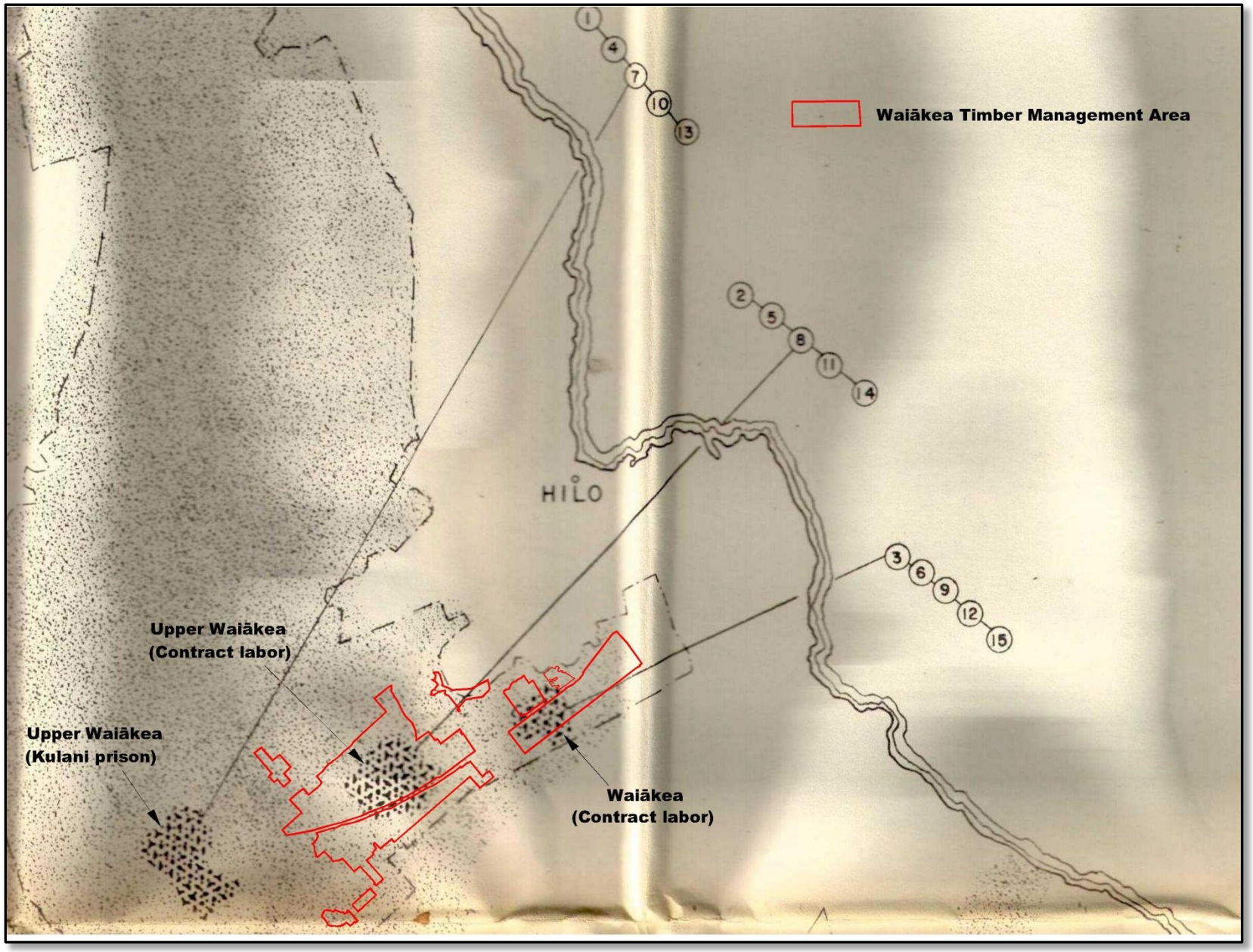

Figure 5. Hawaii Island Plantings - 1962-1966 (Division of Forestry 1961)

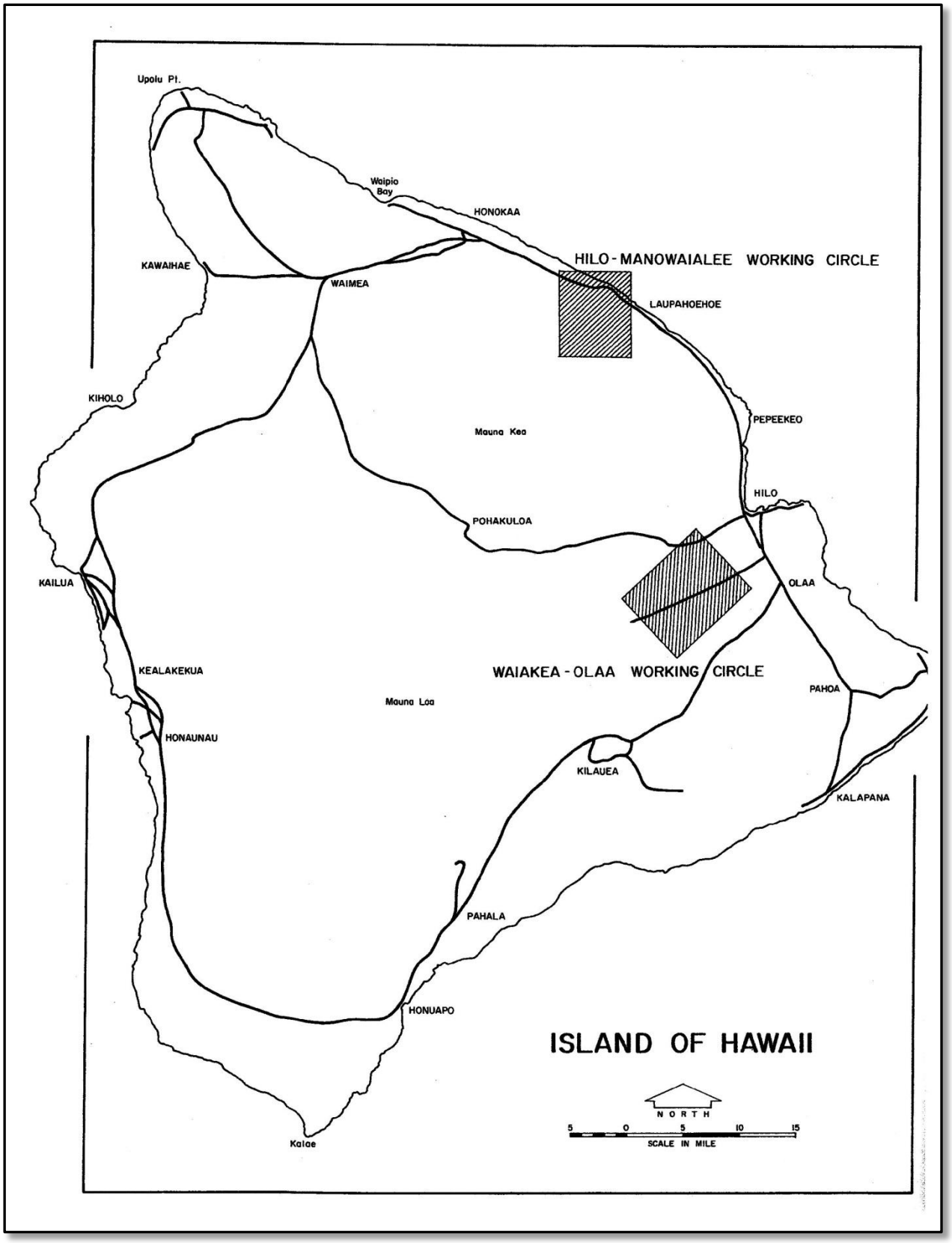

Figure 6. Hawaii Island Plantings - 1967-1971 (Division of Forestry 1966:55)

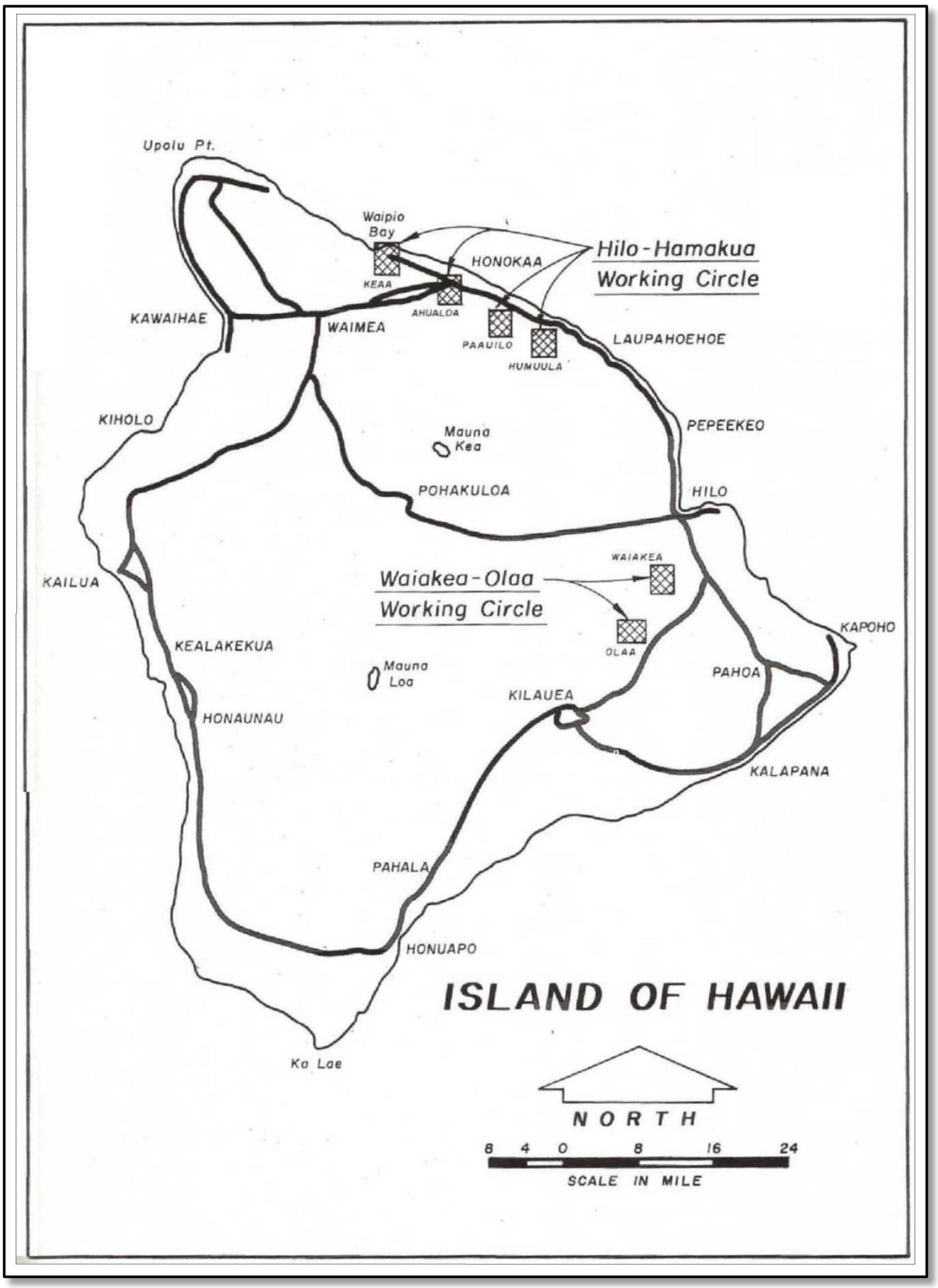

Figure 7. Hawaii Island Plantings - 1972-1976 (Division of Forestry 1971:60)

Table 2. Summary of Plantings between 1962 and 1976

Name	Area	Year	Acres within Waiākea-Olaa Working Circle	Acres within WTMA	Clearing method	Planting method	No. of trees planted in Working Circle (in thousands)	Tree species planted (in thousands)							No. of trees planted in WTMA	Comment
								Australian toon	Queensland-maple	Eucalyptus saligna	Rosegum	Tropical ash	Eucalyptus robusta	Eucalyptus pillularis		
n/a	Upper Waiākea	1962	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1962	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1962	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1963	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1963	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1963	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1964	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1964	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1964	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1965	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1965	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1965	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1966	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1966	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1966	500	500	Machine	Hand	30,000							30	30,000	
H-1-67	Olaa	1967	320	320	Machine	Hand	128,000	64				64			128,000	
H-2-67	Waiākea	1967	187	187	Machine	Hand	60,000		40			20			60,000	3 sections (1, 2, 3) - Fern sale area
H-3-67	Upper Waiākea	1967	320	230	Machine	Hand	128,000	64		16		48			92,000*	
H-4-67	Waiākea and Olaa	1967	280	280	Machine	Hand	128,000	48		16		64			128,000	2 sections (1, 2) - Fern sale area
H-5-67	Upper Waiākea	1967	200	200	Machine	Hand	80,000	40				40			80,000	
H-6-67	Upper Waiākea	1967	300	0	Machine	Hand	120,000	60				60			0	
F-1-67	Olaa	1967	200	83	Machine	Hand	80,000		80						33,000*	Dirt area
H-1-68	Upper Waiākea	1968	280	0	Machine	Hand	112,000	48	64						0	
H-2-68	Waiākea	1968	200	200	Machine	Hand	96,000	38	58						96,000	
H-3-68	Upper Waiākea	1968	280	75	Machine	Hand	112,000	48	64						30,000*	
H-4-68	Upper Waiākea	1968	280	243	Machine	Hand	64,000						64		55,000*	
H-5-68	Waiākea and Upper Waiākea	1968	320	77	Machine	Hand	128,000	64	64						31,000*	2 sections (1, 2)
F-1-68	Olaa	1968	200	84	Hand	Hand	80,000		80						34,000*	Dirt area
H-1-69	Upper Waiākea	1969	310	0	Machine	Hand	125,000	125							0	2 sections (1, 2)
H-2-69	Upper Waiākea	1969	320	0	Machine	Hand	144,000	72		72					0	
H-3-69	Upper Waiākea	1969	320	0	Machine	Hand	130,000	65	65						0	
H-4-69	Upper Waiākea	1969	320	0	Machine	Hand	130,000			130					0	
H-5-69	Waiākea	1969	200	41	Machine	Hand	88,000		88						17,000*	
F-1-69	Olaa	1969	220	40	H/C/LT**	Hand	88,000	40	48						18,000*	
H-1-70	Olaa	1970	300	300	Machine	Hand	138,000	138							138,000	
H-2-70	Olaa	1970	240	240	Machine	Hand	96,000			96					96,000	
H-3-70	Upper Waiākea	1970	320	320	Machine	Hand	128,000	80					48		128,000	
H-4-70	Waiākea and Upper Waiākea	1970	335	335	Machine	Hand	148,000	60	88						148,000	2 sections (1, 2)
H-5-70	Upper Waiākea	1970	320	320	Machine	Hand	128,000		128						128,000	
F-1-70	Olaa	1970	205	0	H/C/LT**	Hand	82,000		82						0	
H-1-71	Upper Waiākea	1971	330	330	Machine	Hand	132,000	132							132,000	
H-2-71	Upper Waiākea	1971	285	285	Machine	Hand	114,000		114						114,000	
H-3-71	Waiākea	1971	200	44	Machine	Hand	80,000	40	40						18,000*	
H-4-71	Upper Waiākea	1971	335	258	Machine	Hand	134,000			134					103,000*	
H-5-71	Upper Waiākea	1971	330	152	Machine	Hand	132,000	80					52		61,000*	
F-1-71	Olaa	1971	210	0	H/C/LT**	Hand	84,000						84		0	
H-1-72	Olaa	1972	200	0	Machine	Hand	87,000			87					0	H-1-72 overlaps F-1-69
H-2-72	Waiākea	1972	243	135	Machine	Hand	95,000		24		71				53,000*	
H-4-72	Olaa	1972	200	0	Machine	Hand	87,000				87				0	2 sections - H-4-72 overlaps F-1-67
H-1-73	Olaa	1973	200	0	Machine	Hand	87,000				87				0	
H-3-73	Olaa	1973	200	0	Machine	Hand	87,000				87				0	
H-5-73	Waiākea	1973	200	0	Machine	Hand	36,000	18	18						0	H-5-72 overlaps H-5-68(2) and H-5-69
H-1-74	Olaa	1974	320	0	Machine	Hand	128,000		24	52	52				0	
H-3-74	Olaa	1974	320	0	Machine	Hand	138,000			69	69				0	
H-1-75	Olaa	1975	220	0	Machine	Hand	95,000			95					0	
H-3-75	Olaa	1975	400	0	Machine	Hand	174,000			87	87				0	H-3-75 overlaps F-1-68 and F-1-70
H-1-76	Olaa	1975	200	0	Machine	Hand	95,000				95				0	
H-3-76	Olaa	1975	240	0	Machine	Hand	104,000				104				0	
		Total	**16610**	**9279**			**7,555,000**	**1324**	**1169**	**854**	**739**	**296**	**248**	**150**	**2,288,200**	

** - estimated based on % of area witihn WTMA*

*** - Hand, chemical or light tractor clearing may be used*

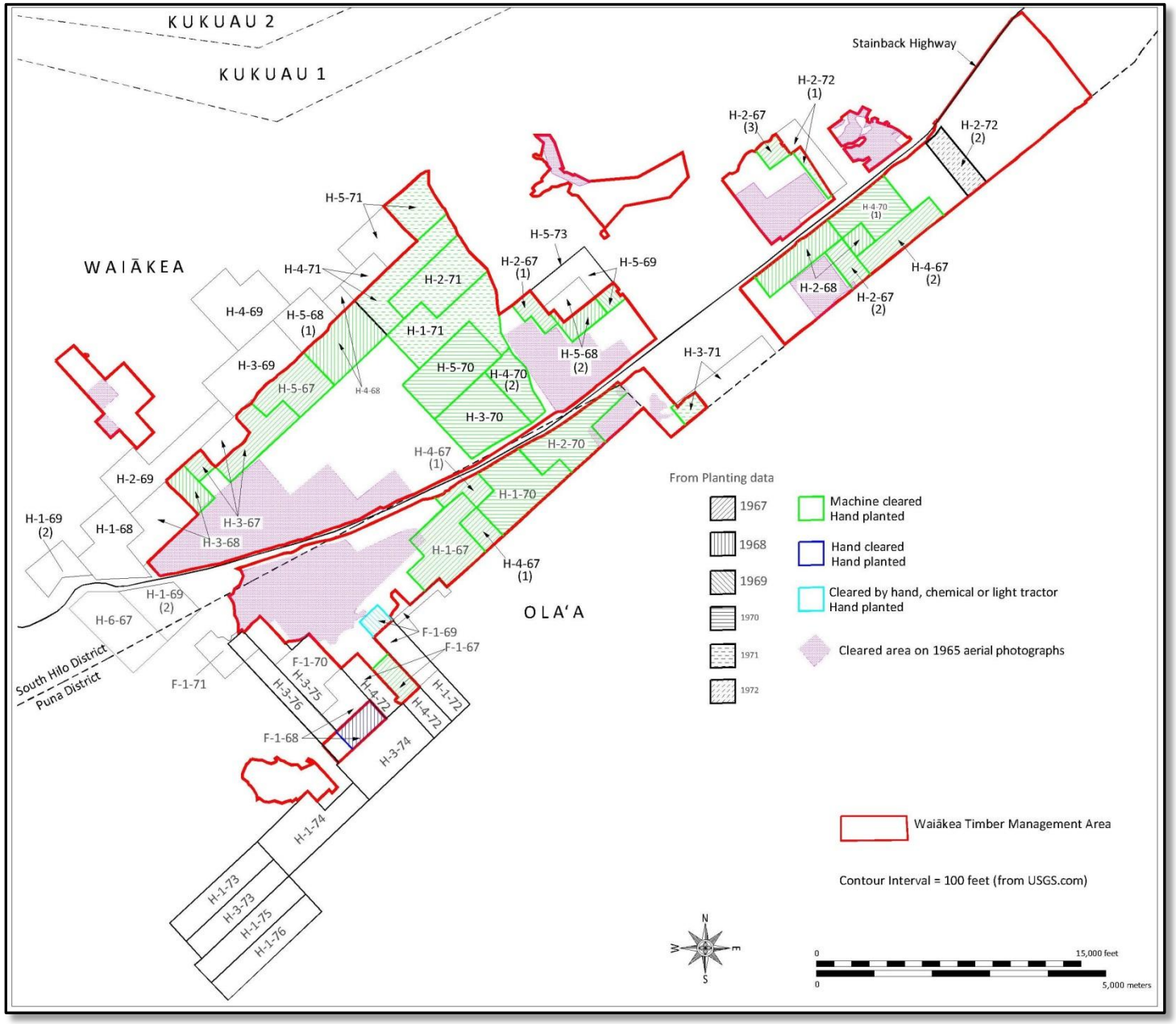

Figure 8. Plantings in the Waiakea-Olaa Planting Circle

planting areas (see *Figure 5*). The exclusion of this data leaves large gaps in the WTMA. To fill in these areas, a series of aerial photographs depicting the area were consulted (*Figure 9*). These photographs were taken by the U.S. Department of Agriculture between January 16 and February 1, 1965 (University of Hawai'i Library 2013). These photographs indicate that large portions of the WTMA had been cleared by early 1965. This information has also been incorporated into the *Figure 8* planting map.

As indicated in *Table 2,* nearly all of the areas planted within the WTMA had been mechanically cleared prior to the tree plantings. Of the 9,279 acres planted, only 84 acres were cleared by hand. An additional 40 acres were cleared using an undetermined combination of hand, chemical or light tractor. All of the areas were hand planted.

Currently, the majority of the 12,506-acre WTMA is planted in introduced tree species that are to be commercially harvested (10,608 acres or 85%). The distribution of these tree species is presented in *Figure 10* and is summarized in *Table 3*. Most of these trees are comprised of various species of eucalyptus, including Sidney blue gum (*Eucalyptus salinga & E. grandis,* 3,745 acres), swamp mahogany or swamp messmate (*Eucalyptus robusta,* 227 acres), and blackbutt or rainbow eucalyptus (*Eucalyptus deglupta & E. pilularis,* 54 acres). Additional tree species consist of Australian toon (*Toona ciliate* - 3,343 acres), tropical ash (*Fraxinus uhdei*, 1,577 acres), Queensland maple (*Flindersia brayleyana*, 1,536 acre), Nepal alder (Alnue nepalensis, 24 acres), and Sugi or Japanese cryptomeria (*Cryptomeria japonica,* 102 acres). The remaining 15% of the WTMA consists of 1,201-acres of native hardwoods and 28-aces of experimental hardwoods that will not be harvested, 349-acres of block roads, a 35 acre staging area and 285 acres of former cane lands (non-stocked on *Figure 10*).

Table 3. Cultivated tree species within the Waiākea Timber Management Area

Tree species (scientific name)	Common name (s)	Acres within project area	% of project area
Eucalyptus salinga & E. grandis	Sydney blue gum	3,745	30
Toona ciliata	Australian toon	3,343	27
Fraxinus uhdei	Tropical ash	1,577	13
Flindersia brayleyana	Queensland maple	1,536	12
Eucalyptus robusta	Swamp mahogany or Swamp messmate	227	2
Cryptomeria japonica	Sugi, Japanese cryptomeria, Japanese cedar	102	>1
Eucalyptus deglupta & E. pilularis	Blackbutt, Rainbow eucalyptus	54	>1
Alnue nepalensis	Nepal alder	24	>1
	Total	**10,608**	**85**

Although the WTMA was primarily created as a commercial timber resource, it also provides a locale for public recreation activities. These include motorcycle, mountain bike and horseback riding, hiking, pig hunting birdwatching and botanical exploration (*Ibid.* 1998:5). An ATV/Dirt Bike Park is located in the western portion of the WTMA and a network of mountain bike trails is located in the eastern portion (*Figure 11*). The ATV/Dirt Bike Park occupies approximately 1,588 acres or 12.7% of the WTMA and the area of mountain bike trails comprise approximately 213 acres (1.7%).

THE ENVIRONMENT

The WTMA is situated on the windward slopes of Mauna Loa Volcano, approximately 5 miles to the southwest of Hilo and from 0.6 to 3.5 miles northwest of the communities of Keaau, Kurtistown and Mountain View. The majority of the WTMA area (approximately 79% or 9,823 acres) is located within Waiākea Ahupua'a in the South Hilo District with the remaining 21% (2,683 acres) situated within 'Ōla'a Ahupua'a in the Puna District.

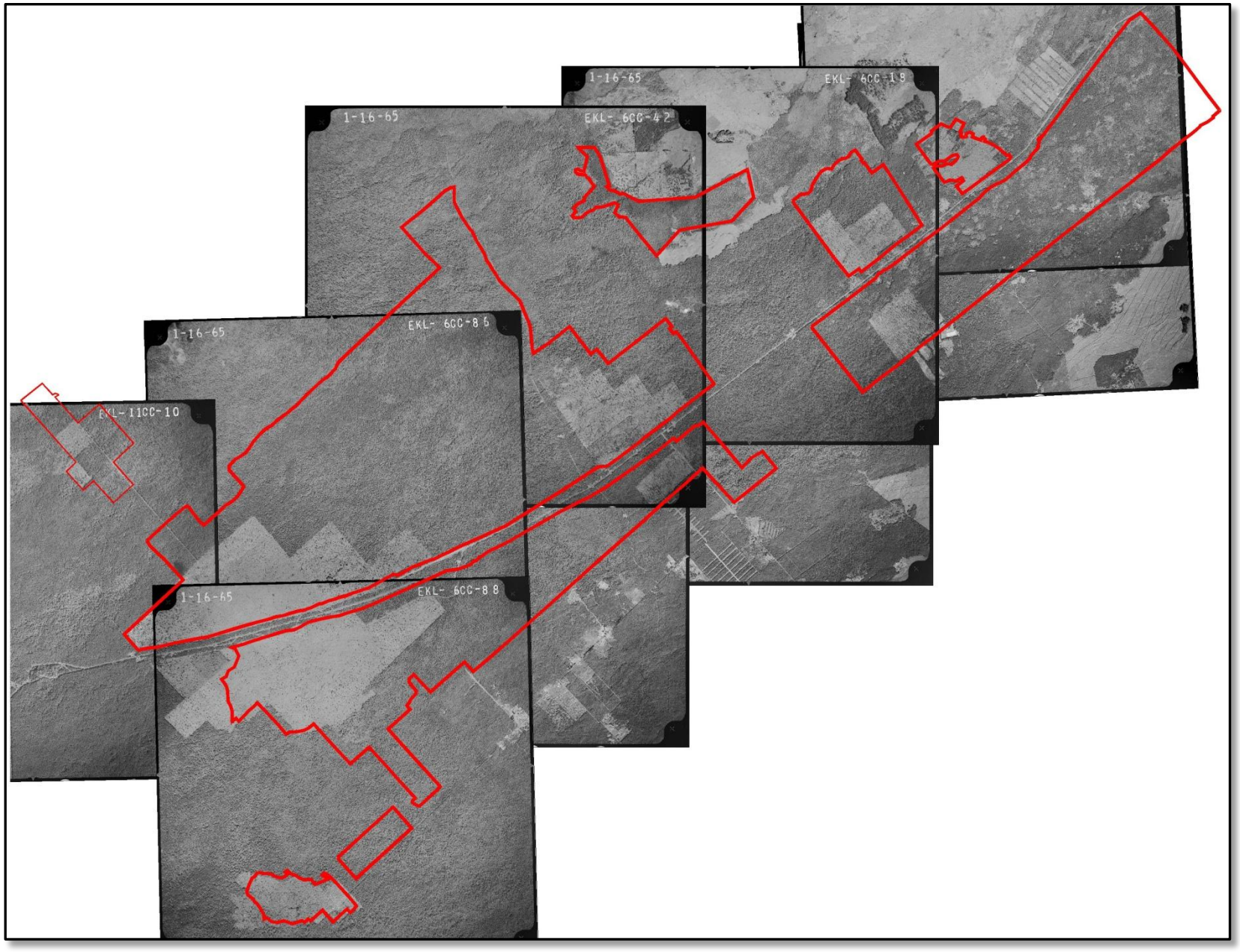

Figure 9. 1965 aerial photographs showing the Waiākea Timber Management Area

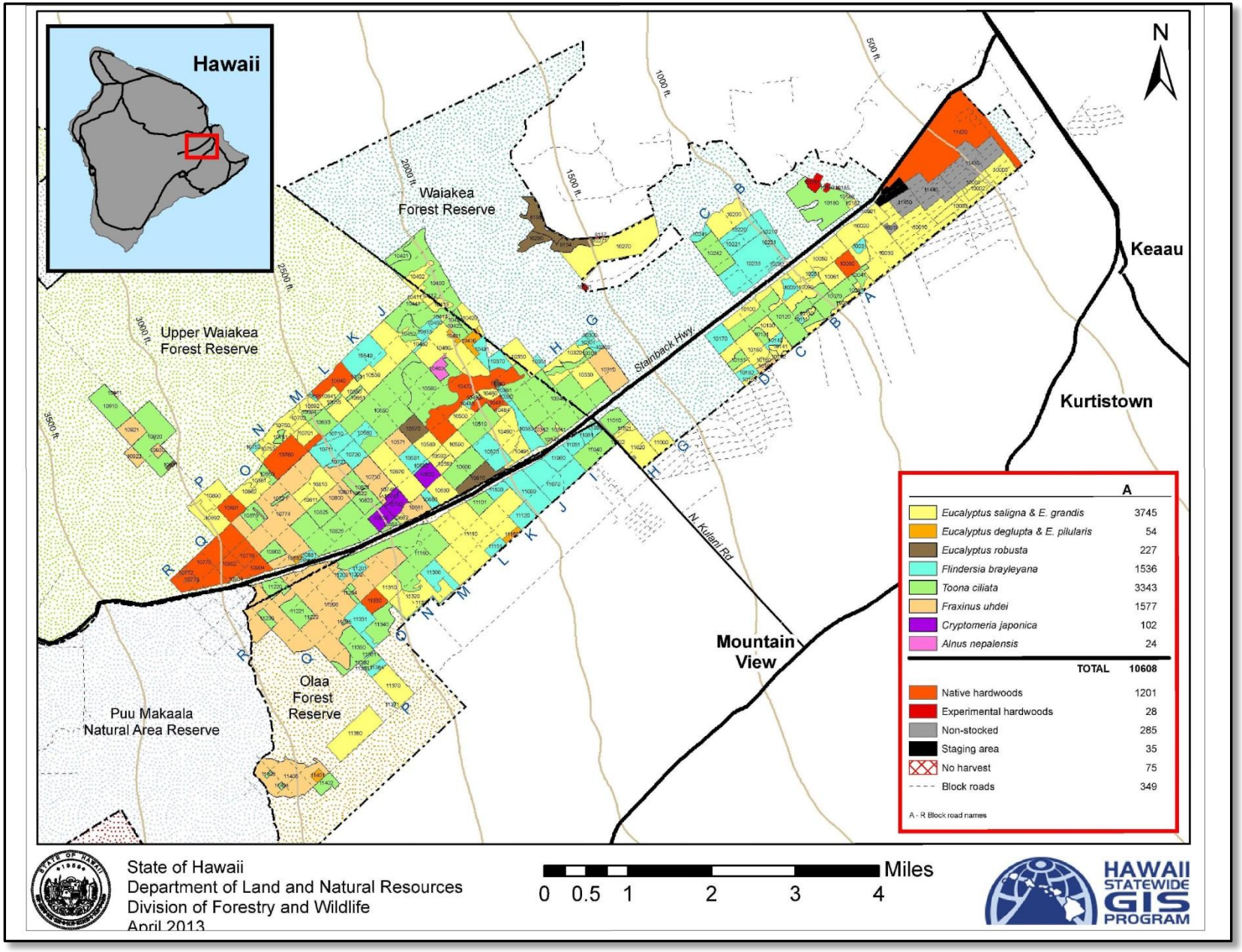

Figure 10. Tree species planted within the Waiākea Timber Management Area

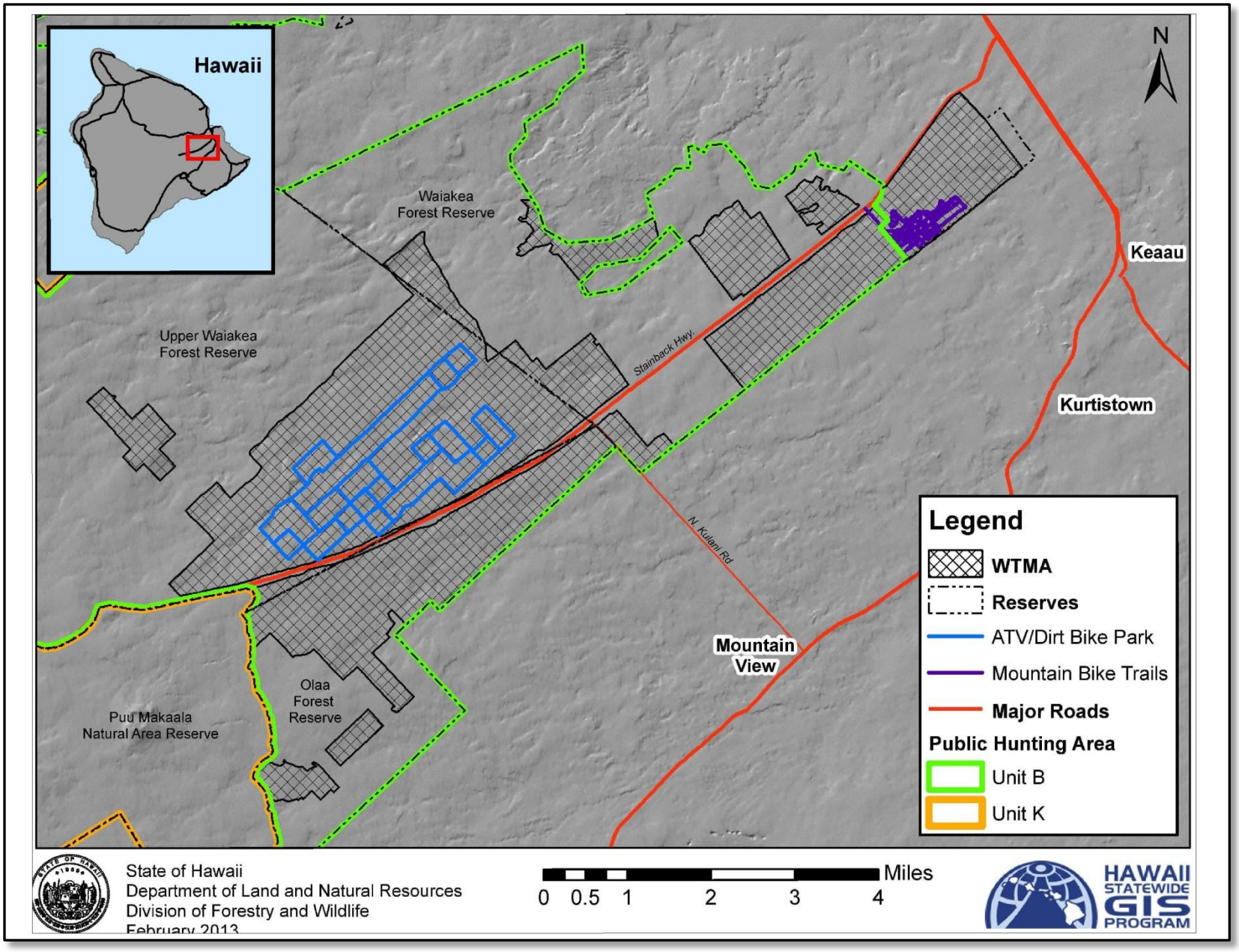

Figure 11. ATV/Dirt Bike Park and Mountain Bike Trails within Waiākea Timber Management Area

The 12,506 acre WTMA is comprised of eight discrete parcels that range in size from approximately 193 to 5,981 acres. Based on the USGS quadrangle map (see *Figure 1*) and other maps, the Stainback Highway extends through the WTMA, separating several of the larger parcels. The Stainback Highway's location on the *Figure 3* tax map appears to be inaccurate, depicting the highway further north of its actual location.

There are nine soil types present within the WTMA (Sato *et al.* 1973). These soil types are summarized in *Table 4* and are depicted in *Figure 12*. The nine soil types consist of Kiloa extremely rocky muck, Keei extremely rocky muck, Papai extremely stony muck, Keaukaha extremely rocky muck, Hilea silty clay loam, two variants of Akaka soils and two variants of Ohia soils.

Table 4. Soil types in the Waiākea Timber Management Area

Soil Type*	Symbol	Acres within WTMA	% of WTMA	Description	Permeability	Runoff	Erozion Hazard	Suitability
Kiloa extremely stony muck (6-20% slopes)	rKXD	7,022	56.1	Muck surface layer (10" thick) over fragmental aa lava substrate	Rapid	Very slow	Slight	Woodland and pasture
Keei extremely rocky muck (6-20% slopes)	rKGD	2,086	16.7	Muck surface layer (10") over pahoehoe lava substrate. Rock outcrops cover 25-50% of surface	Rapid	Medium	Slight	Pasture
Papai extremely stony muck (3-25% slopes)	rPAE	1,192	9.5	Stony muck surface layer (8") over fragmental aa lava substrate	Rapid	Slow	Slight	Woodlands
Akaka silty clay loam (10-20% slopes)	AkD	720	5.8	Silt clay loam surface layer (15") over silt clay loam subsoil (57") dehydrating into aggregates	Rapid	Slow	Slight	Woodlands and watershed
Keaukaha extremely rocky muck (6-20% slopes)	rKFD	869	6.9	Muck surface layer (8") over pahoehoe lava substrate	Rapid	Medium	Slight	Woodland and pasture
Akaka silty clay loam (0-10% slopes)	AkC	528	4.2	Silt clay loam surface layer (15") over silt clay loam subsoil (57") dehydrating into aggregates	Rapid	Medium	Moderate	Sugarcane, pasture, woodlands, wildlife
Hilea silty clay loam (6-20% slopes)	HIC	54	0.4	Silt clay loam surface layer (8") over silt clay loam subsoil (11") over pahoehoe bedrock	Rapid	Medium	Slight	Sugarcane, pasture, woodlands
Ohia extremely stony silty clay loam (0-20% slopes)	OSD	27	0.2	Silt clay loam surface layer (26") with stones covering 3-15% of surface, over fragmental aa lava	Rapid	Slow to medium	Slight to moderate	Sugarcane, pasture, woodlands
Ohia silty clay loam (0-10% slopes)	OHC	8	0.1	Silt clay loam surface layer (9") over silt clay loam subsoil (53") over pahoehoe bedrock	Rapid	Slow	Slight	Sugarcane, pasture, woodlands
Total		12506	100.0					

* Data from Sato *et al.* (1973)

The majority of the soils are shallow (8" to 10") muck deposits overlying either aa or pahoehoe lava substrates (11,169 acres or 89.3%). The remaining 1,580 acres (10.7%) consist of one to two layers of silt clay loam over fragmental aa or pahoehoe lava, or a subsoil that dehydrates into aggregates. Eight of the nine soils are classified as suitable for woodlands, comprising 10,420 acres or 83.3% of the WTMA. Seven of the nine soils are suitable for pasture (10,594 acres, 84.73%) and four soils are suitable for the cultivation of sugarcane (617 acres, 4.9%). One soil type is suitable as watershed area (720 acres, 5.8%) and one is suitable for wildlife habitat (528 acres, 4.2%).

The underlying lavas within the WTMA were deposited from Mauna Loa Volcano between 200 and 10,000 years ago (*Table 5* – Wolfe and Morris 2001). The majority of the area is covered by lava flows that date to between 750 and 1,500 years ago (8,878-acres, 71%) of the project area. Five to ten thousand (5,000-10,000) year old flows encompass approximately 1,940 acres (16%). Two hundred to seven hundred and fifty (200-750) year old flows cover 1,552 acres (12%) and 1,500 to 3,000 year old flows span 136 acres (1%). The distribution of the lava flows is depicted in *Figure 13.*

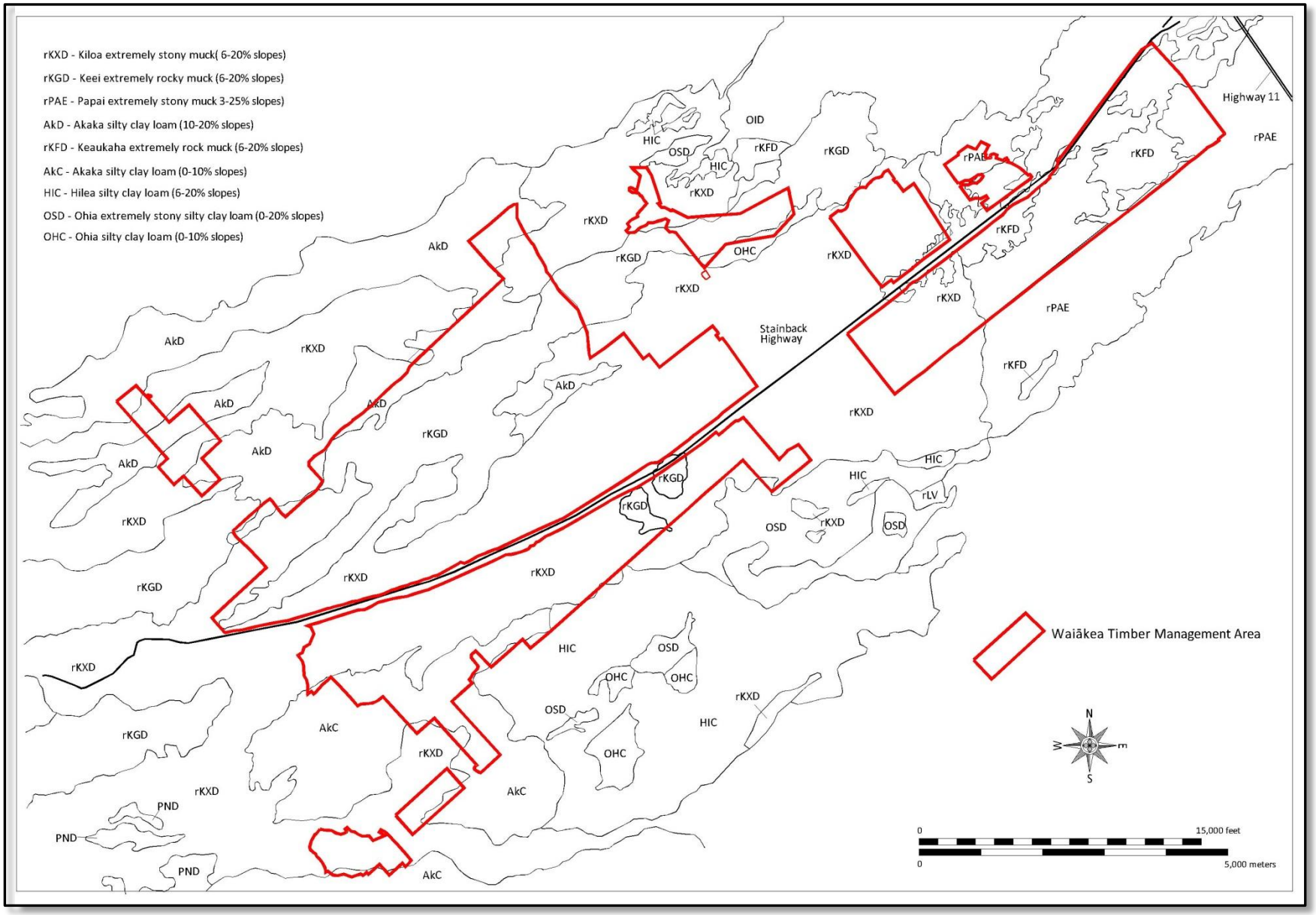

Figure 12. Soils in the Waiākea Timber Management Area (created from Sato *et al.* 1973)

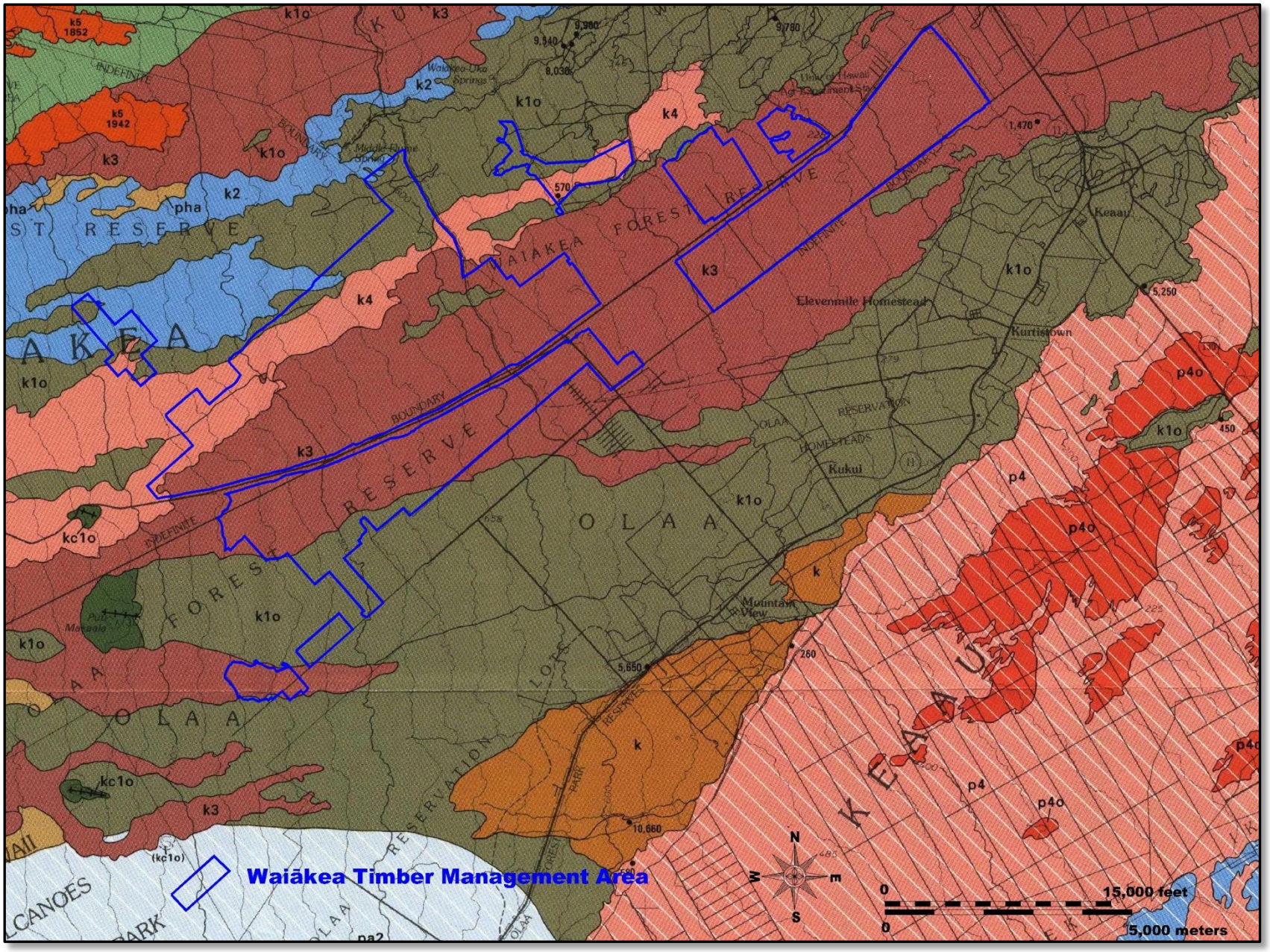

Figure 13. Lava flows in the Waiākea Timber Management Area (modified from Wolfe and Morris 2001)

Table 5. Mauna Loa lava flows in the Waiākea Timber Management Area

Lava flow classification*	k1o	k2	K3	k4	Total
Age of lava flow deposited from Mauna Loa Volcano**	5,000-10,000	1,500-3,000	750-1,500	200-750	-
Acres within project area	1,940	136	8,878	1,552	12,506
% of project area	16	1	71	12	100%

** - data from Wolfe and Morris (2001)*

*** years before present*

The WTMA varies in elevation from approximately 360 ft at the northeastern end to nearly 3,300 ft at the northwestern end (*Figure 14*). *Table 6* presents a summary of elevation in the project area, using a 500 ft interval. The majority of the WTMA is located between 2,000-2,500 ft, comprising 30% of the project area or 3,701 acres. This is followed by the 2,500-3,000 ft elevation range (22%, 2,760 acres), the 1,500-2,000 ft range (18%, 2,196 acres) and the 500-1,000 ft range (14%, 1,715 acres). The smallest percentages of the project area are located at the lowest (0-500 ft; 4%, 507 acres) and highest portions (3,000-3,500 ft; 3%, 440 acres) of the WTMA.

Table 6. Elevation in the Waiākea Timber Management Area

Elevation range* (in feet AMSL)	Acres within WTMA	% of WTMA
0-500	507	4
500-1,000	1715	14
1,000-1,500	1187	9
1,500-2,000	2196	18
2,000-2,500	3701	30
2,500-3,000	2760	22
3,000-3,500	440	3
Total	12506	100

** data from USGS.com*

Rainfall within the WTMA is directly related to elevation, with precipitation increasing from 140-160 inches per year in the seaward, southeastern portion of the area at less than 800 ft elevation, to more than 240 inches in the inland portion at more than 2,600 ft elevation (see *Figure 14* and *Table 7*). Most of the WTMA receives between 220-240 inches of rainfall per year, comprising 43% of the project area or 5,352 acres. This is followed by areas with 200-220 inches (19%, 2,329 acres), 160-180 inches (14%, 1,810 acres) and more than 240 inches (11%, 1,396 acre). Approximately 5% of the project area (620 acres) receives 180-200 inches of rainfall a year, and 8% (999 acres) receives 140-160 inches.

Table 7. Rainfall in the Waiākea Timber Management Area

Rainfall range* (inches per year)	Acres within WTMA	% of WTMA	Elevation range (in feet AMSL)
140-160	999	8	>800
160-180	1810	14	600-1,575
180-200	620	5	800-1,900
200-220	2329	19	1,200-2,200
220-240	5352	43	1,900-2,600
240+	1396	11	<2,600
Total	12506	100	

** data from ESRI.com*

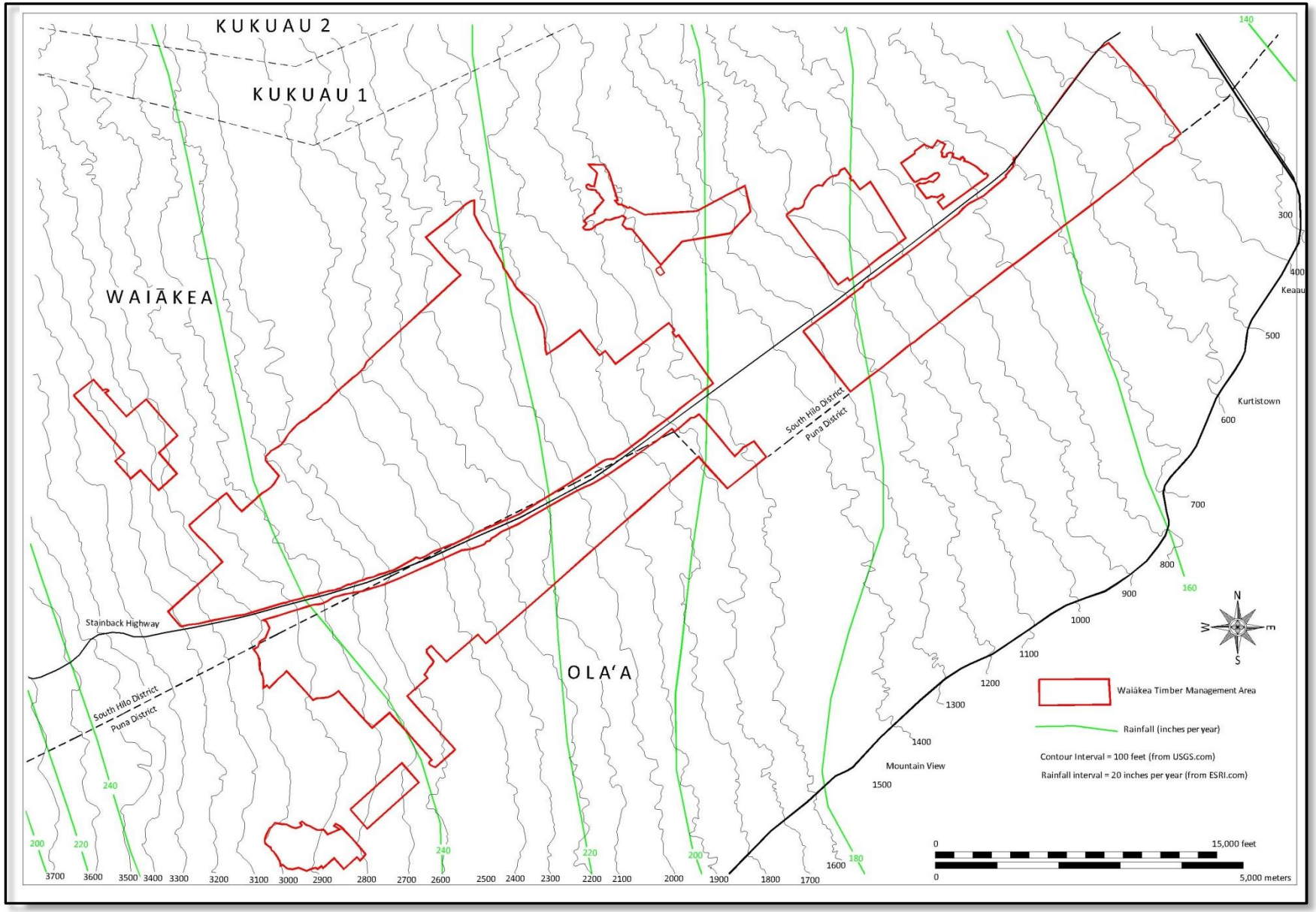

Figure 14. Elevation and rainfall in the Waiākea Timber Management Area

HISTORIC BACKGROUND RESEARCH

Historical Documentary Research

The WTMA spans Waiākea Ahupuaʻa in South Hilo District (79%) and ʻŌlaʻa Ahupuaʻa in Puna District (21%). Waiākea Ahupuaʻa is one of the largest in the district of South Hilo covering over 95,000 acres and extending along the coast from the west side of Hilo Bay to the Puna District boundary and inland to approximately 6,000 ft elevation (*Figure 15*). Similarly, ʻŌlaʻa Ahupuaʻa is one of the largest land divisions in the Puna District (approximately 57,000 acres), second only to the Land of Keaau. ʻŌlaʻa is atypical of Hawaiian *ahupuaʻa,* in that it is land-locked with no ocean frontage. According to Maly and Maly, "the land of ʻŌlaʻa stood alone, almost independent of the other lands adjoining it in Puna, though it had no ocean frontage — being cut off by Keaʻau and Waiākea" (2004:6).

The project area *ahupuaʻa* contained a variety of valuable resources that made Waiākea and ʻŌlaʻa important locales. Waiākea served as the seat of chiefly residences as early as the mid-1500s with chiefly associations continuing out traditional times. Waiākea was retained by Kamehameha at the time of his death he, "…held Hilo lands including Pi'ihonua, Punahoa, and Waiākea, descended to Liholiho, his son and heir to the kingdom" (Kelly *et al.* 1981:11). According to Maly and Maly, the name ʻŌlaʻa, "connotes sacredness and sanctity; the root of the name being "*laʻa*." ʻŌlaʻa is famed in native tradition for it's sacred lands, forest, native birds, and *olonā* resource" (2004:6).

Much of the following is summarized from *Hilo Bay: A Chronological History,* an extensive and thorough compendium of historical information about the Hilo area by Kelly *et al.* (1981) and from *He Moʻolelo ʻĀina*: A Cultural Study of the Puʻu Makaʻala Natural Area Reserve by Maly and Maly (2004). Hawaiian traditional and legendary accounts attest to the longstanding importance of the area. The chief of the Hilo region, Kulukuluʻa, who resided in Waiākea, was the first conquest of ʻUmi-a-Liloa in his campaign to unify the districts of Hawaiʻi Island. Hilo with its large bay, fishponds, wet taro fields, and abundant freshwater was a population center for commoners and royalty. Kamehameha I and his court resided in Hilo in the 1790s. In preparation for his planned invasion of Kauai in 1802, Kamehameha built a canoe fleet at Hilo, reportedly consisting of 800 vessels. Kamehameha gave his favorite wife, Kaʻahumanu, the *ili kupono* of Piʻopiʻo in Waiākea.

Maly and Maly (2004:8-19) present the tradition of Pikoi-a-ka-ʻalalā (Pikoi-son-of-the-crow), which was printed in the *Ku Okoa,* the Hawaiian language newspaper in 1865-1866. According to the account, this represents the earliest written accounts of the cultural practices within the vicinity of the project area, in the upland forests of Waiākea and ʻŌlaʻa. Pikoi-a-ka-ʻalalā was a *kūpua,* a supernatural being with the ability to change his body forms and was skilled at the *pana pua* or the use of bow and arrow.

In this tradition, Pikoi-a-ka-ʻalalā travels throughout the islands and competes against other archers. On his arrival in Hawaiʻi, he learns that the chief of Hawaiʻi Island, Keawenui a ʻUmi, needed help getting rid of two supernatural *ʻelepaio* birds that were interrupting the canoe makers in a clearing in upland ʻŌlaʻa called Kalehaupueo. The birds roosted in a large *koa* tree and when they would hear the striking of the adzes they would fly down and call out, "Say Keawenui a ʻUmi! Leave it behind; it is a bad canoe, a canoe that will shatter a rotted hull" (2004:10). The chief had already enlisted Mainele, an archer from Oʻahu to rid him of the troublesome birds, promising him the hand of his daughter Keakalaulani if he could accomplish the task. Although Mainele bragged of his abilities, he was not able to kill the *elepaio* birds.

During this time, Pikoi-a-ka-ʻalalā` befriended the steward of the chief Waiākea, and takes up residence with him in Hilo. He hunts in the uplands of ʻŌlaʻa where he kills many birds and gives them to the chief for food. Learning that Mainele has not been able to kill the *ʻelepaio* birds, Waiākea asks the chief if his friend Pikoi-a-ka-ʻalalā` might be given a chance to kill the birds and Keawenui a ʻUmi agrees.

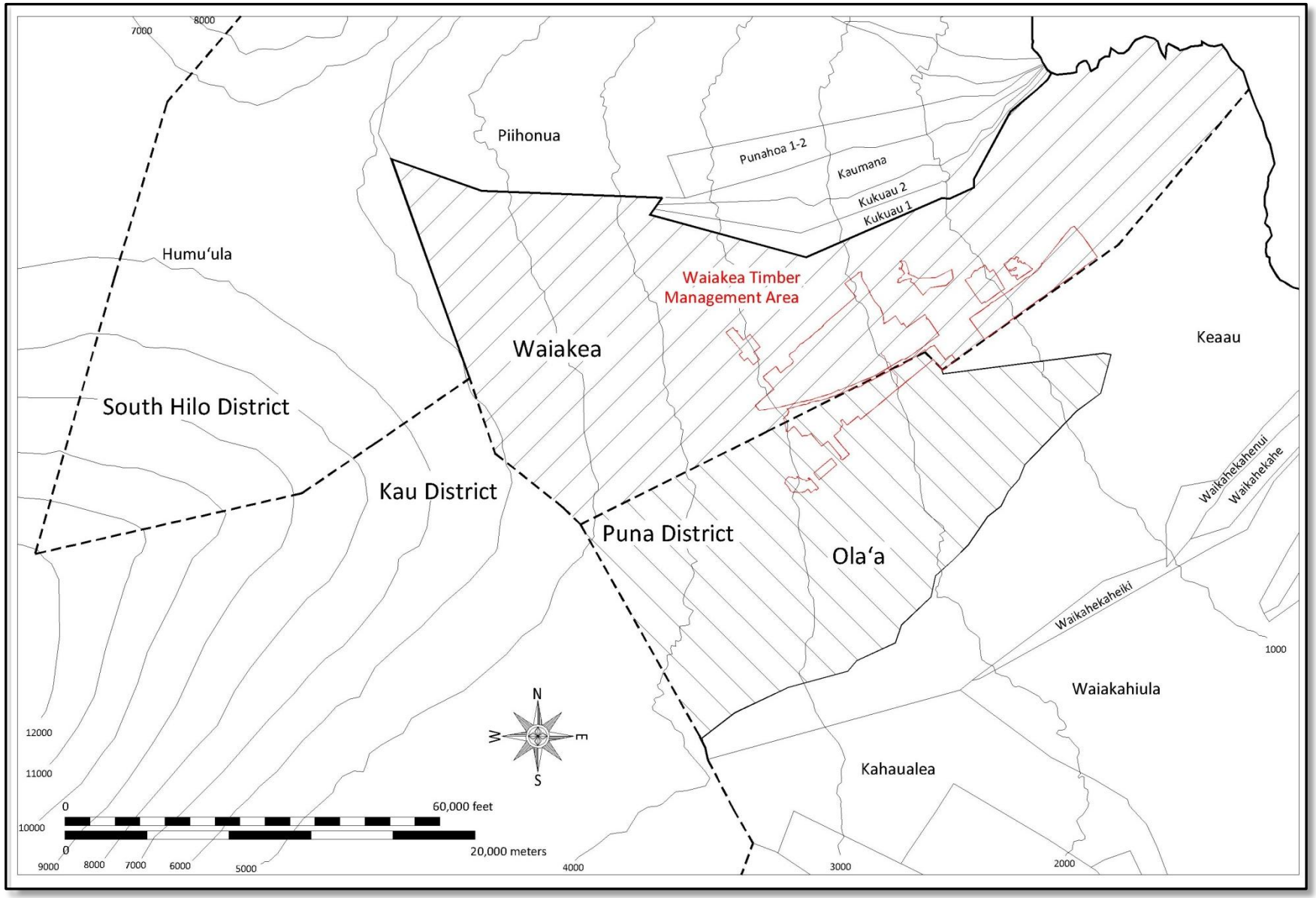

Figure 15. Ahupua'a boundaries

Pikoi-a-ka-ʻalalā` and Waiākea set out for the Kalehaupueo clearing. On the way they stop at a resting place called Mahinaʻakaaka along the trail to ʻŌlaʻa. There Pikoi-a-ka-ʻalalā` shoots a large rat named ʻAkiʻakiaʻiole. Further along he stops at a place called Makaulele where he becomes engrossed in making leis from the fragrant red and white *lehua* blossoms. Eventually they reach Kalehaupueo and Pikoi-a-ka-ʻalalā` kills the two supernatural *ʻelepaio* birds with a single arrow while Waiākea strikes down Mainele and his companions. In gratitude Keawenui a ʻUmi tells Pikoiakaʻalalā that he can wed his daughter, and that he will inherit his kingdom.

Early historic accounts also document the importance of the general Hilo area. In 1823, the missionary William Ellis estimated the population to be 2,000 people in 400 houses and described the extensive use of *lauhala* thatch in house construction. Lauhala was gathered from eastern Waiākea beyond the Wailoa River. He described the land as intensively cultivated with plantains, bananas, sugar cane, taro, potatoes, melons, coconuts, and breadfruit. Wet taro was grown in mounds (*kipi*) in marshlands. Hilo was a center for trade between the people of Kaʻu, Hamakua, and Hilo. Between the 1790s and 1820s, sandalwood was cut and brought to Hilo for export. *Pulu* and *pia* (arrowroot) were also exported. Ellis also describes coastal fishing.

Ellis recalls a visit to the Puna District and describes the nearby community of Keaʻau (or Kaau) as "the last village in the division of Puna. It was extensive and populous, abounding with well cultivated plantations of taro, sweet potatoes, and sugar cane, and probably owes its fertility to a fine, rapid stream, which, descending from the mountains, runs through it into the sea" (1963: 60).

In 1824, a missionary station was established in Waiākea. Soon after, churches and schools were established. Whalers began stopping at Hilo in the mid-1820s. In the 1830s, a sawmill was built, and two stores were opened. By the end of the decade, a sugar cane plantation and mill were established on Ponahawai lands. In 1840, the Wilkes Expedition arrived in Hilo and constructed an observatory on Waiākea Point on the east side of Hilo Bay.

In 1841, members of the United States Exploring Expedition, under the command of Charles Wilkes, accompanied by a party of native Hawaiians and foreign residents (numbering nearly three hundred individuals) traveled to the summit of Mauna Loa. The party departed from Waiākea, traveled *mauka* through ʻŌlaʻa, and on to Kīlauea. Observations and exploration were undertaken at Kīlauea, and then the party traveled through Keauhou, *mauka*, along the forest above ʻŌlaʻa and Puʻu Makaʻala, and on to Mauna Loa.

The Volcano Trail was the primary transportation route between Hilo and Kilauea, and potentially represents the route traveled by Wilkes. McEldowney describes this trail as follows:

> …From here to Mountain View or just beyond the "halfway house," the trail crossed on to an extensive Kīlauea pahoehoe flow and continued along its western margin, which abutted mostly ash-covered Mauna Loa flows. The route of this old trail basically corresponds to the Ōlaʻa-Keaʻau boundary line on the current U.S.G.S. maps. Descriptions of scattered, stunted trees, mixed with ferns, grasses, *ʻōhelo* (*Vaccinium* sp.), and low shrubs, sound typical of pioneer or early successional plant communities. When compared to the previous portion of the trail, ferns became more dominant, *pia* disappeared, and scattered clumps of woods, probably small *kīpūkas*, replaced the groves.
>
> …the woods started one or two miles SE and NW of the path, giving it the appearance of an unwooded corridor. Several villages, as well as scattered huts along the forest edge, were reported without much detail other than the presence of fertile soil and a burial cave marked with poles. Most describe leaving this open stretch somewhere beyond the "halfway house" by entering a thick forest, which Pickering [1840-41] placed at 1,500 ft elevation (1979:20}.

In the 1840s, a political act of the Hawaiian Kingdom government would forever change the land tenure system in Hawai`i and have far-reaching effects on its people. The historic land transformation process was an evolution of concepts brought about by fear, growing concerns of takeovers, and western influence regarding land possession.

King Kamehameha III, in his mid-thirties, was persuaded by his *kuhina nui* and other advisors to take a course that would assure personal rights to land. One-third of all lands in the kingdom would be retained by the king; another one-third would go to *ali'i* as designated by the king; and the last one-third would be set aside for the *maka`ainana* or the people who looked after the land. In 1846, King Kamehameha III appointed a Board of Commissioners, commonly known as the Land Commissioners, to "confirm or reject all claims to land arising previously to the 10th day of December, AD 1845." Notices were frequently posted in *The Polynesian* (Moffat and Kirkpatrick, 1995); however, the legislature did not acknowledge this act until June 7, 1848 (Chinen 1958:16; Moffat and Kirkpatrick 1995:48-49) and the act is known today as *The Great Māhele*. In 1850, the Kingdom government passed laws allowing foreigners to purchase fee simple lands (Speakman 2001:91).

The Waihona 'Aina (2000) Mahele Database; which is a compilation of data from the Indices of Awards (Indices 1929), Native Register (NR n.d.), Native Testimony (NT n.d.), Foreign Register (FR n.d.) and Foreign Testimony (FT n.d.) provides information on the Land Commission Awards (LCA) awarded during the Mahele. This database lists 51 parcels claimed by 37 claimants within Waiākea, though only 26 of the claims were subsequently awarded. All of the awarded claims in the coastal portion of the *ahupua'a,* except two that are located at the approximately 100 ft elevation, are situated well seaward of the WTMA.

Land use described in the LCA claim testimony for Waiākea includes agriculture, pasture, burial, and residence. Thirty-four houses are mentioned and one describes the presence of a grave. Most of the claim testimony mentions cultivated fields. Crops include wet taro, sweet potatoes, breadfruit, coffee, and *kukui.* A *hala* (*Pandanus* spp.) grove and fishponds are also mentioned.

During the *Māhele*, 'Ōla'a Ahupua'a was relinquished by Kaunuohua to Kamehameha III and retained as Crown Land (Maly and Maly 2004:40). Only one Land Commission Award was claimed in 'Ōla'a. LCA 11049B was claimed by Naiilima for a parcel of land in the *ili* of Kupalu. The claim was not awarded (Waihona 'Aina 2000). The Crown Lands were further opened up for homesteading under the Land Act of 1895, and large section of 'Ōla'a Ahupua'a was segmented into the 'Ōla'a Lots, located to the south of the WTMA. *Figure 16* is E.D. Baldwin's 1892 map of the 'Ōla'a Lots, depicting "Crown Land Lots for Lease on Very Favorable Terms". The map shows a subdivision of 391 lots located to the north of the Old Volcano Trail. It also presents a photograph labeled "View at Olaa on Volcano Road" showing settlement within the area.

The first sugar plantation was established in the Hawaiian Islands on Kauai in 1836 (Kent 1983:22, 23, 29), although sugar cane was cultivated on all the islands at the time of Cooks arrived in 1778. According to Orr (2004:14), the Chinese on Lanai are credited with first producing sugar as early as 1802. The commercial cultivation of sugarcane occurred in 1835 to replace the declining sandalwood industry (Kuykendall and Day 1976:92).

Although sugar plantations were established in the Hilo and Kohala Districts by the 1860s, it wasn't until 1899 that a plantation was established in Puna. This plantation was the Puna Sugar Company (*Figure 17* – No. 50) founded by Benjamin Dillingham, Lorrin Thurston and James Castle (Dorrance 2000:105-107) A year later they founded the Olaa [Kea'au] Sugar Company (No. 49) on lands owned by the Shipman family .

The following is an excerpt from Sugar Waters by Dorrance (2000:105-107):

> The rocky, acidic Puna District south of Hilo had a much smaller number of plantations. In the 1890s the land was peppered with small homesteads, some devoted to coffee growing. After Hawai`i was annexed to the United States [1898], Benjamin Dillingham saw a sugar-growing opportunity in Puna. Along with investors that included Lorrin Thurston and James Castle, he incorporated Olaa Sugar Company to exploit the land. At the time Dillingham was building the Hilo Railroad Company and considered the new plantation a source of revenue for the railroad. By 1905 Olaa Sugar Company had a modern mill, and 7, 676 acres under cultivation serviced by the only gauge plantation railway in Hawai`i.

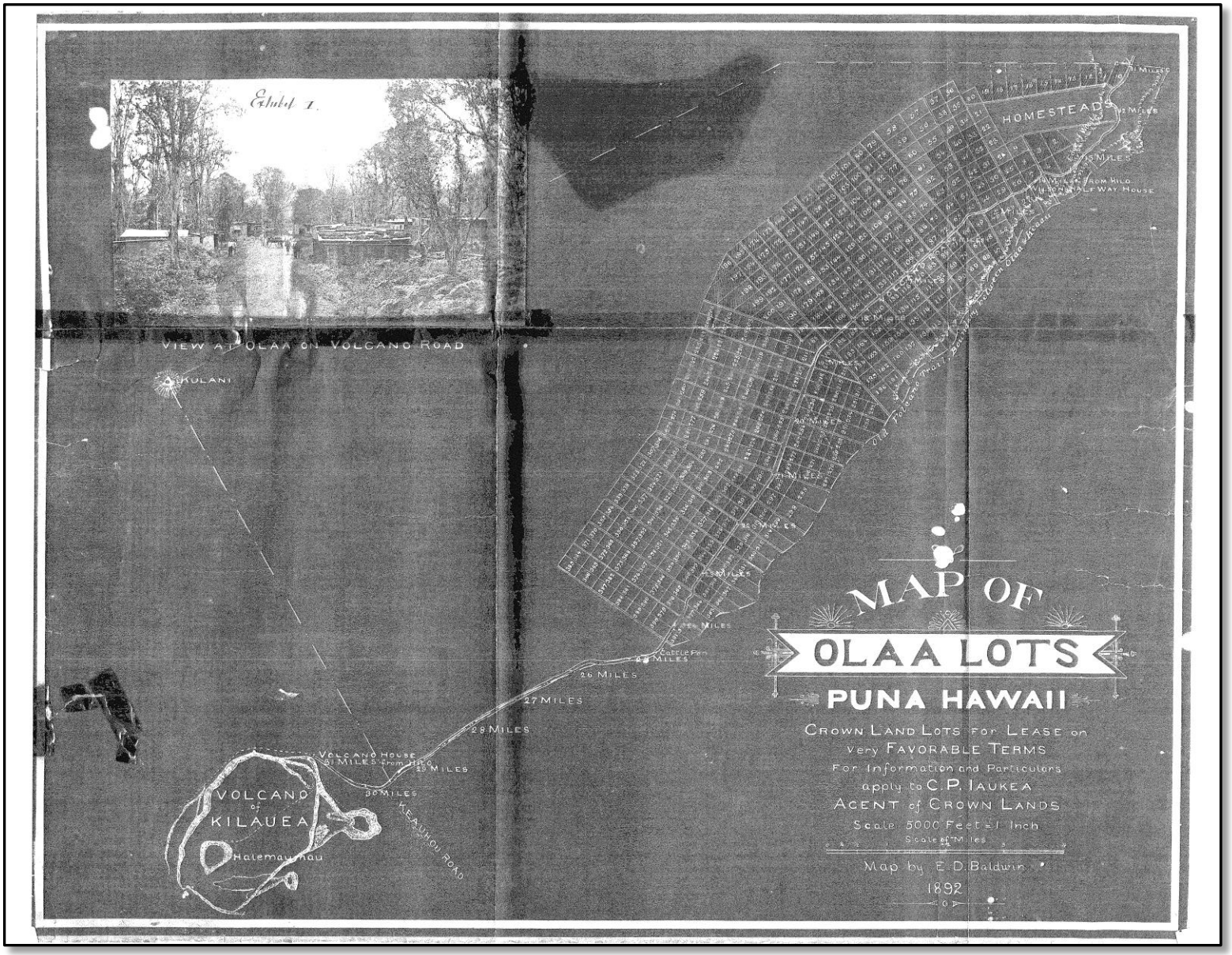

Figure 16. Baldwin's 1892 Map of Olaa Lots

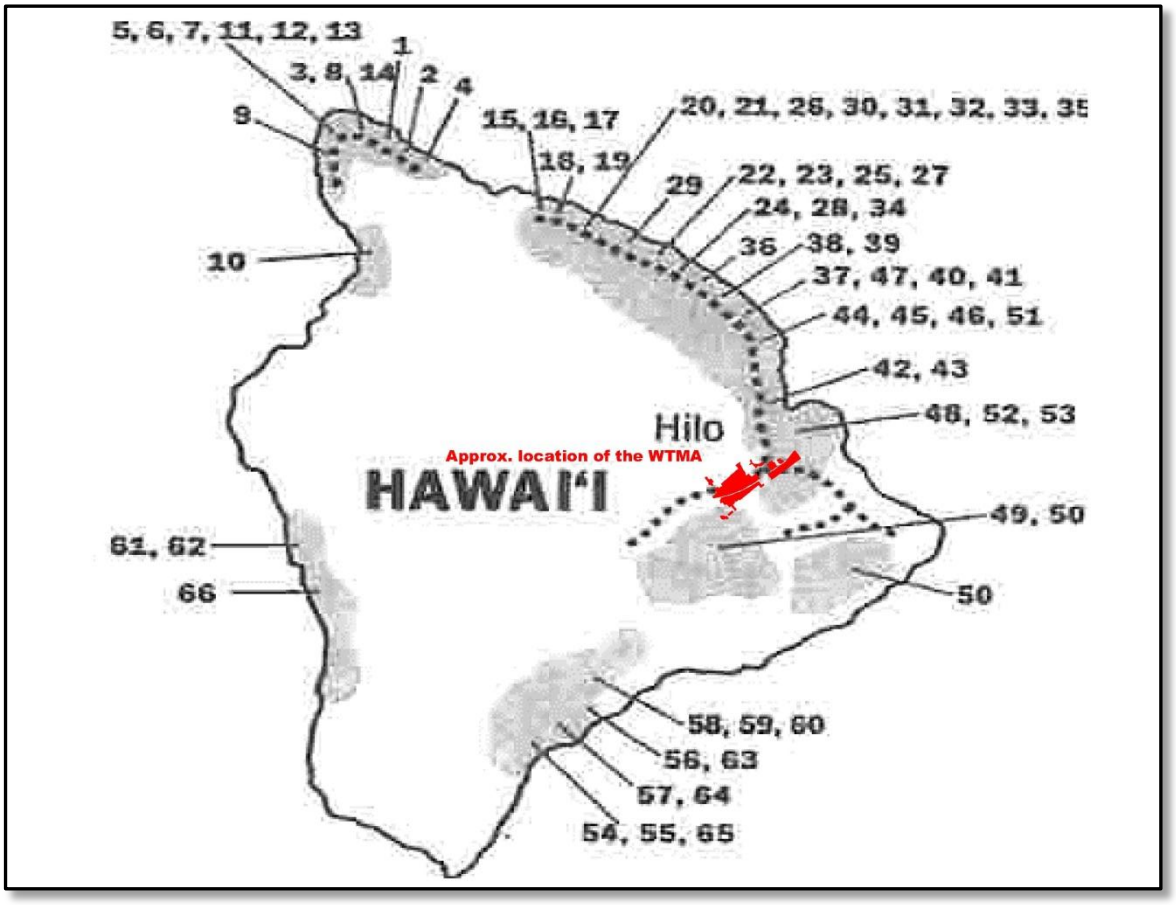

Figure 17. Map of Hawaii Sugar Ventures (modified from Dorrance 2000)

Production increased when Olaa Sugar Company began milling Puna Sugar Company's harvest in and around Kapoho. But Olaa Sugar Company waxed and waned during the first 20 years of its life, paying dividends only twice in all that time. The land was rocky, sticky, acidic, and difficult to clear and cultivate. Not every acre received adequate rainfall, growth was stunted, and irrigation water was lacking. An infestation of leaf hoppers in 1916-1917 ruined 10,000 tons of sugar from the 1918 crop. In later years mechanical harvesting was limited because field equipment rusted and eroded too rapidly under the difficult conditions.

In the 1930s, cultivated acreage stabilized at slightly over 15,000 acres. The fields extended up to 23 miles from the mill. Harvests were delivered via the Glenwood branch of Hawaiian Consolidated Railway, which ran from Olaa toward Kilauea Volcano, and stopped seven miles short of it at the village of Glenwood. Harvests from the Pahoa region were delivered by the Kapoho branch of tracks that extended 17 miles southwest of the mill. Flumes and the plantation's railroad took care of about half of each harvest, while the Hawaiian Consolidated Railway hauled the rest, and also transported product to the Hilo docks.

In 1935 the plantation housed 5,648 workers and dependents in 1,086 company-supplied houses distributed among over 15 camps or villages. In addition, some 230 homesteaders lived and grew cane on family plots. Maximum production of the combined Olaa and Puna/Kapoho enterprises was 52,011 tons of sugar in 1937.

> The tsunami of 1946 struck a serious blow when it caused the Hilo railroad to shut down. Then the 1955 volcanic eruption covered thousands of acres in the Kapoho Division and isolated it. Despite all, the plantation company, renamed Puna Sugar Company in 1960 at the urging of landowner Herbert Shipman (1892-1976), struggled on.
>
> By 1982, the Olaa mill generated over 40 million kilowatt hours of electric power that was sold to Hawai`i Electric Light Company. The end of sugar operations came when its owners, Amfac, Inc. closed the Puna Sugar Company in the same year. But the mill's generating capability was perpetuated and increased. Oil was burned in the furnaces instead of the former mixture of bagasse and oil, and fulfilled a dire need for electrical energy.
>
> Shops in nearby Kea'au (Olaa) served the mill camps and homesteaders who supplied harvests to the Olaa mill. When it shut down in 1982, many small businesses were devastated. Highway 11 leading to Kilauea Volcano bypassed the town and further accentuated the demise of its prosperity.

In the early 1800s, missionaries established a mission station at Hilo because of its large population, abundant freshwater, and cultivation potential. Soon churches and schools were established. Whalers stopped at Hilo because of the protected anchorage and availability of freshwater and provisions. Sugar cane cultivation, cattle ranching, and trade in *pulu*, arrowroot, and sandalwood rapidly changed the traditional subsistence economy during the early to mid-1800s.

By the late 1800s, vast areas were in sugar cane production and large scale timber harvesting was underway. Transportation infrastructure including a railroad system and wharf facilities were established. The area underwent a dramatic increase in population as people came to the area to work for the plantations and other commercial developments.

By 1857, there were three sugar cane mills in the Hilo area. Large tracts of land were put in the cane cultivation and sugar cane was also grown by individuals around their houses. In 1861, a stone wharf was constructed at Waiākea landing on the west side of Waiākea Point. A sugar mill was established in Waiākea at the inland end of Waiākea Fishpond in the late 1870s. A railroad transport system was constructed for the Waiākea Mill between 1879 and 1880. By 1880, 1,400 acres of sugar cane were in cultivation and by the end of the decade over 5,600 acres were cultivated. In 1877, a 16 ft high tsunami struck the coast of Waiākea destroying all houses within 100 yards of the shore along with a wharf, storehouse, a quarantine hospital on Coconut Island, and a bridge.

Between 1900 and the 1930s, the population of the area grew dramatically with the expansion of sugar cane cultivation, pineapple production, the timber industry, and other commercial developments. In the 1910s, the Hilo Railroad Company expanded the rail system to Puna and Hilo Town. A railroad wharf was built north of the mouth of the Wailoa River. Between 1909 and 1913, the railroad was extended to North Hilo and Hamakua Districts.

Figure 18 is a compilation of four U.S. Geologic Survey maps of the area that date between 1912 and 1930 (Waiākea – 1912, Mountain View – 1914, Olaa Back Road 1930, Piihonua – 1930). This map depicts the ʻŌlaʻa Mill located to the east of Keaau, with the Hilo Railroad connecting the mill to the town of Hilo. The Waiākea Mill is located off the map to the north, inland of Hilo Bay. The Waiākea Plantation Railroad extends to the east from this mill, with offshoot branches that continue to the traverse the area, terminating just north of the WTMA. Several plantation camps are located along the rail lines, providing housing for the plantation workers.

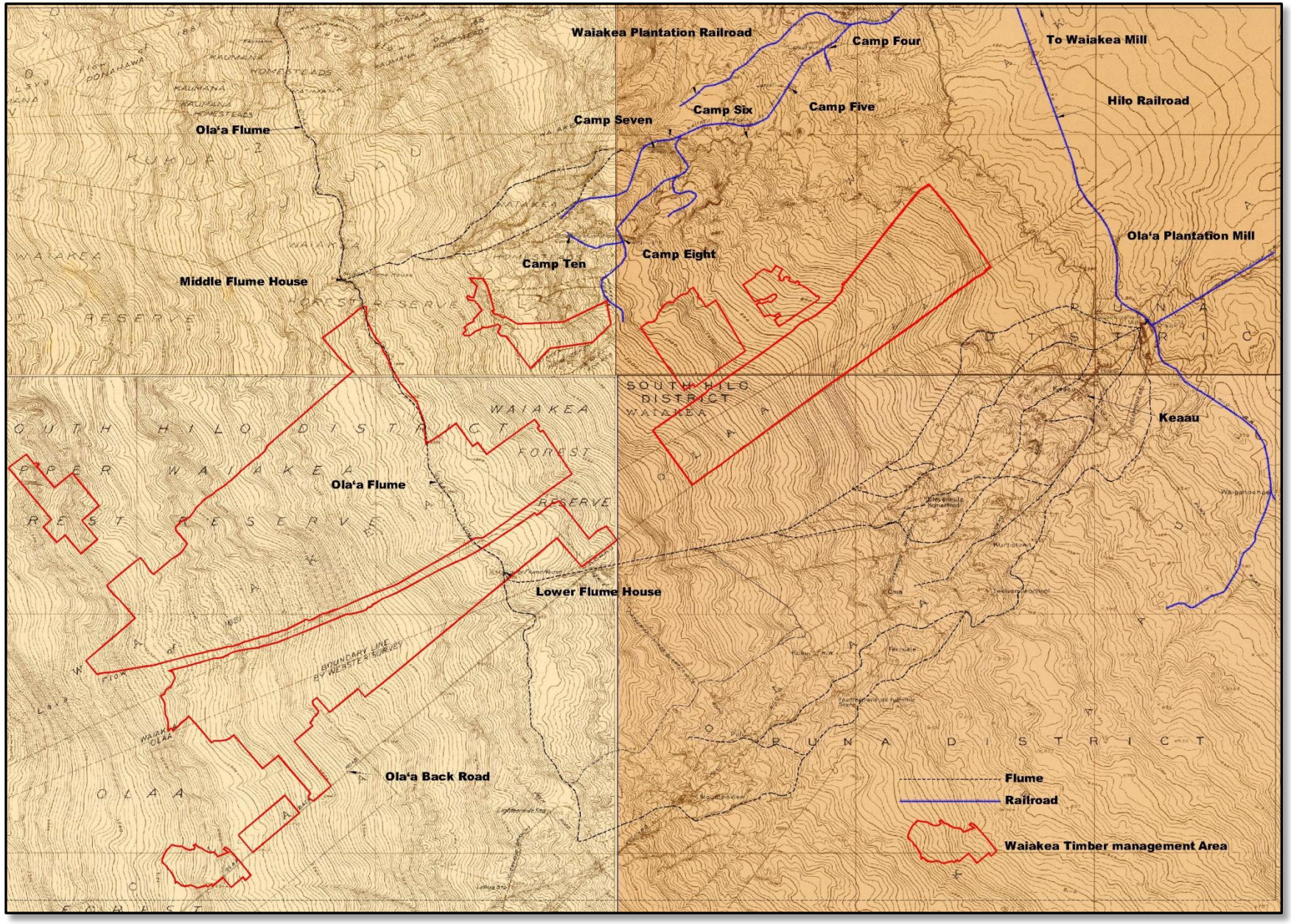

Figure 18. Compilation map of 1912-1930 U.S. Geologic Survey Maps

The ʻŌlaʻa Flume passes through the WTMA in a north-south direction and angles to the southeast, terminating at the ʻŌlaʻa Mill. The flume fed an extensive network of smaller ditches that branch out and provided water to the plantation. Two flume houses that direct the flow of water are located on the main ditch line. The Lower Flume House is located within the boundaries of the WTMA and the Upper Flume House is situated to the north. The ʻŌlaʻa Flume originates in upper Kaumana at the ʻŌlaʻa Flume Spring located in Punahou Ahupuaʻa 2 at approximately 1,980 ft elevation (*Figure 19*). The ʻŌlaʻa Back Road extends from the flume to the southwest, passing through and long the southern side of portions of the WTMA.

While sugarcane was the dominant industry in the area, other agricultural pursuits were being undertaken at the turn of the 20th Century. According to Baldwin:

> The Olaa section of Puna is a fine agricultural region, but owing to the want of a market, small truck farming does not pay. However, vanilla, tobacco, pineapples, and bananas grow well; and the rubber industry is destined to be an important one, as the climate is particularly well adapted to the growth of rubber trees. The cultivation of coffee in Olaa has been abandoned, as the trees did not thrive.
>
> All the lower lands of Olaa are planted with the cane of the Olaa Sugar Company. This is one of the largest plantations on Hawaiʻi, and occupies nearly all of the available cane land of the Puna district… (1908:78-79)

The Stainback Highway extends through the WTMA in a northeast by southwest direction. According to Hammatt and Bush, this road was constructed by the Territorial Department of Institutions in 1945 and was used to provide access to the Kulani Prison (1999a:12). The prison was subsequently renamed the Kulani Honor Camp and is currently referred to as the Kulani Correctional Facility. The following description of the road's construction, from a 1945 Honolulu Advertiser article, is presented in Hammatt and Bush:

> Hacking out the land for the new Kuulani [sic] Prison is a rough job and the date of its completion would be a risky conjecture, according to Thomas Vance, Director of Institutions, who recently returned from Hawaiʻi where he observed the completed five mile stretch of road to the site.
>
> "Eight operational days were spent in building the first five miles with one bulldozer" he said, "but with two bulldozers and good weather we should cut our work in half."
>
> "Barring delays, the 10-mile road, the first step to completion of the prison project, should be completed in six weeks," he said. (1999a:12).

The Stainback Highway was named for former State Governor Ingram M. Stainback who was instrumental in annexing the Kulani Prison lands from the Upper Waiākea and Olaa Forest Reserves and setting aside the lands to the Department of Institutions for the Kulani Prison Farm (Maly and Maly 2004:98).

Previous Archaeological Research

A search of the DLNR-SHPD archaeological report database and other sources identified more than 40 archaeological projects that have been conducted in Waiākea and ʻŌlaʻa Ahupuaʻa. The majority of these studies are located in the seaward portion of Waiākea below 200 ft elevation. Several studies were conducted in the vicinity of the WTMA. The locations of these studies are depicted in *Figure 20* and they are described below.

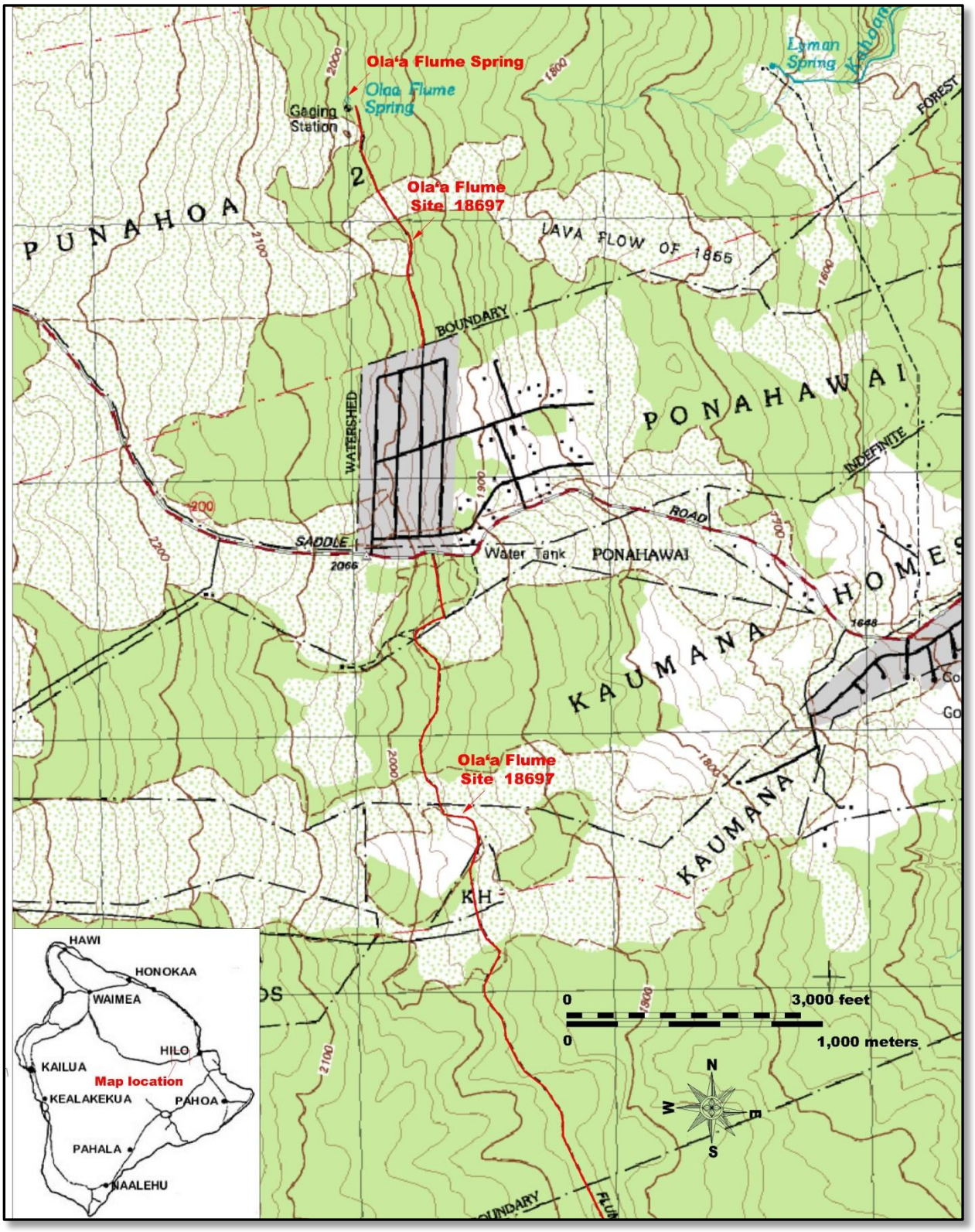

Figure 19. Portion of 1997 7.5' Piihonua quadrangle showing ʻŌlaʻa Flume and Spring

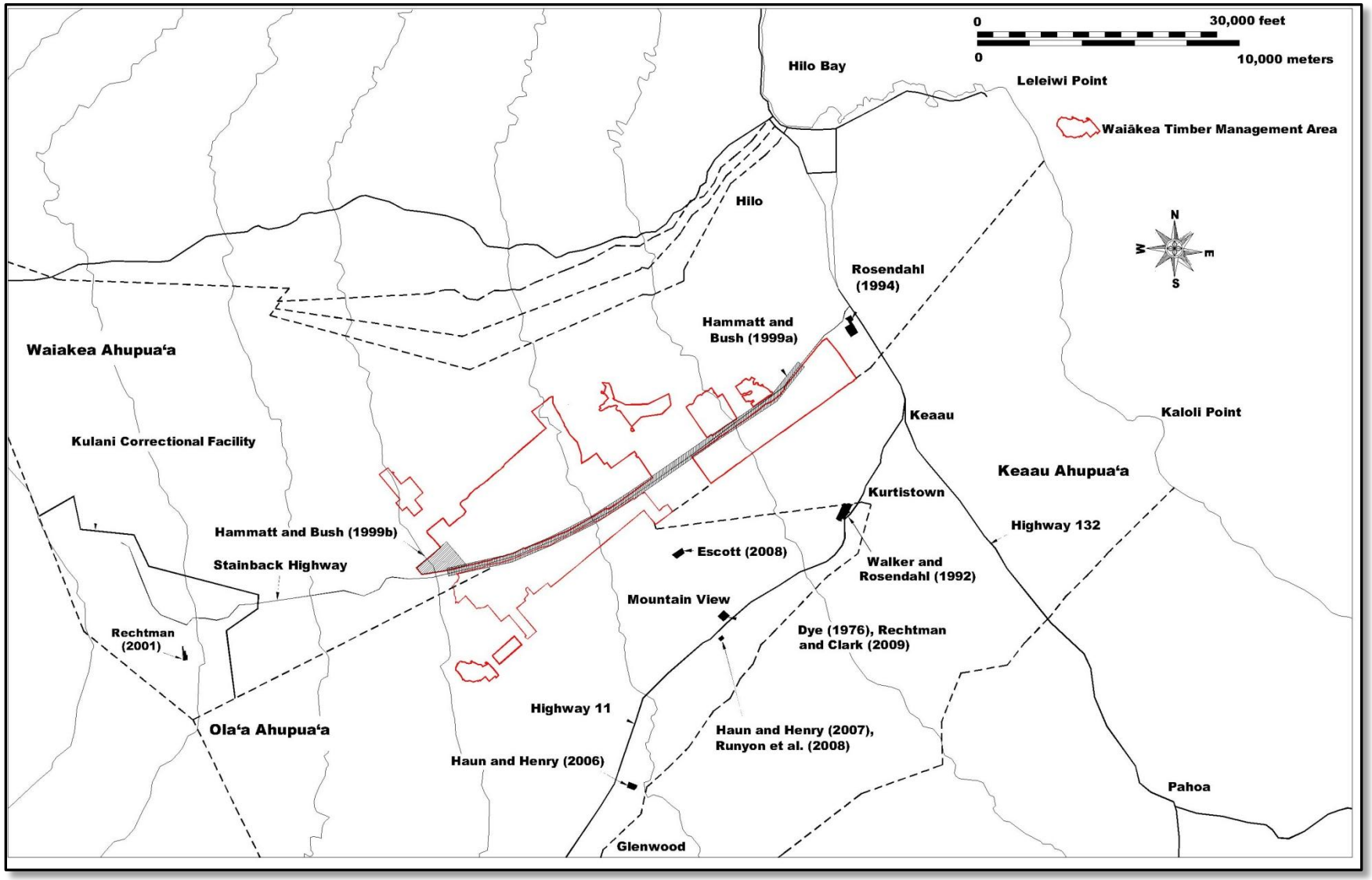

Figure 20. Previous archaeological work

Not included in *Figure 20* are the studies by Stokes (Stokes and Dye 1991), which focused on major sites, primarily *heiau* throughout Hawai'i Island, a survey of east Hawai'i by Hudson (1932), the fishpond study of Kikuchi (1973), and the general, primarily archival, studies of McEldowney (1979) and Moniz (n.d.). Stokes (Stokes and Dye 1991:155), relying in part on the earlier observations of Thrum, listed 11 *heiau* for the Hilo area, including five in North Hilo (Mamala, Lonopūha, Kama'o, Papaulekei'I, Moeapuhi) and six in the South Hilo (Kanoa, Pinao, Kaipalaoa, Kiniailoa, Ohele and Kahinihini'ula - *Figure 21*). A total of ten *heiau* were noted in the Puna District, including nine named (Kuki'i, Mahinaakaaka, Kumakaula, Niukukahi, Kekaloa, Waiaka Punalu'u, Waha'ula and Makaoiki) and one unnamed *heiau* (*Figure 22*). None of the *heiau* are located in the vicinity of the WTMA.

Three studies have been conducted within or immediately adjacent to the WTMA. These include a field inspection reported by Nagata (1985) and two inventory surveys conducted by Cultural Surveys Hawai'i, Inc. (Hammatt and Bush 1999a and 1999b; CSH). On February 12, 1985, a cave in TMK (3) 2-4-08:022, in the seaward portion of the WTMA was examined by State staff archaeologist, Wendall Kam (Nagata 1985). This cave was discovered by the director of the Hawai'i County Economic Opportunity Council, Mr. George Yokoyama during examination of a planned agricultural area.

Although the cave was not mapped, it was determined to be approximately 150 feet long and 20 feet wide. Two adult human burials were found in the cave with no other evidence of cultural modification. It was recommended that a 75 foot buffer zone be established around the cave entrance and that all vehicular traffic in the area be restricted to prevent damage to the site. The cave was subsequently assigned State Inventory of Historic Places (SIHP) Site No. 50-10-35-18697.

In 1999, CSH conducted an archaeological inventory survey of the Stainback Highway in conjunction with proposed improvements to the road (Hammatt and Bush 1999a). The road corridor examined during this project extends through the WTMA in a northeast by southwest direction. The project was conducted in three phases: (a) an aerial survey by helicopter; (b) a pedestrian survey that extended 20 to 40 feet beyond the pavement edge on either side of the road and (c) examination of several lava tubes located outside the road corridor.

No archaeological sites were found during the survey; however, 25 non-cultural features were identified although none are located within the boundaries of the WTMA (*Figure 23*). The majority of the features (17) consist of small lava blisters (Temporary Sites CSH-1, 2, 5-7, 9, 10, 12, 13, and 16-23), with the remainder comprised of four lava tubes (CSH-3, 4, 8 and 11), two sinkholes with associated lava tubes (CSH-14 and 15), a possible stone alignment (CSH-24) and a pavement area (CSH-25). The 23 blisters and tubes contained no indigenous cultural remains or modification and were interpreted as natural features. Most were breached during the construction of Stainback Highway. One of the sinkhole tubes (CSH-15) was used as a trash dump in recent years based on the presence of approximately 100 plastic bags of garbage.

CSH-24 is a circular stone alignment that Hammatt and Bush postulate may be a modern burial. A pot with flowers in it was present on top of the alignment with a note to "Dad" placed inside. A pig skull was noted adjacent to the flower pot. CSH-25 is adjacent to a section of the Stainback Highway that is 12 feet wider than the rest of the road. Research conducted by Hammatt and Bush (1999a:22) indicate that this wider section may have been a small aircraft landing strip associated with the Kulani Honor Camp.

Five additional lava tubes located outside the Stainback Highway corridor were also examined by Hammatt and Bush (1999a). These tubes were previously noted by entomologists conducting research in conjunction with a proposed new correctional facility to be located along the Stainback Highway (Howarth *et al.* 1999). The caves were named during the Howarth *et al.* The researchers named the caves "Powerline Cave", "Shelley's Cave #1", "Olona Cave", "Maze Cave" and "Hele-On Cave" (*see Figure 23*). Hammatt and Bush (1999a) explored each of these caves and no cultural remains or modifications were identified.

Hammatt and Bush (1999b) also conducted an inventory survey of the approximately 280 acre proposed New Hawai'i Island Correctional Facility, located along the northern side of Stainback Highway at the inland end of their

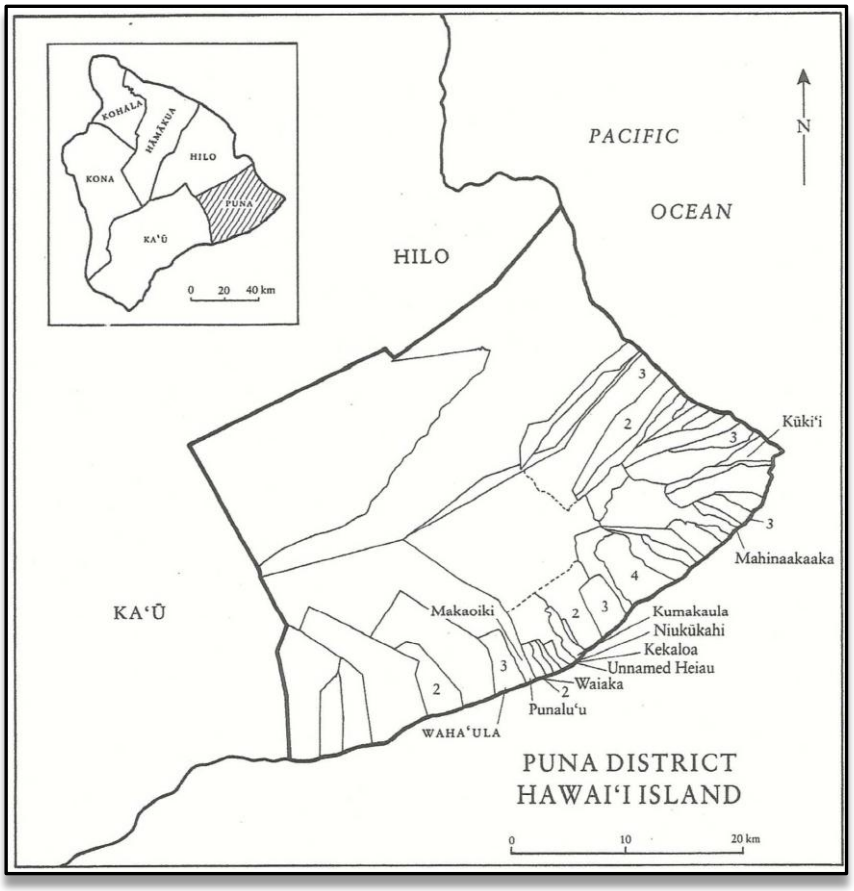

Figure 21. Heaiu in the Puna District (from Stokes and Dye 1991:137)

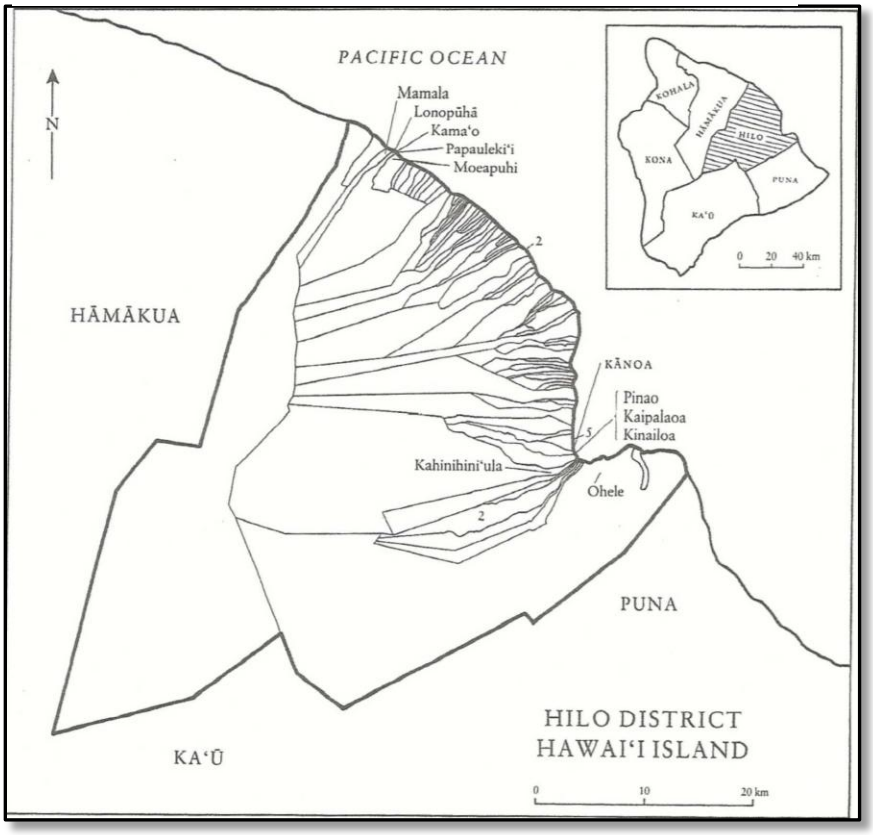

Figure 22. Heiau in the Hilo District (from Stokes and Dye 1991:155)

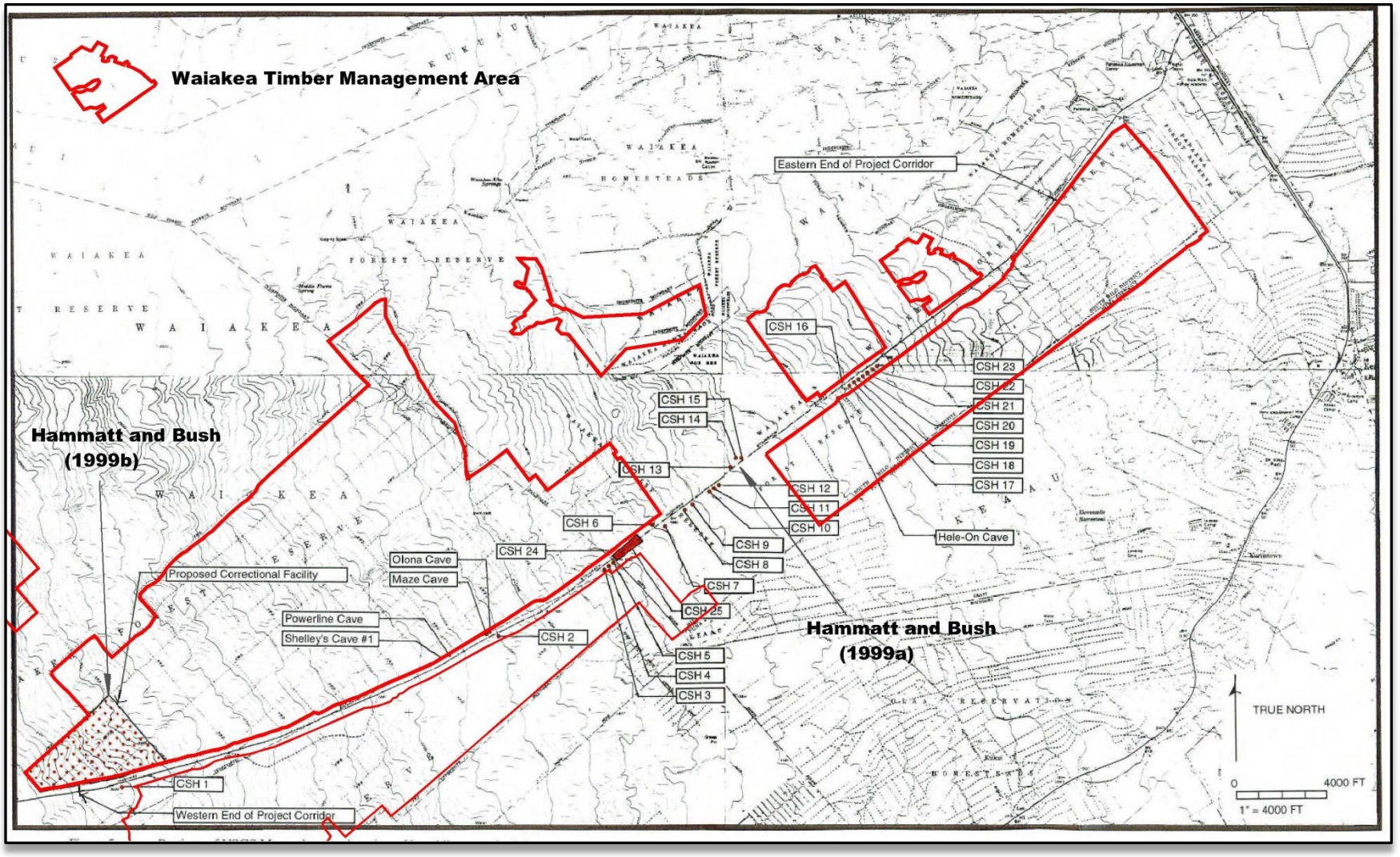

Figure 23. Cultural Surveys Hawaii, Inc. Stainback Highway site location map

Stainback Highway improvements project area (see *Figure 23*). This area is situated within the boundaries of the WTMA. The survey identified three lava tubes, but none had cultural remains or evidence of use. The remainder of the area was extensively impacted by bulldozer activity associated with reforestation efforts

Several other studies have been conducted in the general vicinity of the WTMA. In 1992, Paul H. Rosendahl, Inc. (PHRI) examined a 46.0 acre parcel located in ʻŌlaʻa Ahupuaʻa inland of Highway 11 in Kurtistown (Walker and Rosendahl 1992). This area was previously used for sugarcane cultivation and no sites or cultural remains were identified.

In 1994, PHRI undertook a field inspection of the proposed Hale Nani Annex of the Hawaiʻi Community Correctional Center (Rosendahl 1994). This area is situated along the inland side of Highway 11, approximately 700 m seaward of the WTMA between 250 and 290 ft elevation. The inspection identified a single mound interpreted as a possible prehistoric agricultural planting feature.

Rechtman (2001) conducted an inventory survey of a portion of the Kulani Correctional Facility located south of the Stainback Highway at approximately 5,100 ft elevation, situated 6 miles inland of the WTMA in Waiākea Ahupuaʻa. The project surveyed 6 acres within the facility for a proposed wastewater treatment plant. No archaeological sites or features were identified.

In 2006, Haun & Associates conducted an archaeological assessment of a 52.2 acre parcel seaward of Highway 11 in ʻŌlaʻa Ahupuaʻa (Haun and Henry 2006). A dirt road extended along one side of the parcel, following the route of the Old Volcano Trail. This road appeared to have been periodically maintained with earthmoving equipment that probably obliterated any physical evidence of the historic trail thus this segment of the road lacked any integrity and was not assigned a SIHP site number. No other sites were present in the parcel.

In 2007 Haun & Associates undertook archaeological monitoring of fencing installation at Mountain View Elementary School in ʻŌlaʻa Ahupuaʻa situated between 1,370 and 1,420 ft elevation (Haun and Henry 2007). Subsequent monitoring work was conducted at the school in 2008 by CSH (Runyon *et al.* 2008). No archaeological sites or features were identified during either project; however, these studies did provide a record of the soil stratigraphy in this area.

In 2008, Scientific Consultant Services, Inc. (SCS) conducted a field inspection of a 64.48 acre parcel in ʻŌlaʻa Ahupuaʻa, inland of the Mountain View community (Escott 2008). In 2009, Rechtman surveyed a 1.2 acre parcel in ʻŌlaʻa Ahupuaʻa on the inland side of Highway 11, opposite the Mountain View Elementary School (Clark and Rechtman 2009). No sites were identified during either project.

In summary, the previous archaeological studies conducted in the vicinity of the WTMA only identified a single possible agricultural mound and a lava tube used for burial. This extremely low density of archaeological remains is attributed to the extensive ground altering disturbance associated with sugarcane cultivation that occurred seaward of the project area, clearing within the WTMA for reforestation, and the rugged nature of the terrain and the abundance of rainfall in the inland most areas that probably limited prehistoric settlement in the area.

McEldowney (1979) used limited site inventory and historic documentary evidence to develop a traditional Hawaiian land use and settlement pattern model for the Hilo area that is applicable to the WTMA. The model consists of five elevationally-defined zones: Coastal Settlement, Upland Agricultural, Lower Forest, Rainforest, and Sub-Alpine or Montane. The Coastal Settlement Zone extended approximately 0.5 miles inland from the shoreline between sea level and 50 ft elevation. The zone was the most densely populated with both permanent and temporary habitations, high status chiefly residences, and *heiau*. Settlements were concentrated at Hilo Bay and sheltered bays and coves. Also present were fishponds and gardens where breadfruit, coconut, *kukui*, banana, *wauke*, sugar cane, sweet potato, and wet and dryland taro were cultivated. The ocean provided fish and other marine resources.

The Upland Agricultural Zone was situated between approximately 50 ft and 1,500 ft elevation. Settlement in the zone was characterized by scattered residences among economically beneficial trees and agricultural plots of dryland taro and bananas. Lava tubes were utilized for shelter. A pattern of shifting cultivation is believed to have converted the original forest vegetation to parkland of grass and scattered groves of trees. Wetland cultivation of taro occurred along streams.

The Lower Forest Zone ranged from 1,500 ft to 2,500 ft elevation. Timber and other forest resources such as medicinal plants, *olona*, and birds were gathered from the zone. Site types consisted of temporary habitations, trials, shrines, and minor agricultural features in forest clearings and along streams. Sites in the Rainforest Zone (2,500-5,000 ft elevation) and Subalpine or Montane Zone (5,000-9,000 ft) were limited to trails and associated temporary habitations. These zones were used for intra-island travel and gathering of valued resources including hardwoods, birds, and stone for tool making.

The WTMA ranges in elevation from approximately 360 feet in the seaward, eastern portion to 3,250 feet in the inland, western portion (*Figure 24*). This elevation range spans three of McEldowney's (1979) settlement pattern zones: the Upland Agricultural Zone, the Lower Forest Zone and the Rainforest Zone (*Table 8*).

Table 8. Project area elevation zones

McEldowney's (1979) Zone	Acres within project area	% of project area
Upland Agricultural (50-1,500 ft)	3,224	26
Lower Forest (1,500-2,500 ft)	5,830	46
Rainforest (2,500-5,000 ft)	3,452	28
Total	12,506	100

The majority of the project area lies within McEldowney's Lower Forest Zone between 1,500 ft and 2,500 ft elevation (5,830-acres, 46% of project). This zone was the source for timber and other forest resources such as medicinal plants, *olona*, and birds. Predicted site types consist of temporary habitations, trials, shrines, and minor agricultural features in forest clearings and along streams.

The Rainforest Zone comprises 28% of the project area (3,452-acres). Sites in this area would likely be limited trails and associated temporary habitations. This zone was used for intra-island travel and gathering of resources including hardwoods and birds. Sites in the Upland Agricultural Zone (3,224-acres, 26%) would likely consist of trails and associated temporary habitation sites such as lava tubes.

Sites present within the Waiākea Timber Management Area

Based on a review of historical documentary research and previous archaeological work, three archaeological sites are known to exist within the WTMA (*Figure 25*). These include a burial cave, an historic road and an irrigation flume with associated features. The cave containing human remains (SIHP Site 50-10-35-18697) is present in the southeastern portion of the project area and was identified in the mid-1980s (Nagata 1985). The studies by Hammatt and Bush (1999a and 1999b) identified 26 lava tubes immediately adjacent to the WTMA (see *Figure 23*); however none of these subterranean features contained cultural materials or evidence of historic/prehistoric use.

A portion of the historic ʻŌlaʻa Flume extends through the central portion of the WTMA, roughly following the 1,800 ft contour. The main flume originated at the ʻŌlaʻa Flume Spring, located north of the WTMA in Punahou 2 Ahupuaʻa. The flume extended downslope to the ʻŌlaʻa Mill located seaward of Keaʻau town, with numerous branches that provided irrigation water throughout the plantation. The ʻŌlaʻa Flume Trail/Road parallels

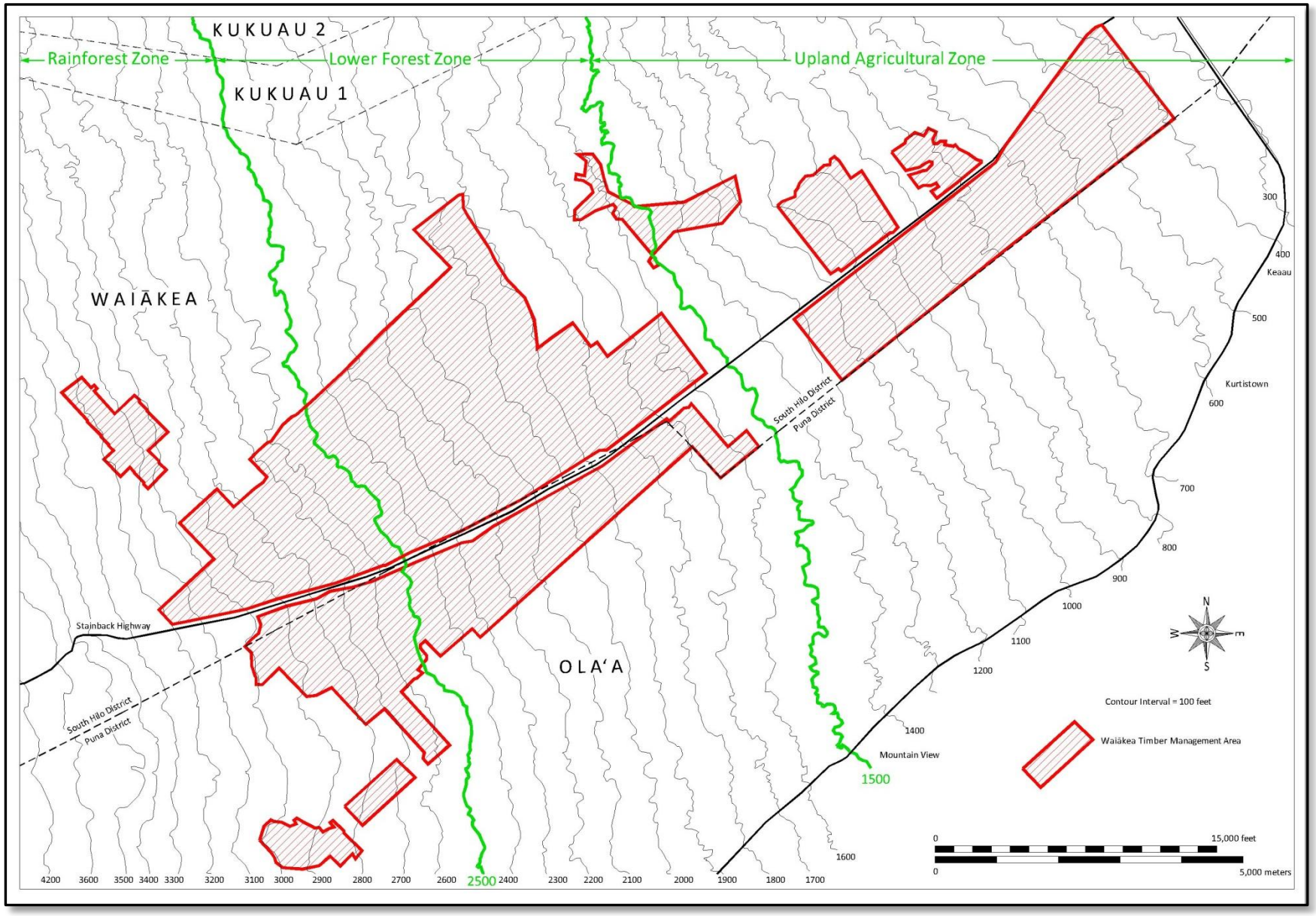

Figure 24. Elevation zones within the Waiākea Timber Management Area

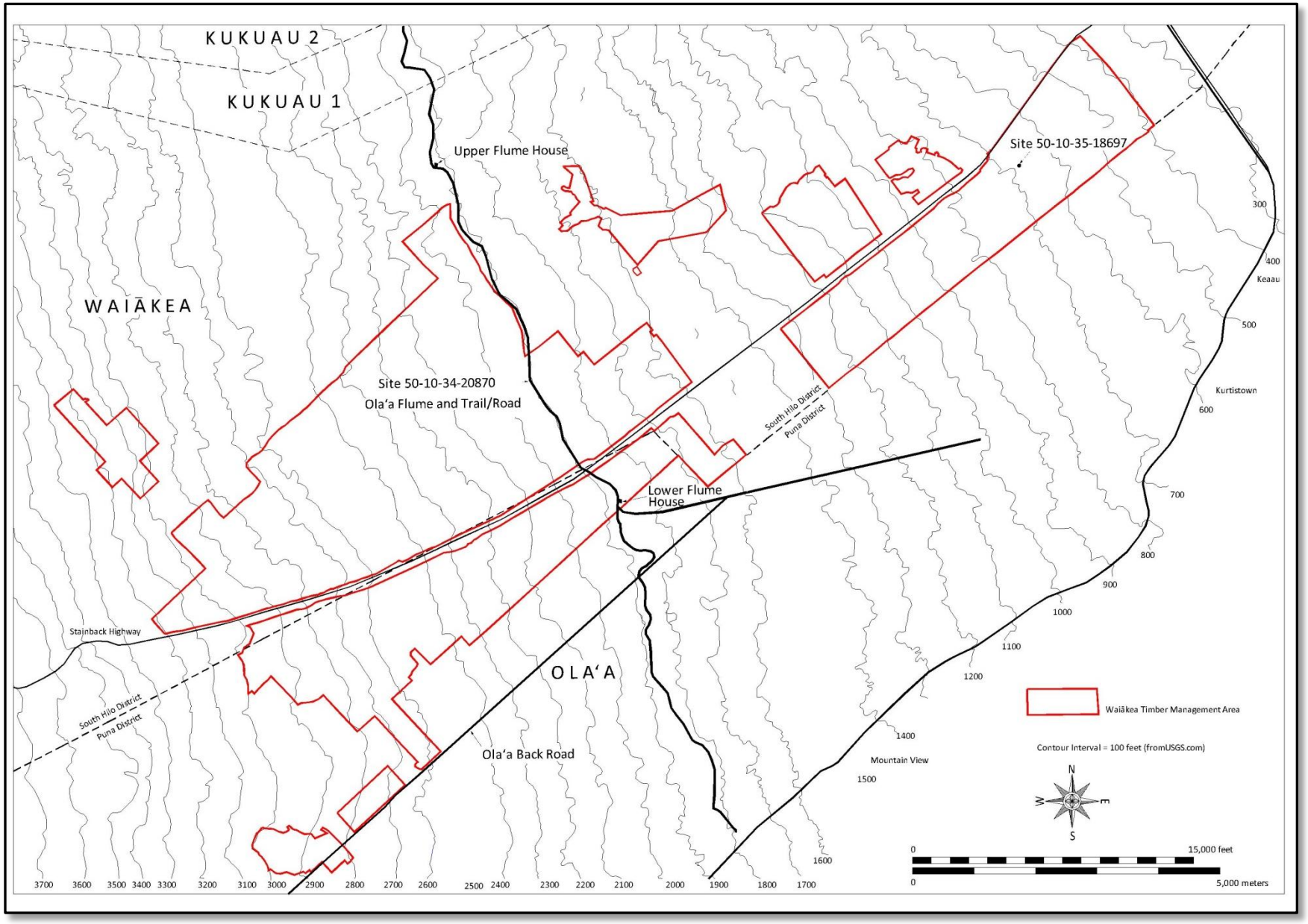

Figure 25. Known sites within the Waiākea Timber Management Area

the flume and was used to maintain the irrigation system. A section of the flume was identified during an archaeological survey conducted in conjunction with improvements to the Saddle Road and was designated SIHP Site 50-10-34-20870 (Langlas *et al.* 1997).

As depicted in *Figure 25,* two flume houses (Upper and Lower) used to control the flow of water were located along the ʻŌlaʻa Flume. The Lower Flume House is situated within the WTMA in ʻŌlaʻa Ahupuaʻa at approximately 1,875 ft elevation. The Upper Flume House is situated outside the project area approximately 700 meters north of the WTMA.

A review of historic maps of the area indicate that a portion of the ʻŌlaʻa Back Road extends through or along the boundary of the WTMA. This road extended out of the Olaa Lots area and was likely used by the inhabitants of this subdivision. The presence of the road on the early 20th Century map of the area (see *Figure 18*) indicates its historic origin.

CONSULTATION

This AIS Plan was prepared in consultation with DOFAW and DLNR-SHPD. The consultation will ensure that the work complies with applicable laws, regulations and rules. This consultation also will ensure that the Plan reflects a mutually acceptable scope of work for the AIS fieldwork prior to implementation. The consultation process, which is an ongoing process that will continue concurrently with the AIS tasks, also will require input from interested organizations and individuals, including the local community and individuals knowledgeable about WTMA cultural resources and land use history. Results of the consultation process will be incorporated into the AIS Report.

Agency consultation done in conjunction with preparation of the AIS plan included meetings with DOFAW Forestry Program Manager Sheri Mann on July 19, 2013 in Honolulu, DOFAW Hawaii Branch Forestry Manager Steve Bergfeld in Hilo on August 21, 2013, and SHPD Archaeology Branch Chief Theresa Donham in Hilo on August 21, 2013. DOFAW Honolulu staff provided background reference documents, GIS mapping data on the WTMA, and details concerning the planned timber harvesting. DOFAW Hilo staff provided information on access, current public recreational use, and updated information on harvesting potential and future planting areas. SHPD staff provided information on previously identified sites in the vicinity of the project area and recommendations regarding the AIS sampling strategy.

Kepa Maly of Kumu Pono Associates LLC previously conducted an interview with an individual with knowledge of the WTMA vicinity. Mr. Ralph Daehler was interviewed by phone on June 9, 2004 in conjunction with a cultural study of the Puʻu Makaʻala Natural Area Reserve located adjacent to the WTMA to the west. Mr. Daehler worked to develop the state's reforestation program in the early 1960 and provided insight into the naming of a hill (*puʻu*) and general background on the WTMA area. According to Maly and Maly:

> The name "Puʻu Makaʻala" was given to the *puʻu* and forest area in 1961 or 1962, when Ralph Daehler was working on the Board of Agriculture and Forestry's Reforestation Program. Mr. Daehler recalled that at the tiem (sp.), he was working with old quad maps and aerial photos, identifying areas in which reforestation projects could be developed, and through the photos—the *puʻu* did not appear on old quad maps—he noticed this *puʻu*, which looked very interesting to him. From the photo, it appeared to him that the hill would offer anyone who traveled to it, a great view of all the surrounding lands, and out to the coast of Hilo and Puna.
>
> Mr. Daehler looked around for *kamaʻāina* to see if anyone knew the name of the *puʻu*, but could find no one familiar with it. During this time, L.W. Bryan had been the Forester, and was just retiring, and Max Landgraf took over. Max's nick name was *Maka* (eye), because he could see things all over. Mr. Daehler found that the word *ala* with *maka*, could mean wide open or imply a lookout point, so he settled on naming the site Puʻu Makaʻala (interpreted as Lookout Hill).

Shortly thereafter, USGS was updating its' quads and contacted him about the region in which the *pu'u* is situated. He explained that he had found no name for the *pu'u*, but that he had called it Pu'u Maka'ala for the forestry program. He recalled being surprised later, to find that on the next quadrangle, the name Pu'u Maka'ala appeared in print.

Mr. Daehler never had the opportunity to actual travel to the *pu'u*, as he was transferred to Kaua'i a shoret (sp.) while later. It had been his goal to establish a trail to the *pu'u*, which he believed would be of interest, and provide travelers with a great view of the region. In his review of the maps and photos, he had determined a couple of possible approaches to the *pu'u*. One of the approaches being from the old Olaa Back Road—which was all overgrown—and which ran out of the old Olaa Homesteads. He recalled also, that while researching the area, he had been surprised to learn that so much of 'Ōla'a had been subdivided into homestead lots, and that many of the homesteaders had been of Galician origin.

Mr. Daehler also recalled that in those early years, the Board of Agriculture and Forestry had a strong component of land development for agricultural purposes. At the time the Board's Reforestation Program began, a number of people had been calling for the Pana'ewa-'Ōla'a forest lands to be cleared for agricultural purposes. The early reforestation program, through planting a number of fast growing introduced species, helped to save much of the area for present-day and future conservation programs and public interest (Maly and Maly 2004:121).

RESEARCH DESIGN

The proposed AIS field work will consist of documenting previously identified sites and a 5% sample survey of the project area. The previously identified sites are the Ola'a Flume (Site 50-10-34-20870), the Site 50-10-35-18697 burial cave, and the Ola'a Back Road. The 12,506-acre WTMA project area contains several areas that will be excluded from the area to be sampled (*Figure 26*). These areas are 814 acres of the 1,201 acres planted in native hardwoods[1] and 28-acres of experimental hardwoods, which will not be harvested, 349 acres of block roads, 285 acres of former sugarcane lands, and a 35 acre staging area that was previously developed. The exclusion of these areas reduces the area to be sampled by twelve percent from 12,506-acres to 10,995 acres. The proposed AIS five percent sample survey area will encompass 549 acres of the remaining 10,995 acre project area. DLNR-SHPD requested that two-thirds of the sample be located below 2,500 ft elevation and the remaining one-third located above 2,500 ft.

The proposed AIS sample is a judgmental quadrat design that is based on obtaining a representative sample of three primary environmental variables: elevation, soil type, and lava flow age. Elevation-based sampling also captures variability in rainfall and temperature in the WTMA area where these variables are directly related to elevation. The proposed AIS sample also includes areas that were mechanically cleared for planting and areas cleared by other means. As discussed by McEldowney (1979), traditional Hawaiian settlement patterning in the Hilo area, including the WTMA can be characterized in terms of five elevationally-defined zones: Coastal Settlement, Upland Agricultural, Lower Forest, Rainforest, and Sub-Alpine or Montane. The project area contains portions of McEldowney's Upland Agricultural, Lower Forest, and Rainforest Zones.

According to Sato *et al*. (1973) the majority of the soils in the WTMA are shallow muck deposits overlying lava substrate (11,169 acres or 89.3%). The remaining 1,580 acres (10.7%) consist of one to two layers of silt clay loam over fragmental a'a or pahoehoe lava, or a subsoil of decomposed lava. The underlying lavas in the area were

[1] According to DOFAW staff, a 387 acre, roughly triangular area along Stainback Highway at the northeastern edge of the project area that is color-coded as "Native Hardwoods" on Figure 10 potentially will be replanted because the native species are not well established there.

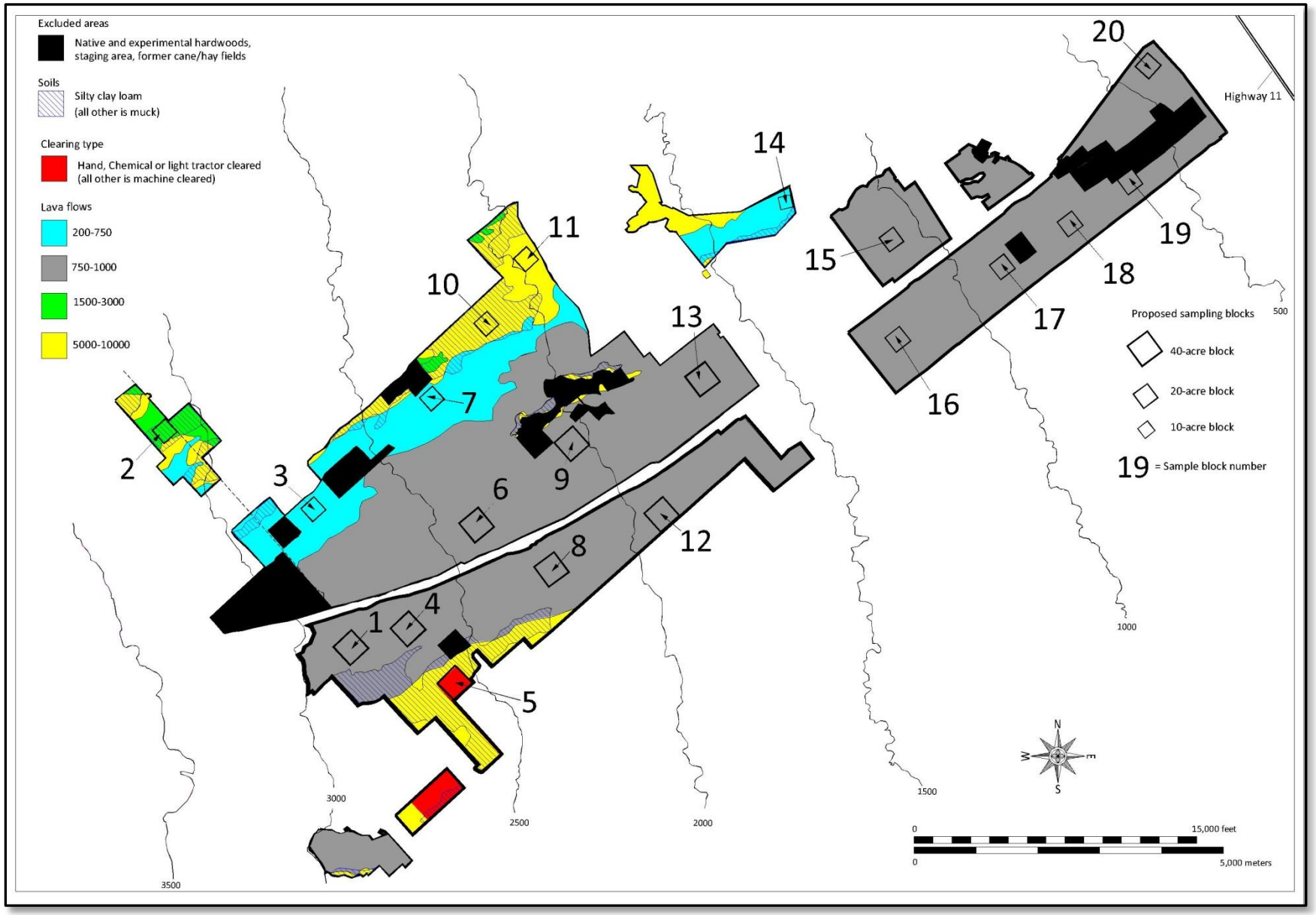

Figure 26. Environmental variables and proposed sampling blocks

deposited from Mauna Loa Volcano between 200 and 10,000 years ago. The majority of the area is characterized by lava flows that date to between 750 and 1,500 years ago (8,878 acres, 71% of the project area). This is followed by 5,000-10,000 year old flows (1,940 acres, 16%), 200-750 year old flows (1,552 acres, 12%) and 1,500-3,000 year old flows (136 acres, 1%).

As indicated in *Table 2,* nearly all of the areas planted within the WTMA were mechanically cleared. Only 124 acres were not machine-cleared consisting of 84 acres cleared by hand and 4 acres cleared either by hand, chemical or light tractor.

Table 9 summarizes environmental variables within the entire 12,506 acre WTMA that are potentially predictive for settlement patterning. These variables are soil type (shallow muck or silty clay loam), lava flow age, and McEldowney's elevation-based settlement zone. The mode of reforestation-related land clearing is also included because its potential effect on site distribution. The table subdivides the data into areas below and above 2,500 ft elevation and gives the percentage composition based on the total acreage within each subdivision in 500 ft elevation range increments. These percentages are used to determine the acreage of the proposed AIS sample by elevation range increment. These acreages are rounded to multiples of 20 acres to facilitate fieldwork because much of the WTMA is divided into 40 acre blocks. The distribution of the environmental variables is depicted in *Figure 26.*

Table 9. Environmental variables within the WTMA

Elevation Zone	Elev. Zone Acreage	Elev. Zone Percent	AIS sample acreage by elevation zone %	AIS Sample Rounded to multiple of 20 acres	Acreage by McEldowney Zone			Soil type (acres)		Age (BP) and acreage of lava flows				Acres Cleared by hand, chemical or light tractor*
					Upland Agriculture	Lower Forest	Rainforest	Shallow muck	Silty clay loam	200-750	750-1000	1500-3000	5000-10000	
Below 2500 ft elevation (70% of AIS sample = 382 acres)														
0-500	507	5	**19**	**20**	487			507			507			
500-1000	1715	18	**69**	**60**	1612			1715			1715			
1000-1500	1187	13	**50**	**40**	1125			1167	20	161	993		33	
1500-2000	2196	24	**92**	**100**		2157		2069	127	107	1692		397	
2000-2500	3701	40	**153**	**160**		3673		3136	565	596	2426	56	623	
Sub-Total	**9306**	**100**	**382**	**380**	**3224**	**5830**		**8594**	**712**	**864**	**7333**	**56**	**1053**	
Above 2500 ft elevation (30% of AIS sample = 164 acres)														
2500-3000	2760	86	**141**	**140**			2969	2277	483	584	1431	11	734	124
3000-3500	440	14	**23**	**20**			483	298	142	104	114	69	153	
Sub-Total	**3200**	**100**	**164**	**160**			**3452**	**2575**	**625**	**688**	**1545**	**80**	**887**	**124**
Grand Total	**12506**	**200**	**546**	**540**	**3224**	**5830**	**3452**	**11169**	**1337**	**1552**	**8878**	**136**	**1940**	**124**

* All other areas machine-cleared

Using the elevation-based AIS sample acreage breakdown discussed above, 20 proposed AIS sample survey blocks were positioned based on elevation, lava flow age and soil type (*Table 10*). The blocks range from 10 to 40 acres in area and comprise a total of 550 acres. The proposed locations of the blocks are approximate and based on data currently available. The precise locations will be adjusted if necessary during the AIS survey based on accessibility and other field conditions.

Table 11 compares the acreage and percentage composition of the environmental variable for the entire WTMA with the proposed sample for the AIS. The percentages demonstrate the representativeness of the proposed AIS sample.

The sample blocks will be subjected to 100% surface pedestrian survey with surveyors spaced no more than 10 meters apart. Site documentation will consist of preparing scaled plan maps, photographic documentation, completing standardized site and feature forms, and evaluating site condition and physical integrity. If lava tubes are encountered during the course of fieldwork, they will be thoroughly explored and documented using laser distance meters, compasses, and hand held tape measures. In order to ensure the protection of survey personnel

Table 10. Summary of proposed sample blocks

Sampling block	Acreage	Elevation range (ft)	Soil	Lava flow age (BP)	Clearing type
1	40	2500-3000	Muck	750-1000	Machine
2	20	>3000	Silty clay loam	1500-3000	Machine
3	20	2500-3000	Muck	200-750	Machine
4	40	2500-3000	Muck	750-1000	Machine
5	40	2500-3000	Silty clay loam	5000-10000	Hand, chemical or light tractor
6	40	2000-2500	Muck	750-1000	Machine
7	20	2000-2500	Muck	200-750	Machine
8	40	2000-2500	Muck	750-1000	Machine
9	40	2000-2500	Muck	750-1000	Machine
10	20	2000-2500	Silty clay loam	5000-10000	Machine
11	20	1500-2000	Muck	5000-10000	Machine
12	40	1500-2000	Muck	750-1000	Machine
13	40	1500-2000	Muck	750-1000	Machine
14	10	1000-1500	Muck	200-750	Machine
15	20	1000-1500	Muck	750-1000	Machine
16	20	1000-1500	Muck	750-1000	Machine
17	20	500-1000	Muck	750-1000	Machine
18	20	500-1000	Muck	750-1000	Machine
19	20	500-1000	Muck	750-1000	Machine
20	20	<500	Muck	750-1000	Machine
Total	**550**				

Table 11. Comparison of environmental variables in WTMA and proposed AIS sample

AIS sample acreage compared with overall acreage by sample variables	Acreage by McEldowney Zone			Soil type (acres)		Age (BP) and acreage of lava flows				Acres Cleared by hand, chemical or light tractor*
	Upland Agriculture	Lower Forest	Rainforest	Shallow muck	Silty clay loam	200-750	750-1000	1500-3000	5000-10000	
Total acres	3224	5830	3452	11169	1337	1552	8878	136	1940	124
% of WTMA	26	46	28	89	11	12	71	1	16	0.99
Acres in proposed sample	130	260	160	470	80	50	400	20	80	40
% of proposed sample	24	47	29	85	15	9	73	4	14	7

during lava tube documentation, procedures outlined Haun & Associates' Safety Plan pertaining to confined spaces will be followed (**Appendix A**).

The location of any surface or subsurface sites or features identified during the AIS will be determined with the aid of a hand-held Global Positioning System (GPS) device using the NAD 83 datum. The accuracy of the GPS device for a single point will be less than one meter. Sites identified during the survey will be marked and their locations plotted on a scaled project area map. At the request of the DOFAW Hilo office staff, the survey transects will be marked with biodegradable flagging tape.

Subsurface testing of selected features will be undertaken if necessary to determine site/feature function. The units will be excavated in arbitrary levels within stratigraphic layers and will be terminated either on bedrock, within culturally sterile soil or upon the identification of human remains. Standardized excavation records will be prepared after the completion of each stratigraphic layer. The soil removed during excavation will be screened through ¼ "mesh. Portable remains collected will be placed in paper bags labeled with the appropriate provenience information. Charcoal

samples will be deposited in aluminum foil pouches and placed in properly labeled paper bags. Following the excavation, a section drawing depicting the stratigraphy will be prepared and post-excavation photographs were taken. Recovered cultural remains were transported to Haun & Associates' office for analysis.

DOFAW and DLNR-SHPD staff will be periodically briefed on the AIS fieldwork findings and status and will be notified immediately in the case of any unusual or highly significant findings. If human remains are identified during the fieldwork, DOFAW and DLNR-SHPD will be contacted. Following agency consultation and approval, the remains will be reburied (if discovered during test excavations) or otherwise protected to ensure the safety and security of the remains until appropriate treatment is determined. All remains will be treated as "previously identified" in accordance with HAR §13-13-300-31(b). Appropriate treatment will be determined through the preparation of a Burial Treatment Plan for review and approval by the DLNR-SHPD and the Hawai'i Island Burial Council (HIBC).

Following completion of fieldwork, analysis of all recovered remains and data will use standard archaeological methods. All recovered artifacts will be analyzed to determine morphological type, condition/degree of completion and material. Metric measurements will include weight, length, width, and thickness. Standard typological classifications will be used for all artifacts. Food remains will be identified to the Family level, or to the Genus/species level, when possible. Quantitative analysis will include a determination of total weight and total number of fragments (TNF) per taxon.

The resulting data will be presented in an AIS Report in conformance with regulatory agency requirements for archaeological inventory survey reports contained in HAR §13-13-276-5. The resulting data will be presented in the AIS report in conformance with regulatory agency requirements for inventory survey reports contained in HAR §13-276. The report will include descriptive information on all sites and features present in the project area, including site type and function, site descriptions, UTM coordinates, significance assessments and specific recommendations for any further archaeological work that might be required. This information will also be included in a geo-database that is compatible with the SHPD database currently under development.

The AIS report will discuss any deviations from the AIS plan and the reasons and rationale for those deviations. A discussion of the survey sampling strategy and predictions derived from it will also be presented. The report will include at least one geo-referenced site location map with the grid layout and designations devised by DOFAW for the Waiākea Timber Management Area overlain on it. The accuracy of the Global Positioning System (GPS) used in the field to generate UTM coordinates for the creation of this map will also be discussed.

Following review by DOFAW, the report would be submitted for DLNR-SHPD review and approval. The report would be promptly revised and resubmitted, if necessary, in response to Division comments.

REFERENCES

Baldwin, C. W.
1908 *Geography of the Hawaiian Islands*. American Book Company, New York.

Chinen, Jon J.
1958 *The Great Mahele: Hawai'i's Land Division of 1848.* University of Hawai'i Press, Honolulu.

Clark, M., and B. Rechtman
2009 An Archaeological and Limited Cultural Assessment for the proposed development of the Department of Water Supply's ʻŌlaʻa No. 6 Production Well and a 1.0 MG reservoir, Kalana of ʻŌlaʻa, Puna District, Island of Hawai'i. (TMK: 3-1-8-01:45 and 50). Rechtman Consulting Report RC-0635 prepared for Planning Solutions, Inc., Honolulu, HI.

Division of Forestry
1961 Five-Year State Forest Planting Plan for State of Hawai'i. FY 1962-1966. Division of Forestry, Department of Agriculture and Conservation. March 1961.

1966 Forestry Planting Plan, Fiscal Years 1967-1971. State of Hawai'i, Department of Land and Natural Resources, Division of Forestry, February 1966.

1971 Forestry Planting Plan, Fiscal Years 1972-1976. State of Hawai'i, Department of Land and Natural Resources, Division of Forestry, July 1971.

Dorrance, William H.
2000 *Sugar Islands: The 165-Year Story of Sugar in Hawai`i* . Mutual Publishing, Honolulu.

Dye, T.
1976 An Archaeological Reconnaissance Survey of Planned Flood-Control Improvement Areas in Mountain View, Hawai'i (TMK: 1-7 and 1-8). Bishop Museum project 161. Prepared for Joerger-Takemoto Historical Research.

Escott, G.
2008 A Field Inspection of 68.48 Acres Located in Mountain View, ʻŌlaʻa Ahupuaʻa, Puna District, Island of Hawai'i [TMK: (3)-1-7-17:170]. Scientific Consultant Services, Inc. Report 947-1. Prepared for Mr. Peter Field, Kaneohe, HI.

Ellis, W.
1963 Journal of William Ellis, Narrative of a Tour of Hawai'i, or Owhyee…Honolulu: Advertiser Publishing Company.

ESRI website
2013 http://www.esri.com/

Hammatt, H. and A. Bush
1999a Archaeological Inventory Survey for the proposed Stainback Highway Improvement Project, Waiākea, South Hila, Island of Hawai'i (TMK 2-4-008). , Cultural Surveys Hawai'i, Inc., Kailua.

1999b Archaeological Inventory Survey for the Proposed New Hawai 'i Island Correctional Facility, Waiākea, South Hila, Island of Hawai'i (TMK 2-4-00S:por. 1), Cultural Surveys Hawai'i, Inc., Kailua.

Haun, A., and D. Henry
2006 Archaeological Assessment, TMK: 3-1-8-08:007, Land of ʻŌlaʻa, Puna District, Island of Hawaiʻi. Haun & Associates Report 433 prepared for Mr. Brian Nishimura, Hilo, Hi.

2007 Archaeological Monitoring Report, Chain Link Fencing for Mountain View Elementary School, Land of ʻŌlaʻa, Puna District, Island of Hawaiʻi. Haun & Associates Report 515 prepared for Inaba Engineering, Inc., Hilo HI.

Howarth, F, R. Cowie, D. Preston, R. Englund, R. Rundell, F. Stone and S. Montgomery
1999 Proposed New Hawaiʻi Correctional Facility, Waiākea, South Hilo, Island of Hawaiʻi, Assessment of Potential Impacts on Invertebrates (Snails, Insects and other Anthropods) of Proposed Improvements to Stainback Highway. Bishop Museum Report to Wilson Okamoto, Inc., Honolulu.

Hudson, A.E.
1932 Archaeology of East Hawaiʻi. B.P. Bishop Museum Manuscript. Honolulu.

Kelly, M., B. Nakamura and D.B Barrere
1981 Hilo Bay: A Chronological History, Land and Water Use in the Hilo Bay Area, Island of Hawaiʻi. Prepared for U.S. Army Engineer District, Honolulu.

Kent, Noel J.
1983 *Hawaiʻi: Islands Under the Influence.* Monthly Review Press, New York.

Kikuchi, W.K.
1973 Hawaiian Aquacultural Systems. Ph.D. Dissertation, University of Arizona.

Kuykendall, Ralph S. and A.G. Day
1976 *Hawaiʻi: A History from Polynesian Kingdom to American State.* Prentice-Hall, Englewood.

Langlas, C., T. Wolforth, J. Head and P. Jensen
1997 Archaeological Inventory Survey and Historic and Traditional Cultural Assessment of the Hawaiʻi Defense Access Road A-AD-6 (1) and Saddle Road (SR) 200 Project, Districts of South Kohala, Hamakua, North Hilo and South Hilo, Island of Hawaii. PHRI Report 1522-022897 prepared for RUST Environmental & Infrastructure, Inc.

McEldowney, H.
1979 Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study, Hilo, Hawaiʻi. Prepared for the U.S. Army Engineer District, Honolulu. Department of Anthropology. Bishop Museum.

Maly, K and O. Maly.
2004 *He Moʻolelo ʻĀina*: A Cultural Study of the Puʻu Makaʻala Natural Area Reserve, Districts of Hilo and Puna, Island of Hawaiʻi. Kumu Pono Associates, LLC Report HINARS80-Makaala. Prepared for Department of Land and Natural Resources, Natural Area Reserves, Hilo, HI.

Moffat, Riley M. and Fitzpatrick, Gary L.
1995 *Surveying the Mahele: Mapping the Hawaiian Land Revolution. Palapala`äina.* Editions Limited, Honolulu.

Moniz, J.J.
n.d. Historical and Archaeological Synthesis of Land Use and Settlement Patterns, Waiakea Ahupuaʻa, Hilo District.

Nagata, R.H
1985 Letter report: Field Inspection of Cave Site, Fodder Growing Project (CDUA-HA 1736) Parcel, Panaewa, South Hilo, Hawai'i (TMK: 2-4-08:22).

Orr, Maria
2004 Cultural Impact Study/Assessment, Kea'au By-Pass Road to Shower Drive Shoulder Land Conversion Project, Kea'au Ahupua'a, District of Puna, Island of Hawai'i., Hawai'i. Prepared for Haun & Associates, Wilson Okamoto & Associates.

Rechtman, R.
2001 Archaeological Inventory Survey and Limited Cultural Assessment for the Proposed Wastewater Treatment Facility at Kulani Correctional Facility (TMK: 3-2-4-08:9). Rechtman Consulting Report RC-0078 prepared for Ron Terry, Ph.D.

Richmond, G.
1963 Species Trials at the Waiākea Arboretum, Hilo Hawai'i. U.S. Forest Service Research Paper PSW-4. Pacific Southwest Forest and Range Experiment Station, Berkeley, California Forest Service, U.S. Department of Agriculture

Rosendahl, P.H.
1994 Archaeological Field Inspection, Hale Nani Work Release Center, Land of Waiākea, South Hilo District, Island of Hawai'i. PHRI Letter Report 1516. Prepared for Belt Collins

Runyon, R., S.Wilkinson, and H. Hammatt
2008 Archaeological Monitoring Report For Mountain View Elementary School, Hawai'i InterIsland DOE Cesspool Project, 'Ōla'a Ahupua'a, Puna District, Island of Hawai'I, TMK: [3] 1-8-001:007. Cultural Surveys Hawai'i, Inc. job code: DOEC 2H6. Prepared for CH2MHill and Department of Education State of Hawai'i.

Sato, H.H., E.W. Ikeda, R. Paeth, R. Smythe, and M. Takehiro Jr.
1973 *Soil Survey of the Island of Hawai'i.* U.S. Dept. of Agriculture, Soil Conservation Service and University of Hawai'i Agricultural Experiment Station. Washington D.C. Government Printing Office.

Speakman, C.E., Jr.
2001 *An Informal History of the Hawaiian Island.* San Rafael: Pueo Press.

State of Hawai'i
1998 Forest Management Plan for the Waiākea Timber Management Area. Prepared by State of Hawai'i, Department of Land and Natural Resources, Division of Forestry and Wildlife.

Stokes and Dye
1991 Heiau of the Island of Hawai'i. *Bishop Museum Bulletin in Anthropology* 2. Bishop Museum Press, Honolulu.

United States Geologic Survey (USGS) website
2013 http://www.usgs.gov/

University of Hawai'i at Manoa Library website
2013 http://magis.manoa.Hawai'i.edu/viewer/Hawai'icty.html

Waihona 'Aina Corporation
1998 The Mahele Database, waihona.com.

Walker, A.T. and P. Rosendahl
1992 Archaeological Inventory Survey, TMK: (3) 1-7-17: 003, Land of ʻŌlaʻa, Puna District, island of Hawaiʻi. Paul H. Rosendahl, Inc. (PHRI), Hilo HI.

Wolfe, E., and J. Morris
2001 Geological Map of the Island of Hawaiʻi. U.S. Department of the Interior. U.S Geological Survey

APPENDIX A

HAUN & ASSOCIATES

ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL RESOURCES MANAGEMENT SERVICES

Confined Spaces Safety

Policy:

It is the policy of Haun & Associates to protect the health and welfare of all employees whose work assignments may require entering or working in lava tubes, blisters, or other cavities. Only persons with appropriate aptitudes and physical competence shall be employed in confined space work. Training of selected persons to carry out confined space work shall include:

- Emergency entry and exit procedures
- First aid, including Cardio-Pulmonary Resuscitation (CPR)
- Lock Out and Isolation procedures
- The use of safety equipment
- Rescue drills
- Communications
- Recognition of any hazards specific to the operation/activity

Purpose:

To establish the policy and procedures regarding management and employee response and actions to working in lava tubes and cavities. Working in confined spaces can lead to injury or even death if adequate precautions are not taken. Only trained persons may enter or work in lava tubes and cavities.

Haun & Associates will ensure that our employees are protected from the potential hazards involved in entering confined spaces. We will make every effort to comply with the OSHA Permit-Required Confined Space Standard (Code of Federal Regulations [CFR] 1910.146) and to exceed those requirements when necessary to ensure the safety of our workers.

For the purposes of this program, the following definitions will apply:

- Confined Space - A confined space has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee. These spaces are limited to lava tubes and cavities. Entry into other confined spaces such as underground vaults, manholes, tanks, storage bins, vessels, and silos is prohibited.
- Permit-Required Confined Space - A "permit-required confined space" is one that meets the definition of a confined space and has one or more of these characteristics:
  (1) Contains or has the potential to contain a hazardous atmosphere.
  (2) Contains a material that has the potential for engulfing an entrant.

(3) Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section.
(4) Contains any other recognized serious safety or health hazards.

Definitions:

a. Acceptable entry conditions means the conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

b. Attendant means an individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program.

c. Authorized entrant means an employee who is authorized by the employer to enter a permit space.

e. Confined space means that:

- It is large enough and so configured that an employee can bodily enter and perform assigned work; and
- Has limited or restricted means for entry; and
- Is not designed for continuous employee occupancy.

f. Emergency means any occurrence (including any failure of hazard control or monitoring equipment) or event internal or external to the permit space that could endanger entrants.

g. Engulfment means the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

h. Entry means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

i. Entry permit (permit) means the written or printed document that is provided by the employer to allow and control entry into a permit space.

j. Entry supervisor means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

k. Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere.
(2) Contains a material that has the potential for engulfing an entrant.
(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-sections.
(4) Contains any other recognized serious safety or health hazard.

l. Permit-required confined space program (permit space program) means the employer's overall program for controlling, and, where appropriate, for protecting employees from, permit space hazards and for regulating employee entry into permit spaces.

m. Permit system means the employer's written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.

n. Prohibited condition means any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

o. Rescue service means the personnel designated to rescue employees from permit spaces.

p. Retrieval system means the equipment (including a retrieval line, chest or full-body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

References:

American National Standards Institute "Safety Requirements for Working in Tanks and other Confined Spaces".

NIOSH "Criteria for a Recommended Standard...Working in Confined Spaces."

U.S. Department of Labor, OSHA regulations, 29 CFR 1910.146, "Permit-Required Confined Spaces."

Identification and Evaluation of Confined Spaces:

An inspection of Haun & Associates's premises or job sites or job sites has identified the following spaces as confined spaces and permit-required confined spaces:

Confined Spaces: Lava, tubes, blisters, and cavities

Permit-Required Confined Spaces: Lava, tubes, blisters, and cavities

All Permit-Required Confined Spaces have been marked with warning signs reading:

"Danger - Permit-Required Confined Space - Authorized Entrants Only"

Procedure:

Work involving entry to a confined space must be planned. An assessment of likely hazards should be made prior to commencing the work. Some thought should also be given to handling possible emergencies.

ENTRY INTO CONFINED SPACES:

Prior to entry into any confined space, the employee's supervisor will be notified regarding the specific location, type, and duration of the work to be done, and the date. Before permitting entry, the employee's supervisor will be responsible for the following:

- Identify all hazards and potential hazards associated with the confined space, such as the danger of explosion, asphyxiation, toxic gases/fumes, engulfment or entrapment, electrical or mechanical hazards, etc.
- Ensure that a supervisor is notified prior to entry and upon exit. The notification shall include the exact location of the cave and estimated time for completing work in the cave.
- Ensure that rescue and emergency services and equipment are in place as noted in this policy.
- Ensure that all required equipment is provided, maintained and properly used. This includes communications equipment, personal protective equipment (PPE), lighting, external barriers and warning signs, ladders, and rescue equipment.

RESCUE & EMERGENCY SERVICES:

If proper protective measures are taken to eliminate and control any possible hazards in the confined space (i.e., ventilation, purging, monitoring, lock out/tag out, etc.), rescue operations should not be necessary. Nonetheless, Haun & Associates will be prepared for the worst case scenario.

The supervisor for the confined space will have access to a telephone and know the proper procedure for alerting the proper personnel in the event of an emergency, including the fire department, paramedics, police, and others as necessary.

Provisions will be made and equipment provided to ensure timely extraction of an unconscious or injured worker from the confined space. Under no circumstances is the attendant to enter the space to effect rescue; rescue operations must be left to trained personnel.

The following Job Hazard Analysis Form details the potential hazards, causes, and preventative measures applicable to lava tubes/cavities. The form will be used in training employees and provides guidance for the required protective measures.

Job Hazard Analysis Form
Confined Space Entry-Lava Tube/Cavity

Step	Hazard	Cause	Preventive Measure
1.a. Approaching opening to lava tube/cavity	Falling into tube	Collapse of ground surface around opening	Insure that surface surrounding opening is stable/thick enough to bear examiner's weight
1.b. Entering opening to lava tube/cavity	Falling into tube	Floor of tube/cavity deeper than 4 ft below surrounding ground surface	Enter using adequate ladder and/or safety harness using hoist or proper belaying/ rappelling techniques
1.c. Entering opening to lava tube/cavity	Struck by falling rock.	Loose rock around edge of opening	Clear loose rock from around opening and wear appropriate PPE (hardhat, foot protection, clothing)
1.d. Entering opening to lava tube/cavity; examination of interior	Struck by falling rock.	Roof fall from machine vibration/ weight	Insure that machines are not parked over tube or operating in vicinity during entry
2.a. Examination of lava tube/cavity interior	Abrasion/contusion	Contact with cave wall, floor, or ceiling while walking/crawling	Adequate illumination with backup light and appropriate PPE including hardhat, foot protection, gloves, elbow and knee pads, and clothing.
2.a. Examination of lava tube/cavity interior	Lost: unable to return to opening	Traveling too far from opening without adequate marking of route	Stay within maximum, mark route with glo-sticks, maintain communication with entry monitor
2.b. Examination of lava tube/cavity interior	Falling	Climbing down vertical faces higher than 5 ft	Use safety harness and roped belaying/ rappelling techniques and/or ladders

Appendix G: Final Archaeological Inventory Survey Waiākea Timber Management Area (Haun and Associates)

Rec'd 12/31/14
HRA 958

HISTORIC PRESERVATION DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

601 Kamokila Boulevard, Suite 555
Kapolei, HI 96806

December 22, 2014

Alan Haun, Ph. D., Principal Investigator
Haun and Associates
73-1168 Kahuna A'o Road
Kailua Kona, Hawai'i 96740

LOG NO: 2014.01730
DOC NO: 1412SN20
Archaeology
History and Culture

Dear Dr. Haun:

SUBJECT: **Chapter 6E-8 Historic Preservation Review –**
Draft Archaeological Inventory Survey for the Waiākea Timber Management Area
Waiākea and Ola'a Ahupua'a, South Hilo District, Island of Hawai'i
TMK: (3) 1-8-012:001 (por); 2-4-008:001, 006, 010, and 020 (por)

Thank you for the opportunity to review the report titled *Archaeological Inventory Survey Waiākea Timber Management Area Waiākea and 'Ōla'a Ahupua'a, South Hilo and Puna Districts, Island of Hawai'i TMK: (3) 1-8-012:001 (por); 2-4-008:001, 006, 010, and 020 (por)* (A. Haun and D. Henry April 2014). This document was received by our office on April 15, 2014. We apologize for the delayed review and thank you for your patience. The fieldwork consisted of a 5% sample (550-acres) survey of the 12,506-acre project area as agreed upon through consultation and an archaeological inventory survey plan (AISP) with SHPD (*Log No. 2013.5274 Doc. No. 1309SN26*). In addition to the sample survey, a total of 6.49-acres were surveyed in order to re-locate a previously identified burial cave (SIHP Site 50-10-35-18697).

Two historic properties were identified during the survey: Site 50-10-34-20870 is a remnant of the 'Ōla'a Flume water transportation/diversion system and is assessed as significant under Hawaii Administrative Rule (HAR) §13-275-6 Criteria A and D. SIHP 50-10-34-30088, the historic road associated with the 'Ōla'a house lots established for homesteading in 1895, has been paved and is still in use as Ihope Road (back road); this site is assessed as significant under HAR §13-275 Criterion D. Sites, 20870 and 30088 have been adequately documented and are recommended for no further work. SIHP Site 18697, the previously identified burial cave, was identified by Mr. George Yokoyama and examined by DLNR archaeologist Wendall Kam in 1985. Efforts were made during the current survey to relocate the cave using information from the previous documentation; the exact location could not be ascertained and the cave entrance is thought to have since been sealed by natural processes. A general location for the cave has been determined.

We concur with the proposed significance assessments and treatment recommendations for Sites 20870 and 30088. For Site 18697, the report recommends that a 500 square meter (61.7 acre) area centered on the reported location of the site and oriented parallel to Stainback Highway be established. Should future land alteration occur in this area, an archaeological monitoring plan pursuant to HAR §13-279 should be submitted to SHPD for review and approval to ensure that the burial is protected if discovered. In consultation with the SHPD-History and Culture Branch, we believe that this provision will provide ample mitigation procedures in the event that the burial is relocated during any future land modification.

This report meets the requirements of Hawaii Administrative Rule (HAR) §13-276 and is accepted by SHPD. Please send one hardcopy of the document, clearly marked **FINAL**, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office. In the event of ground disturbance in the area of Site 18697, we look forward to the opportunity to review an archaeological monitoring plan. Please contact Sean Naleimaile at (808) 933-7651or Sean.P.Naleimaile@Hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Theresa K. Donham, Archaeology Branch Chief

938-040214

FINAL

ARCHAEOLOGICAL INVENTORY SURVEY

WAIĀKEA TIMBER MANAGEMENT AREA

WAIĀKEA AND ʻŌLAʻA AHUPUAʻA

SOUTH HILO AND PUNA DISTRICTS, ISLAND OF HAWAIʻI

TMK: (3) 1-8-012: POR 001; 2-4-008: POR 001, 006, 010 AND 022

HAUN & ASSOCIATES

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Report 938-040214

FINAL

ARCHAEOLOGICAL INVENTORY SURVEY

WAIĀKEA TIMBER MANAGEMENT AREA

WAIĀKEA AND ʻŌLAʻA AHUPUAʻA

SOUTH HILO AND PUNA DISTRICTS

ISLAND OF HAWAIʻI

TMK: (3) 1-8-012: POR 001; 2-4-008: POR 001, 006, 010 AND 022

Prepared by:
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and
Dave Henry, B.S.

Prepared for:

Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl St., Rm. 325
Honolulu, HI 96813

April 2014

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MANAGEMENT SUMMARY

Haun & Associates conducted an archaeological inventory survey of 556.49 acres in the Waiākea Timber Management Area located in Waiākea and ʻŌlaʻa Ahupuaʻa, South Hilo and Puna Districts, Island of Hawaiʻi (TMK: [3] 1-8-012: portion of 001; 2-4-008: portions of 001, 006, 010, and 022). The surveyed areas consist of the 550 acres that were proposed in an archaeological inventory survey plan sampling strategy for the project and an additional 6.49 acres surveyed during efforts to relocate a previously identified burial cave.

The project will be potentially licensed as part of a Commercial Harvest and Reforestation Project under the auspices of the Forestry Program, Division of Forestry and Wildlife. The project is being undertaken to fulfill DOFAW's requirements to comply with the state historic preservation law, Chapter 6E, 7 and 8, Hawaiʻi Revised Statutes (HRS), and it's implementing administrative rules, Chapters 13-275 and 13-276, Hawaiʻi Administrative Rules (HAR).

The survey identified a disturbed remnant of an historic flume associated with the sugarcane industry, and an historic road that has been paved, renamed and is in use by local inhabitants of the area. A burial cave was identified in the WTMA area in 1985. Efforts were made to relocate this cave during the project; however, it could not be positively identified. It is possible that the entrance to the cave may be obscured behind a large sheered-off section of ridge adjacent to the Quarry Road. It is also possible that the cave was inaccurately plotted in 1985 and may be located somewhere in the surrounding area.

The flume site and historic road are assessed as significant for their information content. These sites have yielded information important for understanding historic land use in project area. The flume site is also assessed as significant for its association with the broad pattern of sugar cane plantation agriculture in Hawaiʻi. The documentation of these sites adequately documents them and no further work or preservation is recommended. It is also recommended that archaeological monitoring of any future land modification be conducted in a 500 square meter (61.7 acre) area centered on the reported location of the burial cave and oriented parallel to the Stainback Highway. This monitoring activity would be guided by an Archaeological Monitoring Plan submitted for DLNR-SHPD review and approval.

Cover photo: Eucalyptus trees in the Waiākea Timber Management Area, view to north

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FIGURES

FIGURES (cont.)

FIGURES (cont.)

TABLES

INTRODUCTION

At the request of the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Haun & Associates conducted an archaeological inventory survey (AIS) of 556.49 acres n the 12,506 acre Waiākea Timber Management Area located in Waiākea and ʻŌlaʻa Ahupuaʻa, South Hilo and Puna Districts, Island of Hawaiʻi (TMK: [3] 1-8-012: portions of 001; 2-4-008: portions of 001, 006, 010, and 022 - **Figures 1, 2** and **3**). The surveyed areas include 20 sample cells that ranged in area from 10 to 40 acres.

The project will be potentially licensed as part of a Commercial Harvest and Reforestation Project under the auspices of the Forestry Program, Division of Forestry and Wildlife. The project is being undertaken to fulfill DOFAW's requirements to comply with the state historic preservation law, Chapter 6E, 7 and 8, Hawaiʻi Revised Statutes (HRS), and it's implementing administrative rules, Chapters 13-275 and 13-276, Hawaiʻi Administrative Rules (HAR – DLNR 2003).The AIS fieldwork was guided by an Archaeological Inventory Survey Plan (AISP - Haun and Henry 2013). The plan was reviewed and approved by the DLNR-SHPD on October 4, 2013 (Letter from Archaeology Branch Chief Theresa Donham to Sherri Mann, Forestry Program Manager, Division of Forestry and Wildlife, Log No. 2013.5274, Doc. No. 1309SN26 – **Appendix A**).

The survey fieldwork was conducted by a crew of five to six archaeologists between November 1, 2013 and January 15, 2014 under the direction of Dr. Alan Haun. The field work portion of the project required 107 labor days to complete. Described in this report are the project scope of work, field methods, background information, survey findings, and significance assessments of the sites with recommended treatments. The proposed use of the areas surveyed during the project is timber harvesting. The proposed use of the area will have "No Effect" on the sites identified during the survey pursuant to HAR 13-275-7(a)(1).

This report contains a description of the Waiākea Timber Management Area (WTMA) and its environment, a summary of previous archaeological work in and adjacent to the project area, the research design from the Archaeological Inventory Survey Plan that guided the fieldwork, the findings of the survey and a conclusion section containing significance assessments of the sites with recommended treatments. The historical documentary research section from the SAIS Plan is omitted from this report in conformance with HAR §13-276-5(b)(3).

THE WAIĀKEA TIMBER MANAGEMENT AREA

The DOFAW is the largest land management department in the State of Hawaiʻi, overseeing the management of approximately 800,000 acres of State owned lands. The majority of these lands (700,000+ acres) are located on Hawaiʻi Island with more than 400,000 acres situated in the forest reserve system. The 12,506 acre Waiākea Timber Management Area (WTMA) is situated in the Upper Waiākea, the Waiākea and the ʻŌlaʻa Forest Reserves. According to Maly and Maly, the forest reserves in the area were established between 1904 and 1913:

> Following the development of the Hilo Forest Reserve in 1904, and the addition of portions of the ʻŌlaʻa Tract to the reserve system in 1905 and 1913, the board also set aside the upland portions of Waiākea as a reserve. Thus, making a contiguous line of forest across the Hilo District, and adjoining the Puna District (2004:91).

The WTMA is bisected by the Stainback Highway that extends inland from Highway 11 (**Figure 4**). Large portions of the area are accessed by a series of main primary roads and a grid work of mostly overgrown

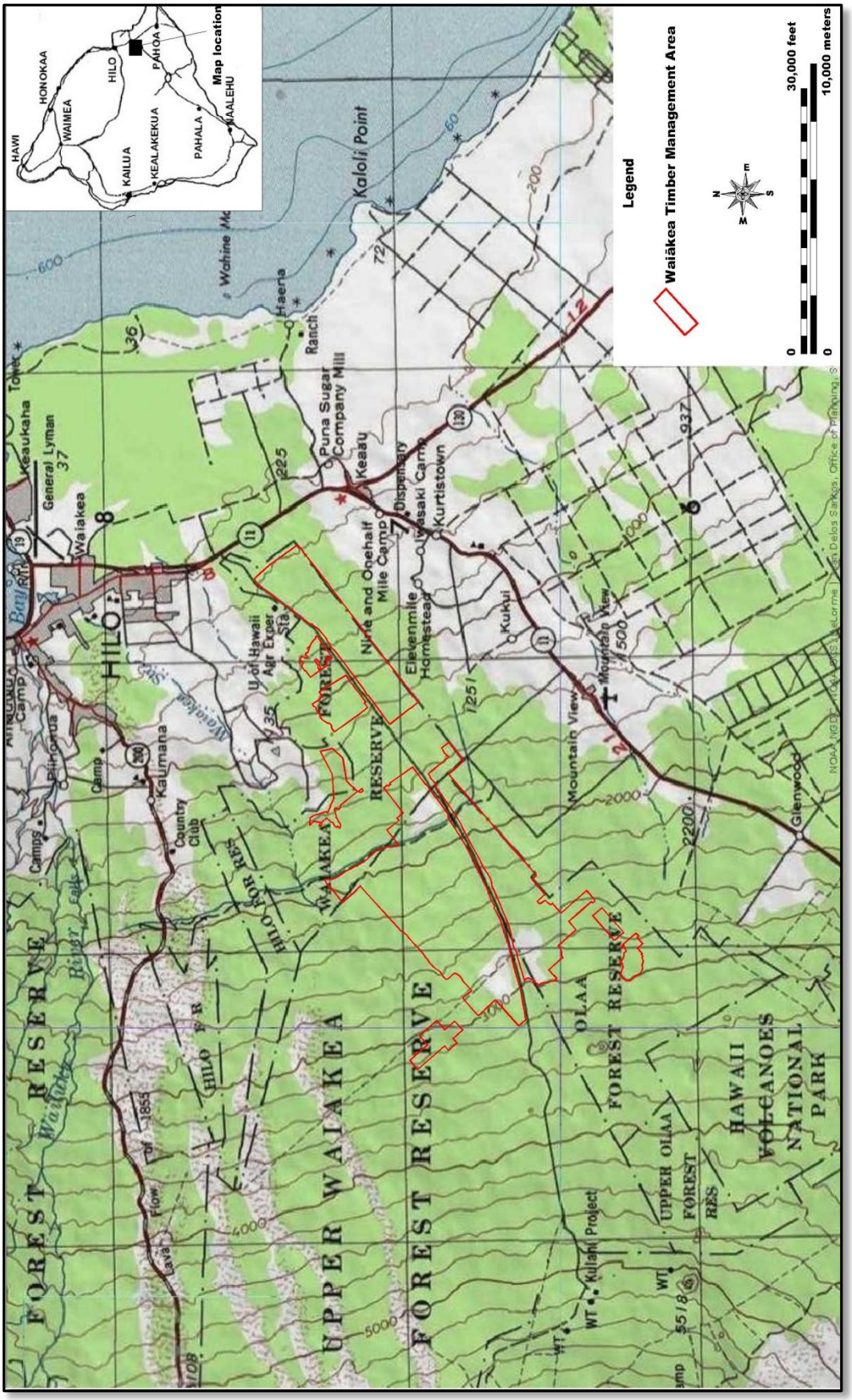

Figure 1. Portion of USGS 7.5' Hilo (1995), Mountain View (1981) and Puu Makaala (1981) quadrangles showing the Waiākea Timber Management Area

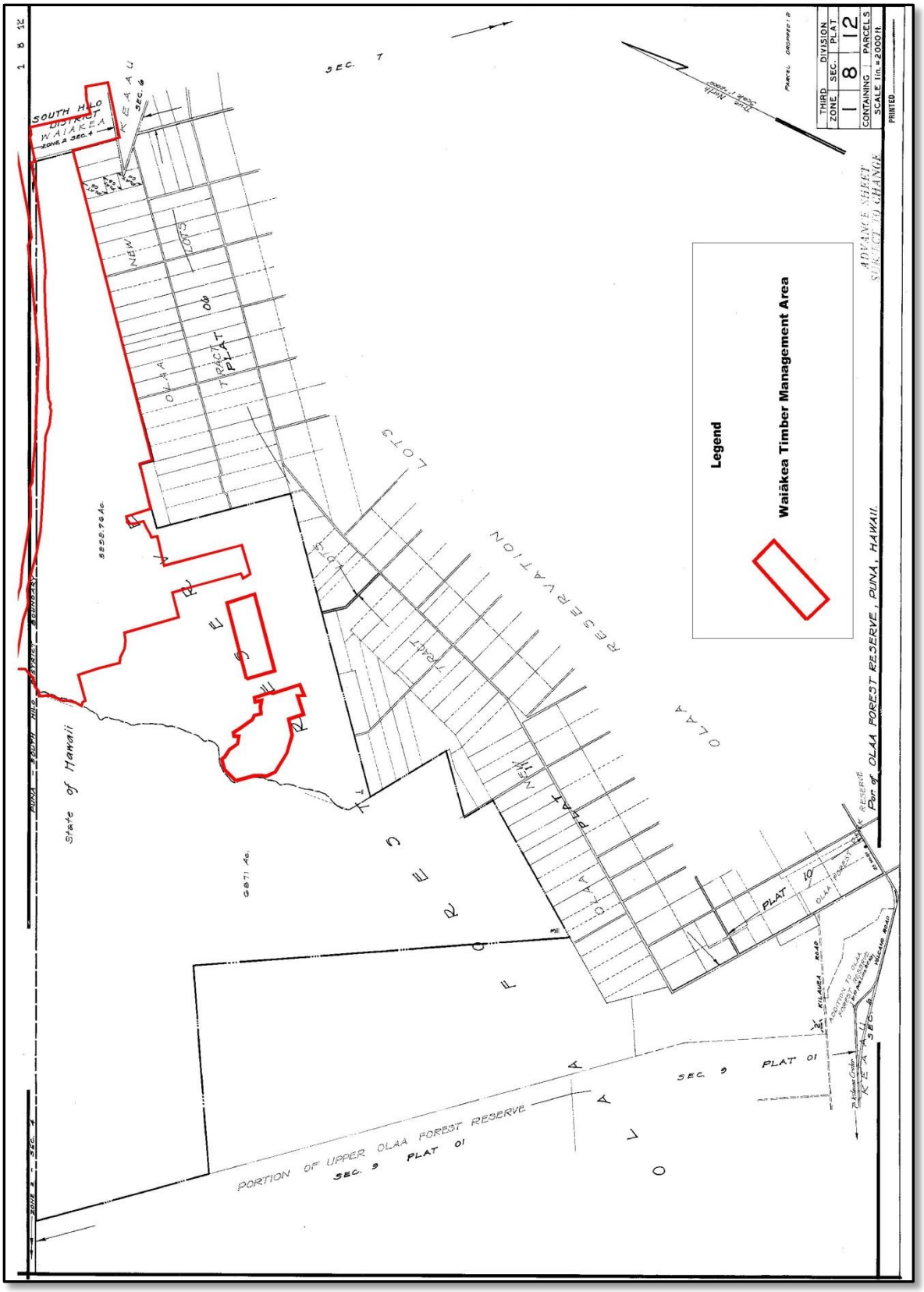

Figure 2. Tax Map Key (3) 1-8-012 showing Waiākea Timber Management Area

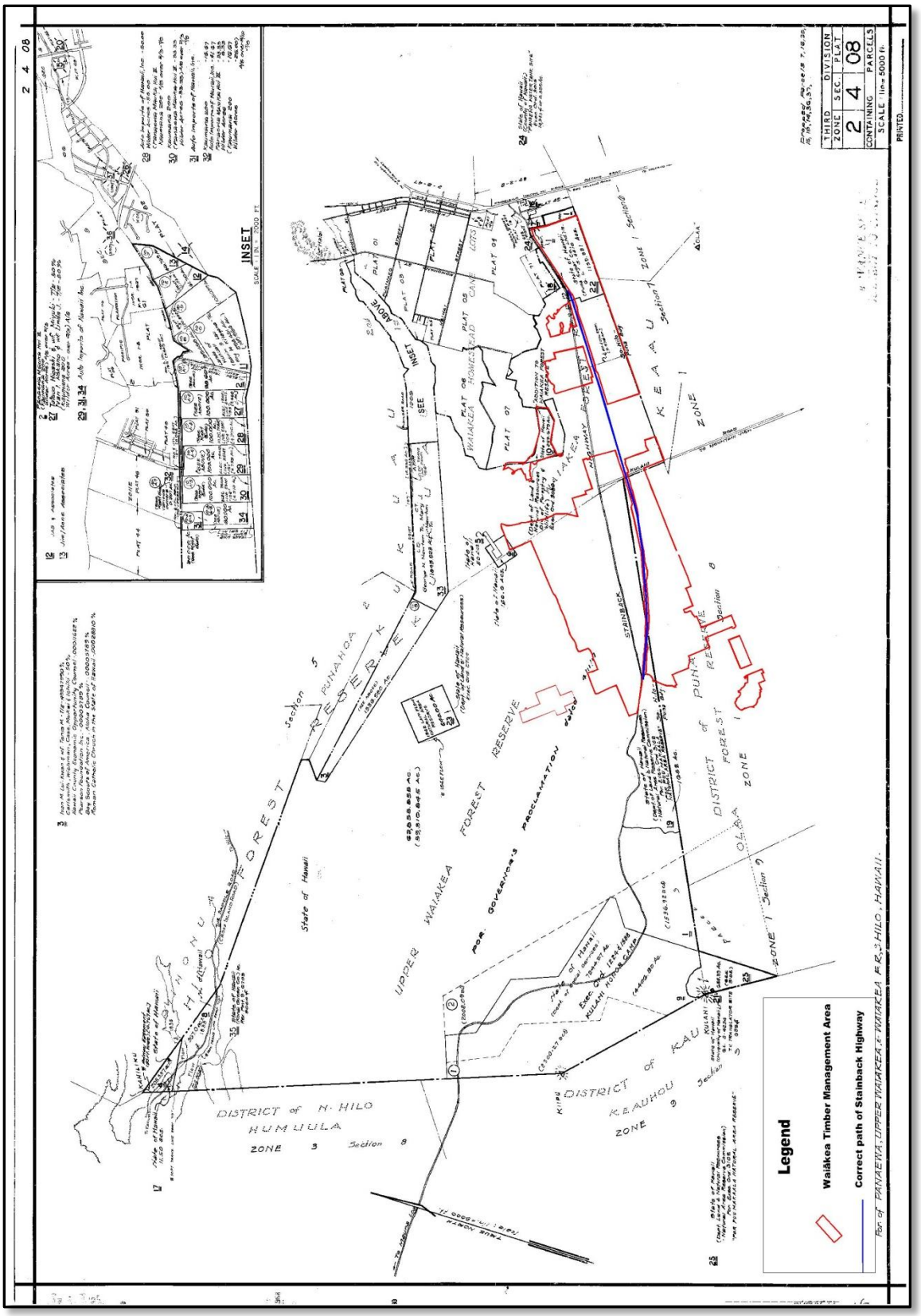

Figure 3. Tax Map Key (3) 2-4-08 showing Waiākea Timber Management Area

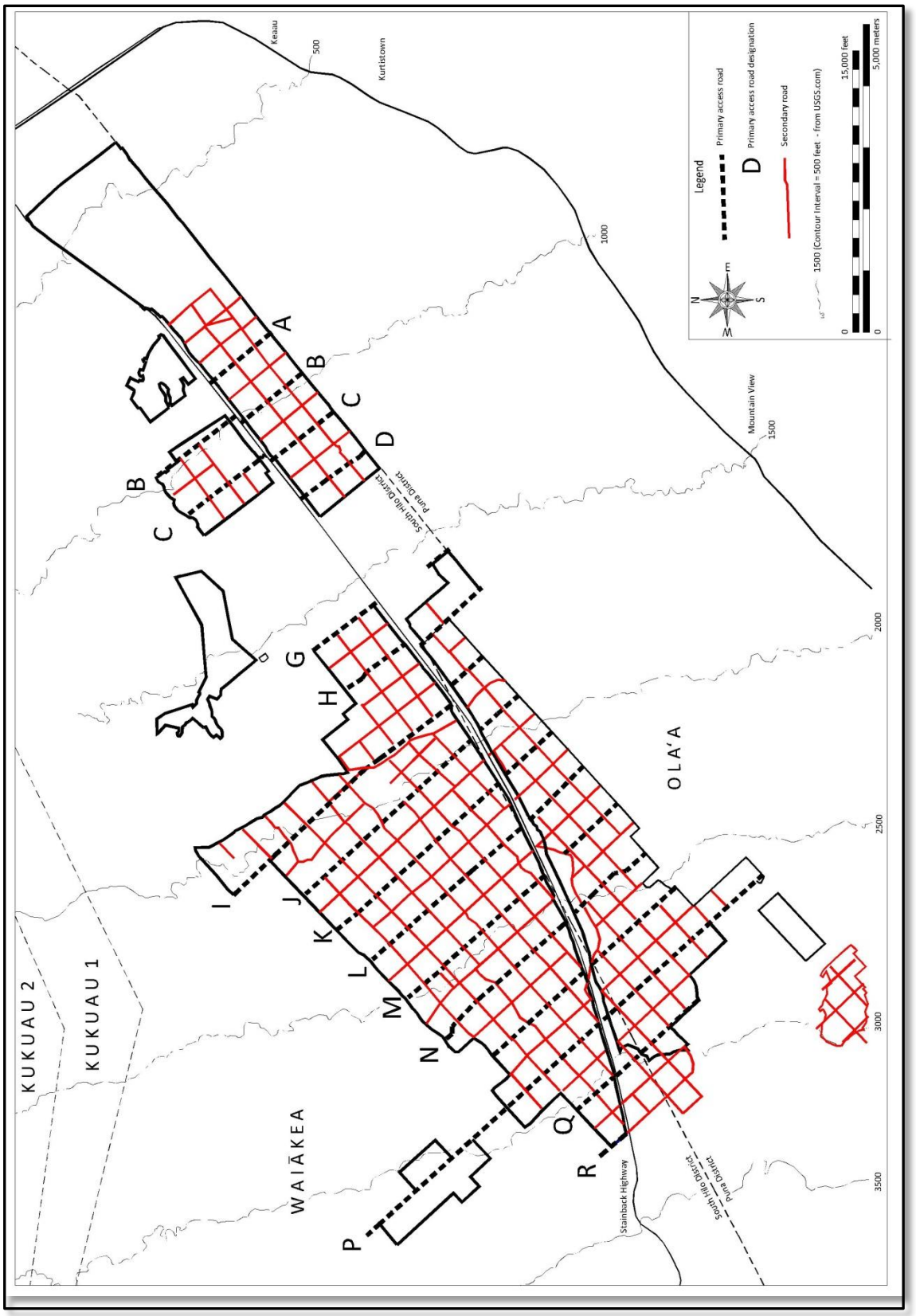

Figure 4. Roads in the Waiākea Timber Management Area

secondary roads. The primary roads are oriented in a northwest by southeast direction and are labeled Roads A-D and G-R. According to DOFAW, "Approximately 130 miles of unimproved access roads grid the WTMA tree planting area into 40 acre blocks. These roads provide access to the public and DOFAW for hunting, recreation, non-timber forest product gathering, forest protection and timber management" (State of Hawai'i 1998:5). According to DOFAW, the road grid forms 245 40-acres lots, 237 lots of which were mechanically grubbed to varying degrees between 1959 and 1968 to prepare the lots for planting with commercial timber species.

The WTMA was established to provide a supply of wood for the State of Hawai'i's timber products industry (State of Hawai'i 1998:4). In 1956, the Waiākea Arboretum was created by the Hawai'i Forestry Division on a 20 acre parcel of land on the north side of Stainback Highway, 3.1 miles southwest of Highway 11 (Richmond 1963:1). The arboretum was established to test the productive viability of 84 tree species. The test results were used to select the timber species to be planted in the WTMA. The first planting at the arboretum occurred in 1956, with subsequent plantings in 1957, 1959 and 1960.

Richmond summarizes the creation of the arboretum. According to his account:

> Wild vegetation was cleared from planting sites shortly before planting. The Kulani prison project of the Hawai'i Department of Social Services cleared the land with bulldozers in preparation for tree planting. Much of the soil overlying the shallow pahoehoe was pushed into natural depressions which are common within the area (1963:2).

Portions of the WTMA were subjected to major plantings beginning in 1959 and continuing through 1968, with additional plantings in the mid-1970s. The development of the area is summarized as follows:

> Some WTMA plantation units were weeded or fertilized in the early years, but the majority was allowed to grow without any timber stand improvement (TSI) activity… During initial land clearing operations, large native trees such as ohi`a lehua (*Metrosideros polymorpha*), koa (*Acacia koa*), and loulu (*Pritchardia spp*.) were left undisturbed. Today, these plants are intermixed with non-native timber species. Primary understory species include hapuu (*Cibotium spp*.), guava (*Psidium spp*.), uluhe (*Dicranopteris spp.*), palm grass (*Setaria palmifolia*), *Melastoma spp*. and scattered native Hawaiian understory shrub species (State of Hawai'i 1998:5).

Tree ferns or *hapu'u* (*Cibotium spp*.), were harvested from the WTMA in the early 1970s. Approximately 1,600 cubic feet of *hapu'u* logs were harvested to supply the landscape and flower industry (State of Hawai'i 1998:5). Between 1985 and 1988, the Puna Sugar Company, in an agreement with the State of Hawai'i, harvested eucalyptus from 2000 acres of the WTMA and turned the trees into wood chips that were subsequently used to generator electricity (*Ibid.* 1998:5).

In 1961, the first of three Five-Year Planting Plans were created to develop and sustain Hawai'i's timber industry. These plans covered the fiscal years 1962-1966, 1967-1971 and 1972-1976 and guided proposed plantings on Hawai'i, Oahu, Maui, Kauai and Molokai Islands (Division of Forestry 1961, 1966, 1971). The timber grown on Hawai'i Island was intended primarily for wood product harvesting, while on Oahu the primary objective was to cover erosion scars and protect watersheds (Division of Forestry 1966:1). On Maui, Kauai and Molokai, the plantings for more than half of the planting sites were for watershed protection and recreation. Recreation was also an objective for the Oahu plantings.

Limited information is presented in the Fiscal Year 1962 to 1966 Planting Plan, although more comprehensive planting data is provided in the subsequent plans. This initial plan called for planting 2,850

acres per year on each of the five islands, with 1,300 acres to be planted on Hawai'i Island. All of the Hawai'i plantings during the first five years occurred in the Waiākea Forest Reserve, consisting of 31% located in the Upper Waiākea Forest that were cleared and planted by prisoners from the Kulani Prison, 31% in the Upper Waiākea Forest cleared and planted by contract labor, and 38% in the Waiākea Forest Waiākea Forest also done by contract labor (**Table 1**).

Figure 5 depicts the extent of the plantings between 1962 and 1966. As indicated in this figure, the area planted in the Upper Waiākea Forest by Kulani Prison personnel is located outside the boundary of the WTMA. During the 1967-1971 plan, the plantings were expanded to include the Hilo-Manowaialee Working Circle (**Figure 6**), followed by the Hilo-Hamakua Working Circle in 1972-1976 (**Figure 7**). As indicated in these figures, the WTMA is situated in an area referred to as the Waiākea-Olaa Working Circle.

Table 2 summarizes all of the available planting data presented in the three Five-Year Planting Plans. According to the data, more than 16,600 acres were planted in the Waiākea-Olaa Working Circle between 1962 and 1976, with more than 9,200 acres located in the WTMA. More than 7.5 million trees were planted during this period, with nearly 2.3 million planted in the WTMA.

Figure 8 is a compilation map that shows the plantings that occurred in the Waiākea-Olaa Working Circle between 1967 and 1976. The data from 1962 through 1966 has been excluded from this figure as it only depicts general planting areas (see **Figure 5**). The exclusion of this data leaves large gaps in the WTMA. To fill in these areas, a series of aerial photographs depicting the area were consulted (**Figure 9**). These photographs were taken by the U.S. Department of Agriculture between January 16 and February 1, 1965 (University of Hawai'i Library 2013). These photographs indicate that large portions of the WTMA had been cleared by early 1965. This information has also been incorporated into the **Figure 8** planting map.

As indicated in **Table 2***,* nearly all of the areas planted in the WTMA had been mechanically cleared prior to tree planting. Of the 9,279 acres planted, only 84 acres were cleared by hand. An additional 40 acres were cleared using an undetermined combination of hand, chemical or light tractor. All of the areas were hand planted.

Currently, the majority of the 12,506-acre WTMA is planted in introduced tree species that are to be commercially harvested (10,608 acres or 85%). The distribution of these tree species is presented in **Figure 10** and is summarized in **Table 3**. Most of these trees are various species of eucalyptus, including Sidney blue gum (*Eucalyptus salinga & E. grandis,* 3,745 acres), swamp mahogany or swamp messmate (*Eucalyptus robusta,* 227 acres), and blackbutt or rainbow eucalyptus (*Eucalyptus deglupta & E. pilularis,* 54 acres). Additional tree species consist of Australian toon (*Toona ciliata* - 3,343 acres), tropical ash (*Fraxinus uhdei*, 1,577 acres), Queensland maple (*Flindersia brayleyana*, 1,536 acre), Nepal alder (*Alnus nepalensis*, 24 acres), and Sugi or Japanese cryptomeria (*Cryptomeria japonica,* 102 acres). The remaining 15% of the WTMA consists of 779-acres of native hardwoods and 28-acres of experimental hardwoods that will not be harvested, 349-acres of block roads, a 35 acre staging area and 707 acres of "non-stocked areas" (see **Figure 10**). The "non-stocked areas" consist of 285 acres of former cane land and 422 acres that will be replanted because the native species are not well established there.

Although the WTMA was primarily created as a commercial timber resource, it also provides a locale for public recreation activities. These include motorcycle, mountain bike and horseback riding, hiking, pig hunting, birdwatching and botanical exploration (*Ibid.* 1998:5). An ATV/Dirt Bike Park is located in the western portion of the WTMA and a network of mountain bike trails is located in the eastern portion (**Figure 11**). The ATV/Dirt Bike Park occupies approximately 1,588 acres or 12.7% of the WTMA and the area of mountain bike trails comprise approximately 213 acres (1.7%).

Table 1. Five Year Planting Plan – Fiscal Years 1962-1966 (Division of Forestry 1961)

FIVE-YEAR PLANTING PLAN
Fiscal Years 1962-66

Island Hawaii
District South Hilo
Forest Reserve Waiakea

Planting Area (Land Name)	Sched. FY	Key No. on map	Acres	Est. Costs Clearing/Planting	Other	Total	Species	Thousands trees	Remarks
*Waiakea, Upper	1962	1	400	--		--	F.uhdei T.ciliata	180 315	Machine clear. & hand plant.- Kulani prison
Waiakea, Upper	1962	2	400	34,000		34,000	F.brayleyana E.saligna	30 30	Contract machine clear. & hand plant.
Waiakea	1962	3	500	42,500		42,500	E.pilularis	30	" " " "
	FY Total		1,300	76,500		76,500		585	
Waiakea	1963	4-6	1,300	76,500		76,500		585	
"	1964	7-9	"	"		"		"	
"	1965	10-12	"	"		"		"	
"	1966	13-15	"	"		"		"	
5-year Total			6,500	382,500		382,500		2,925	

Note: Program to be continued at same level for 5-year period. 30,000 acres in this area in need of commercial reforestation.

* In order to continue this planting project for 5 years with Kulani Prison they will need a new crawler type tractor w/bulldozer blade--approx. cost $45,000.

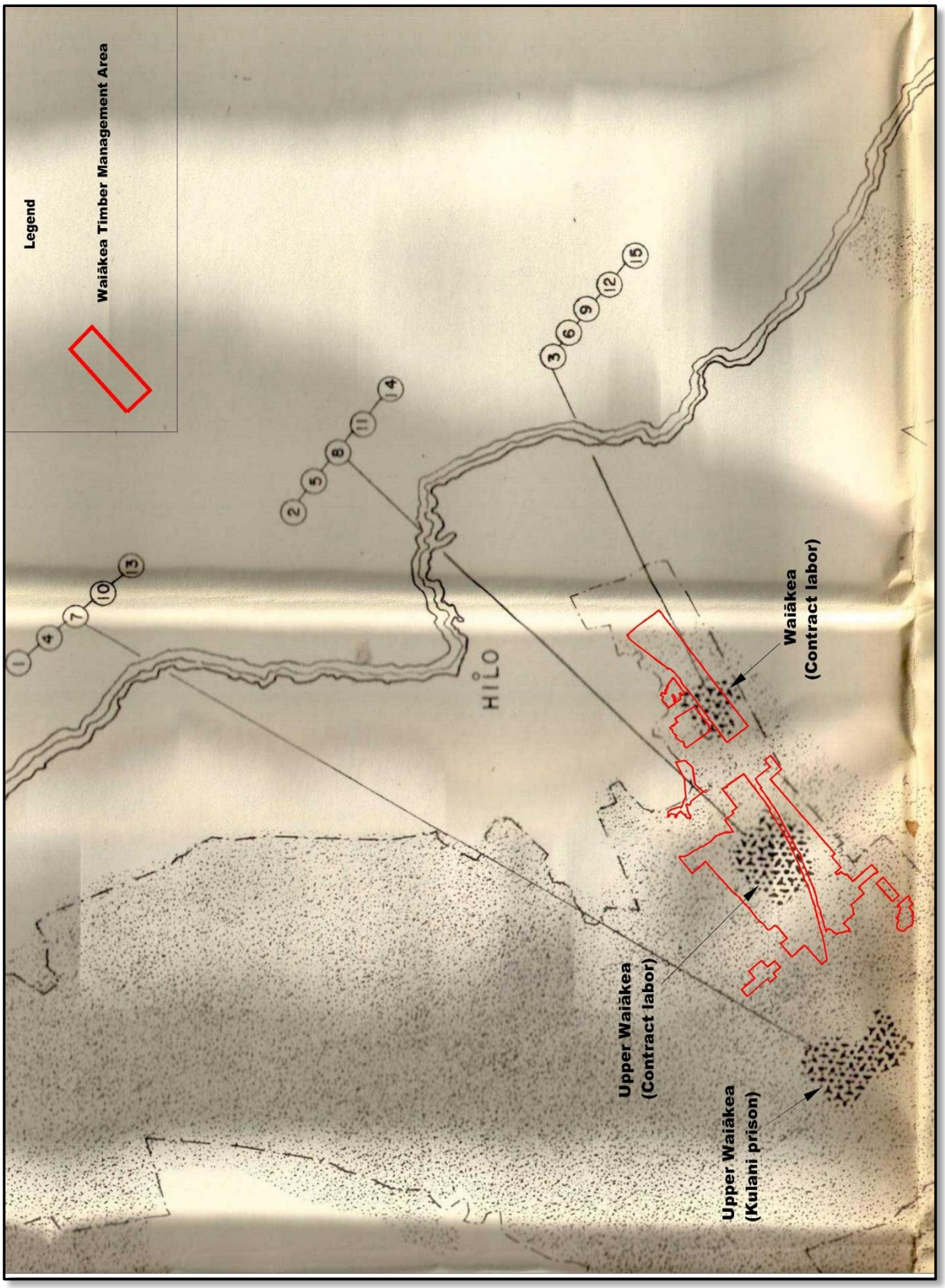

Figure 5. Hawaii Island Plantings - 1962-1966 (Division of Forestry 1961)

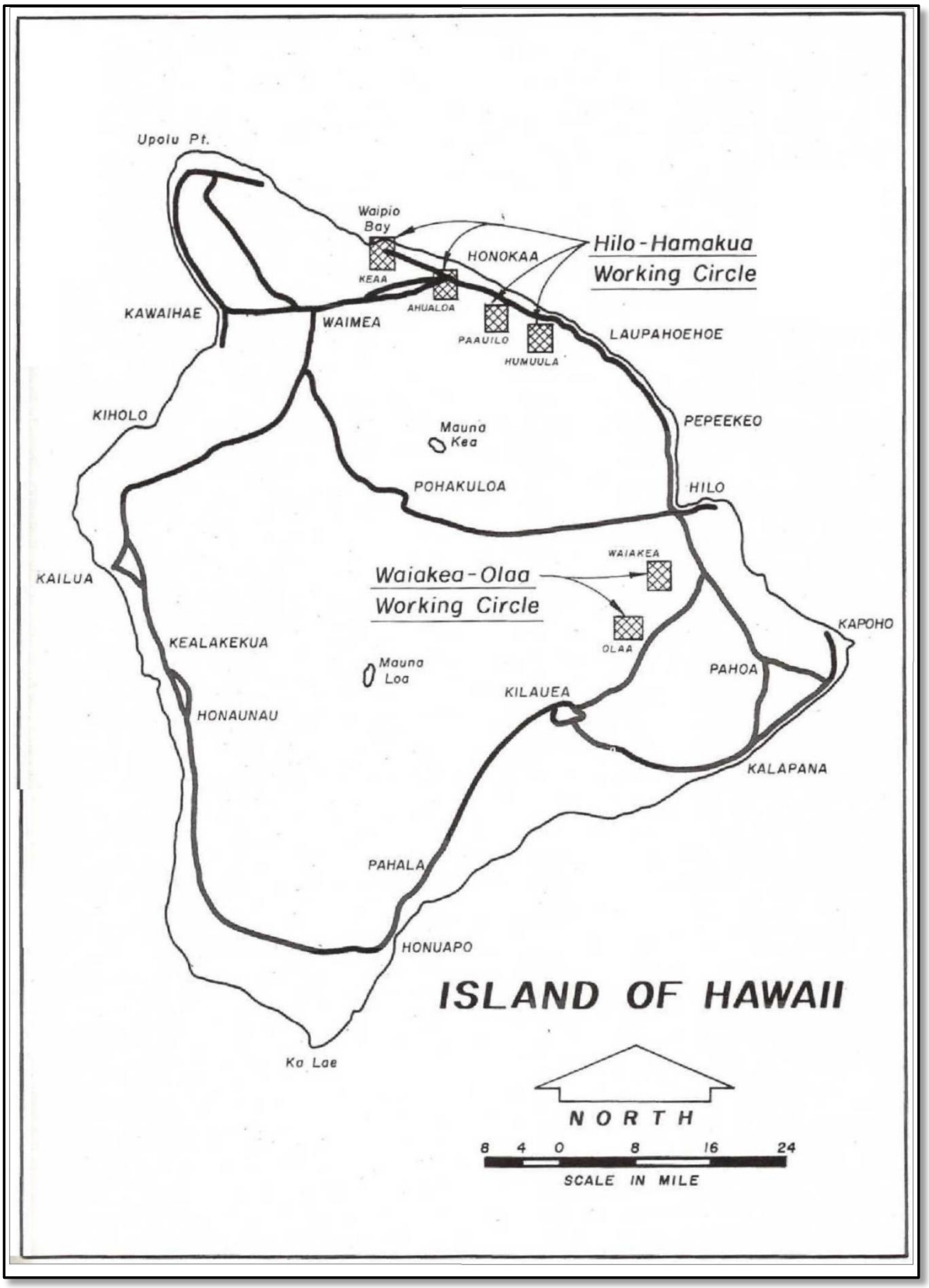

Figure 6. Hawaii Island Plantings - 1967-1971 (Division of Forestry 1966:55)

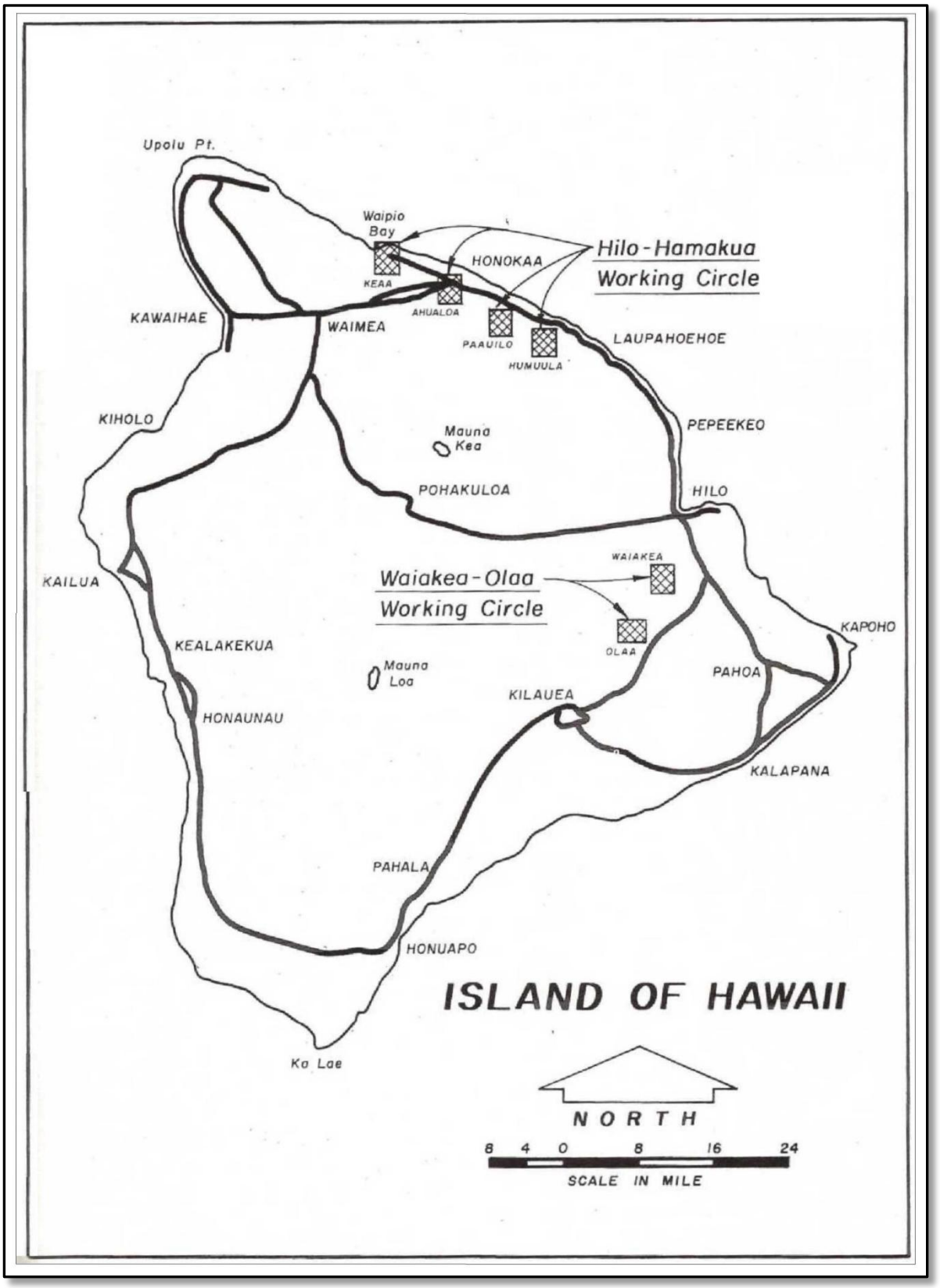

Figure 7. Hawaii Island Plantings - 1972-1976 (Division of Forestry 1971:60)

Table 2. Summary of Plantings between 1962 and 1976

Name	Area	Year	Acres within Waiākea-Olaa Working Circle	Acres within WTMA	Clearing method	Planting method	No. of trees planted in Working Circle (in thousands)	Tree species planted (in thousands)							No. of trees planted in WTMA	Comment
								Australian toon	Queensland-maple	Eucalyptus saligna	Rosegum	Tropical ash	Eucalyptus robusta	Eucalyptus pilularis		
n/a	Upper Waiākea	1962	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1962	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1962	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1963	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1963	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1963	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1964	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1964	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1964	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1965	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1965	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1965	500	500	Machine	Hand	30,000							30	30,000	
n/a	Upper Waiākea	1966	400	0	Machine	Hand	495,000	315				180			0	Kulani prison labor
n/a	Upper Waiākea	1966	400	400	Machine	Hand	60,000		30	30					60,000	Contract labor
n/a	Waiākea	1966	500	500	Machine	Hand	30,000							30	30,000	
H-1-67	Olaa	1967	320	320	Machine	Hand	128,000	64				64			128,000	
H-2-67	Waiākea	1967	187	187	Machine	Hand	60,000		40			20			60,000	3 sections (1, 2, 3) - Fern sale area
H-3-67	Upper Waiākea	1967	320	230	Machine	Hand	128,000	64		16		48			92,000*	
H-4-67	Waiākea and Olaa	1967	280	280	Machine	Hand	128,000	48		16		64			128,000	2 sections (1, 2) - Fern sale area
H-5-67	Upper Waiākea	1967	200	200	Machine	Hand	80,000	40				40			80,000	
H-6-67	Upper Waiākea	1967	300	0	Machine	Hand	120,000	60				60			0	
F-1-67	Olaa	1967	200	83	Machine	Hand	80,000		80						33,000*	Dirt area
H-1-68	Upper Waiākea	1968	280	0	Machine	Hand	112,000	48	64						0	
H-2-68	Waiākea	1968	200	200	Machine	Hand	96,000	38	58						96,000	
H-3-68	Upper Waiākea	1968	280	75	Machine	Hand	112,000	48	64						30,000*	
H-4-68	Upper Waiākea	1968	280	243	Machine	Hand	64,000						64		55,000*	
H-5-68	Waiākea and Upper Waiākea	1968	320	77	Machine	Hand	128,000	64	64						31,000*	2 sections (1, 2)
F-1-68	Olaa	1968	200	84	Hand	Hand	80,000		80						34,000*	Dirt area
H-1-69	Upper Waiākea	1969	310	0	Machine	Hand	125,000	125							0	2 sections (1, 2)
H-2-69	Upper Waiākea	1969	320	0	Machine	Hand	144,000	72		72					0	
H-3-69	Upper Waiākea	1969	320	0	Machine	Hand	130,000	65	65						0	
H-4-69	Upper Waiākea	1969	320	0	Machine	Hand	130,000			130					0	
H-5-69	Waiākea	1969	200	41	Machine	Hand	88,000		88						17,000*	
F-1-69	Olaa	1969	220	40	H/C/LT**	Hand	88,000	40	48						18,000*	
H-1-70	Olaa	1970	300	300	Machine	Hand	138,000	138							138,000	
H-2-70	Olaa	1970	240	240	Machine	Hand	96,000			96					96,000	
H-3-70	Upper Waiākea	1970	320	320	Machine	Hand	128,000	80					48		128,000	
H-4-70	Waiākea and Upper Waiākea	1970	335	335	Machine	Hand	148,000	60	88						148,000	2 sections (1, 2)
H-5-70	Upper Waiākea	1970	320	320	Machine	Hand	128,000		128						128,000	
F-1-70	Olaa	1970	205	0	H/C/LT**	Hand	82,000		82						0	
H-1-71	Upper Waiākea	1971	330	330	Machine	Hand	132,000	132							132,000	
H-2-71	Upper Waiākea	1971	285	285	Machine	Hand	114,000		114						114,000	
H-3-71	Waiākea	1971	200	44	Machine	Hand	80,000	40	40						18,000*	
H-4-71	Upper Waiākea	1971	335	258	Machine	Hand	134,000			134					103,000*	
H-5-71	Upper Waiākea	1971	330	152	Machine	Hand	132,000	80					52		61,000*	
F-1-71	Olaa	1971	210	0	H/C/LT**	Hand	84,000						84		0	
H-1-72	Olaa	1972	200	0	Machine	Hand	87,000			87					0	H-1-72 overlaps F-1-69
H-2-72	Waiākea	1972	243	135	Machine	Hand	95,000		24		71				53,000*	
H-4-72	Olaa	1972	200	0	Machine	Hand	87,000				87				0	2 sections - H-4-72 overlaps F-1-67
H-1-73	Olaa	1973	200	0	Machine	Hand	87,000				87				0	
H-3-73	Olaa	1973	200	0	Machine	Hand	87,000				87				0	
H-5-73	Waiākea	1973	200	0	Machine	Hand	36,000	18	18						0	H-5-72 overlaps H-5-68(2) and H-5-69
H-1-74	Olaa	1974	320	0	Machine	Hand	128,000		24	52	52				0	
H-3-74	Olaa	1974	320	0	Machine	Hand	138,000			69	69				0	
H-1-75	Olaa	1975	220	0	Machine	Hand	95,000			95					0	
H-3-75	Olaa	1975	400	0	Machine	Hand	174,000			87	87				0	H-3-75 overlaps F-1-68 and F-1-70
H-1-76	Olaa	1975	200	0	Machine	Hand	95,000				95				0	
H-3-76	Olaa	1975	240	0	Machine	Hand	104,000				104				0	
		Total	**16610**	**9279**			**7,555,000**	**1324**	**1169**	**854**	**739**	**296**	**248**	**150**	**2,288,200**	

** - estimated based on % of area witihn WTMA*

*** - Hand, chemical or light tractor clearing may be used*

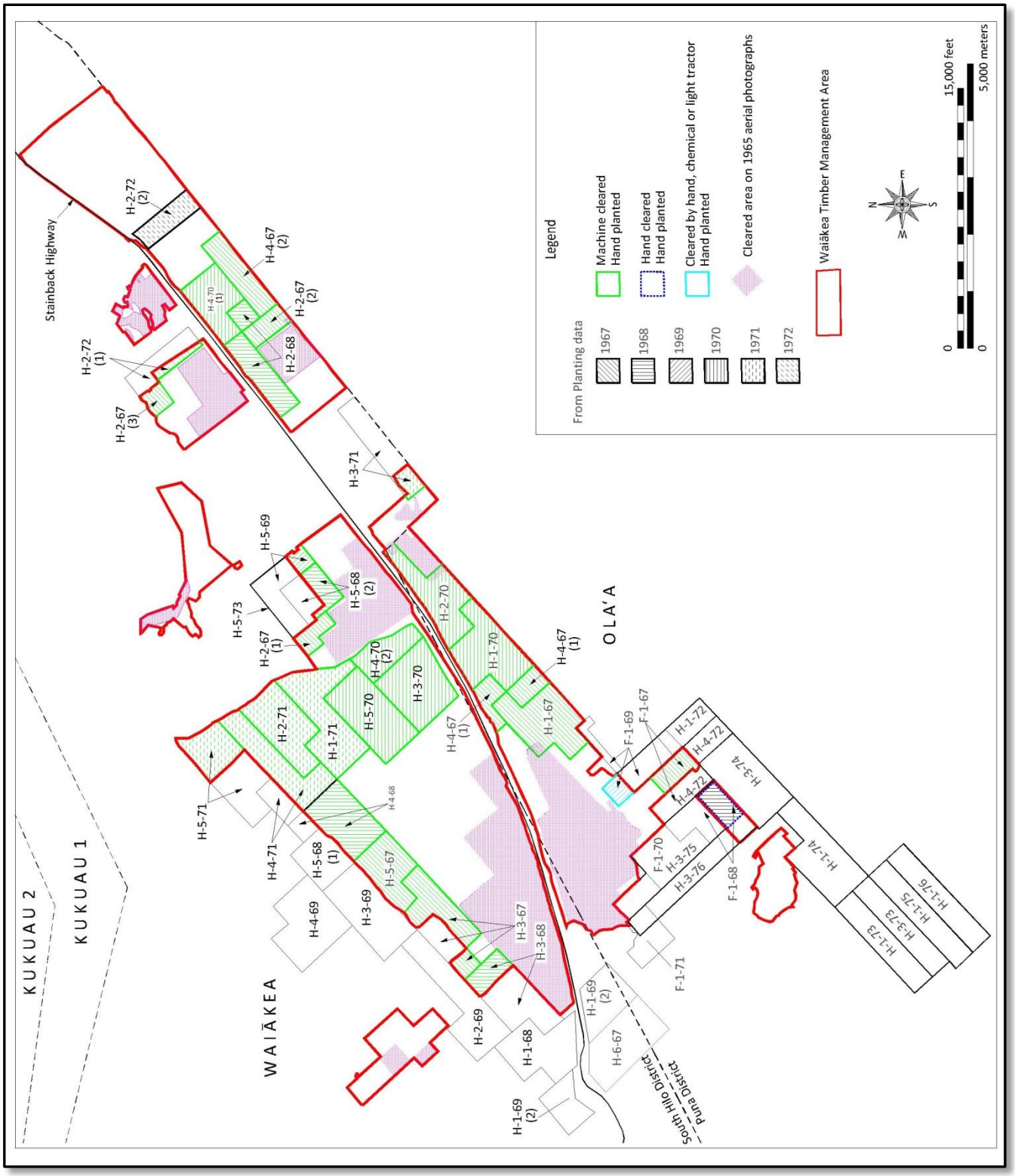

Figure 8. Plantings in the Waiakea-Olaa Planting Circle

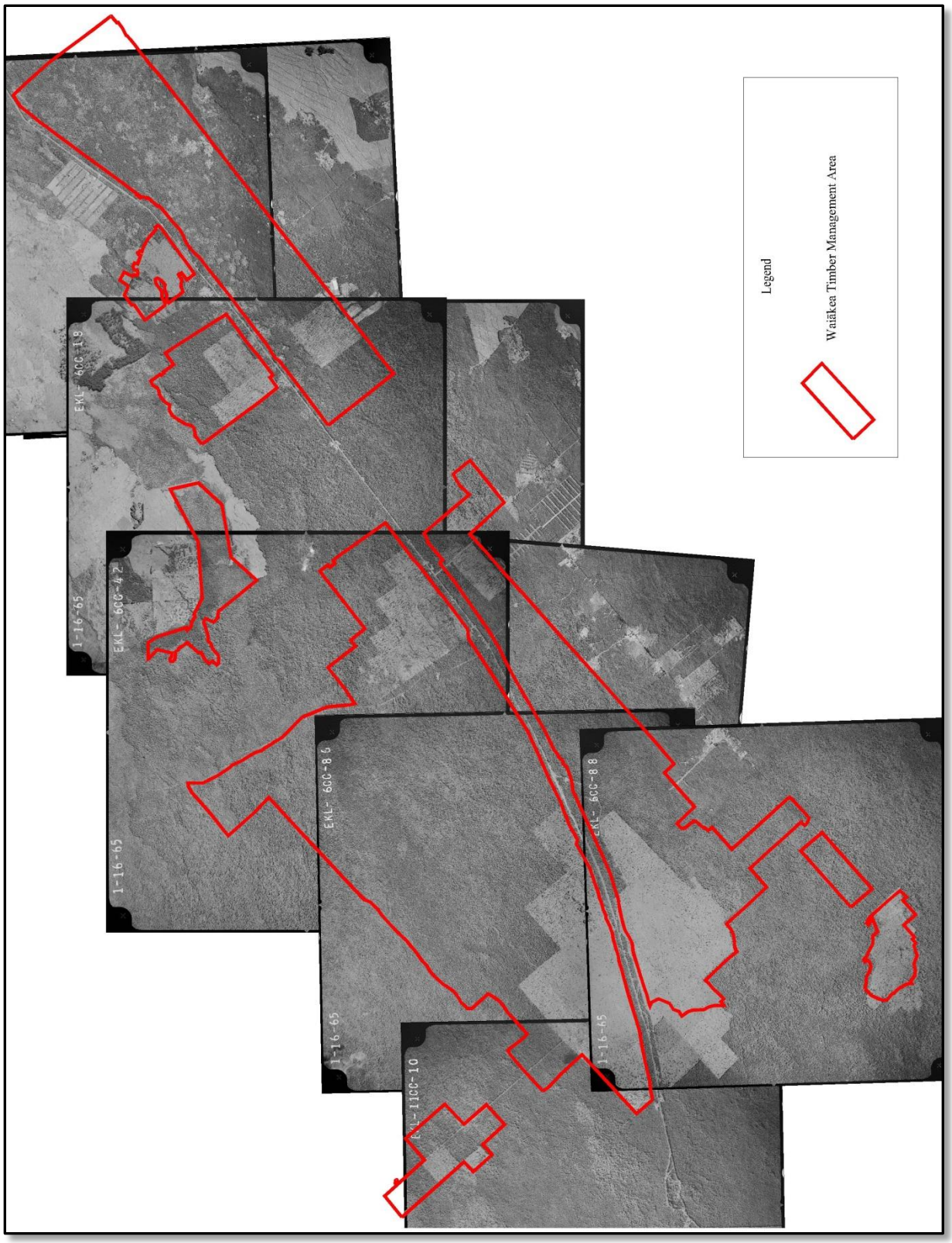

Figure 9. 1965 USDA aerial photographs showing the Waiākea Timber Management Area (from University of Hawaii Library)

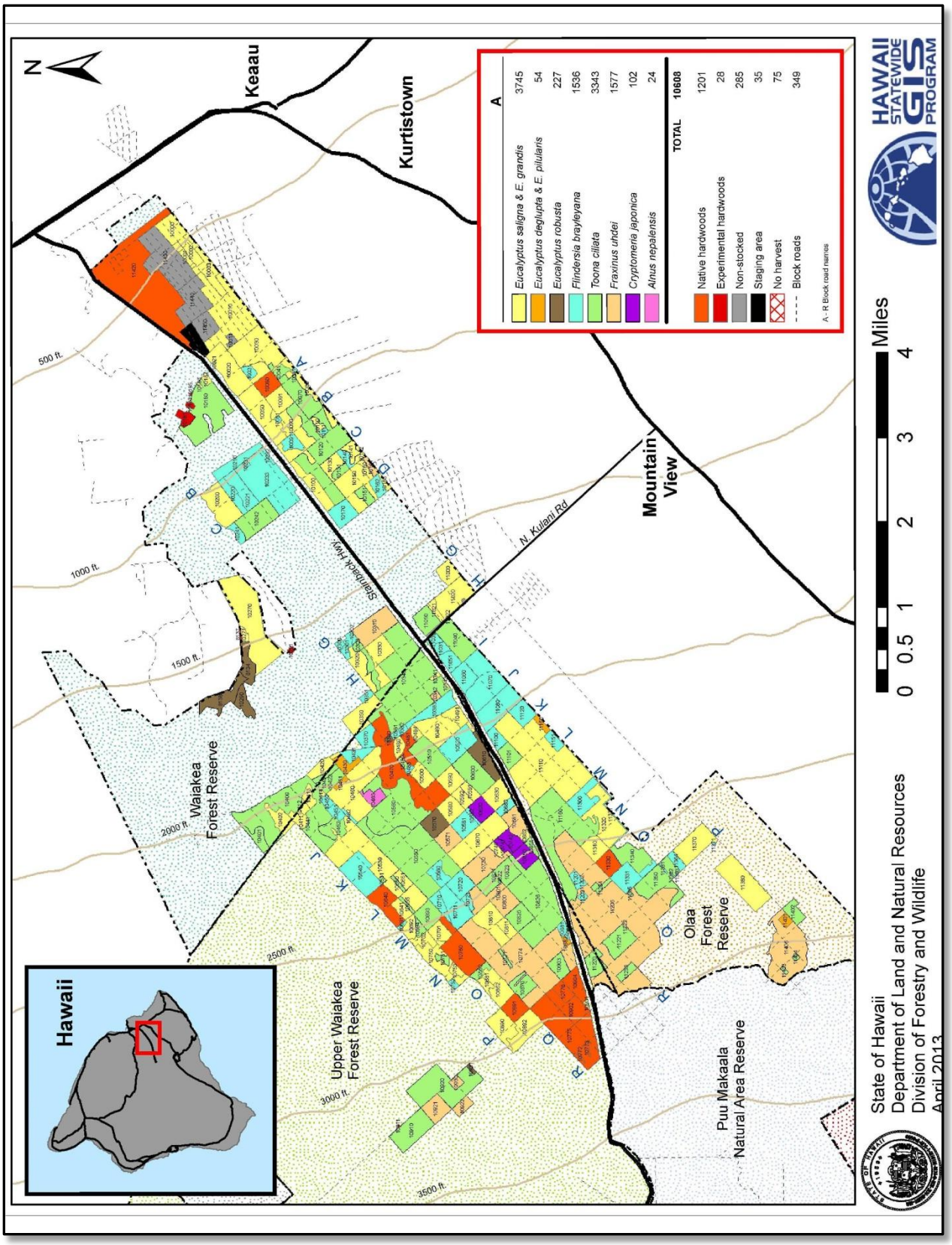

Figure 10. Tree species planted in the Waiākea Timber Management Area

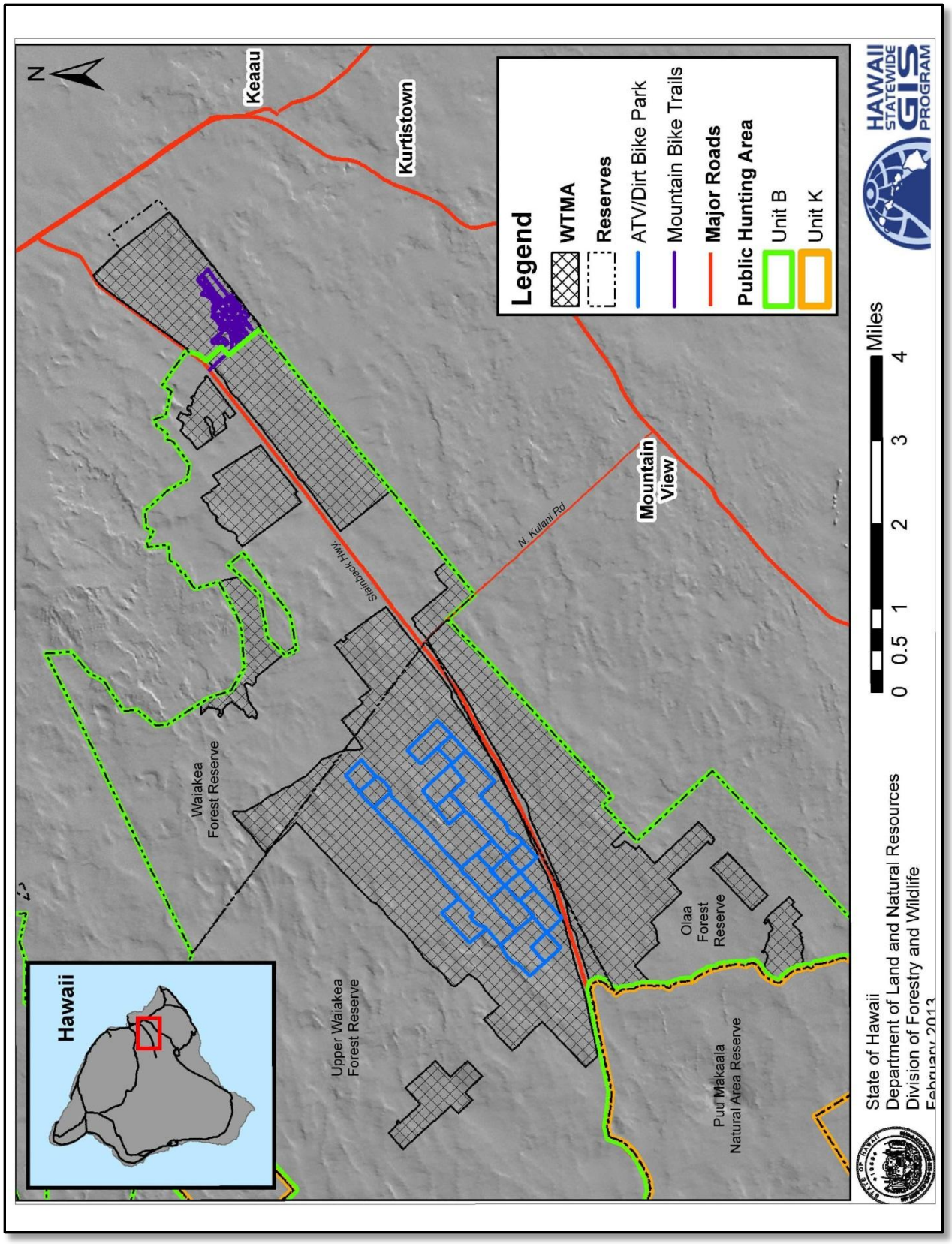

Figure 11. ATV/Dirt Bike Park and Mountain Bike Trails in the Waiākea Timber Management Area

Table 3. Cultivated tree species in the Waiākea Timber Management Area

Tree species (scientific name)	Common name (s)	Acres within project area	% of project area
Eucalyptus salinga & E. grandis	Sydney blue gum	3,745	30
Toona ciliata	Australian toon	3,343	27
Fraxinus uhdei	Tropical ash	1,577	13
Flindersia brayleyana	Queensland maple	1,536	12
Eucalyptus robusta	Swamp mahogany or Swamp messmate	227	2
Cryptomeria japonica	Sugi, Japanese cryptomeria, Japanese cedar	102	>1
Eucalyptus deglupta & E. pilularis	Blackbutt, Rainbow eucalyptus	54	>1
Alnus nepalensis	Nepal alder	24	>1
	Total	**10,608**	**85**

Environment of the Waiākea Timber Management Area

The WTMA is situated on the windward slopes of Mauna Loa Volcano, approximately 5 miles to the southwest of Hilo and from 0.6 to 3.5 miles northwest of the communities of Keaau, Kurtistown and Mountain View. The majority of the WTMA area (approximately 79% or 9,823 acres) is located in Waiākea Ahupua'a in the South Hilo District with the remaining 21% (2,683 acres) situated in 'Ōla'a Ahupua'a in the Puna District.

The 12,506 acre WTMA is comprised of eight discrete parcels that range in size from approximately 193 to 5,981 acres. Based on the USGS quadrangle map (see **Figure 1**) and other maps, the Stainback Highway extends through the WTMA, separating several of the larger parcels. The Stainback Highway's location on the **Figure 3** tax map appears to be inaccurate, depicting the highway further north of its actual location.

There are nine soil types present in the WTMA (Sato *et al.* 1973). These soil types are summarized in **Table 4** and are depicted in **Figure 12**. The nine soil types are Kiloa extremely rocky muck, Keei extremely rocky muck, Papai extremely stony muck, Keaukaha extremely rocky muck, Hilea silty clay loam, two variants of Akaka soils and two variants of Ohia soils.

Table 4. Soil types in the Waiākea Timber Management Area

Soil Type*	Symbol	Acres within WTMA	% of WTMA	Description	Permeability	Runoff	Erozion Hazard	Suitability
Kiloa extremely stony muck (6-20% slopes)	rKXD	7,022	56.1	Muck surface layer (10" thick) over fragmental aa lava substrate	Rapid	Very slow	Slight	Woodland and pasture
Keei extremely rocky muck (6-20% slopes)	rKGD	2,086	16.7	Muck surface layer (10") over pahoehoe lava substrate. Rock outcrops cover 25-50% of surface	Rapid	Medium	Slight	Pasture
Papai extremely stony muck (3-25% slopes)	rPAE	1,192	9.5	Stony muck surface layer (8") over fragmental aa lava substrate	Rapid	Slow	Slight	Woodlands
Akaka silty clay loam (10-20% slopes)	AkD	720	5.8	Silt clay loam surface layer (15") over silt clay loam subsoil (57") dehydrating into aggregates	Rapid	Slow	Slight	Woodlands and watershed
Keaukaha extremely rocky muck (6-20% slopes)	rKFD	869	6.9	Muck surface layer (8") over pahoehoe lava substrate	Rapid	Medium	Slight	Woodland and pasture
Akaka silty clay loam (0-10% slopes)	AkC	528	4.2	Silt clay loam surface layer (15") over silt clay loam subsoil (57") dehydrating into aggregates	Rapid	Medium	Moderate	Sugarcane, pasture, woodlands, wildlife
Hilea silty clay loam (6-20% slopes)	HIC	54	0.4	Silt clay loam surface layer (8") over silt clay loam subsoil (11") over pahoehoe bedrock	Rapid	Medium	Slight	Sugarcane, pasture, woodlands
Ohia extremely stony silty clay loam (0-20% slopes)	OSD	27	0.2	Silt clay loam surface layer (26") with stones covering 3-15% of surface, over fragmental aa lava	Rapid	Slow to medium	Slight to moderate	Sugarcane, pasture, woodlands
Ohia silty clay loam (0-10% slopes)	OHC	8	0.1	Silt clay loam surface layer (9") over silt clay loam subsoil (53") over pahoehoe bedrock	Rapid	Slow	Slight	Sugarcane, pasture, woodlands
Total		12506	100.0					

* Data from Sato *et al.* (1973)

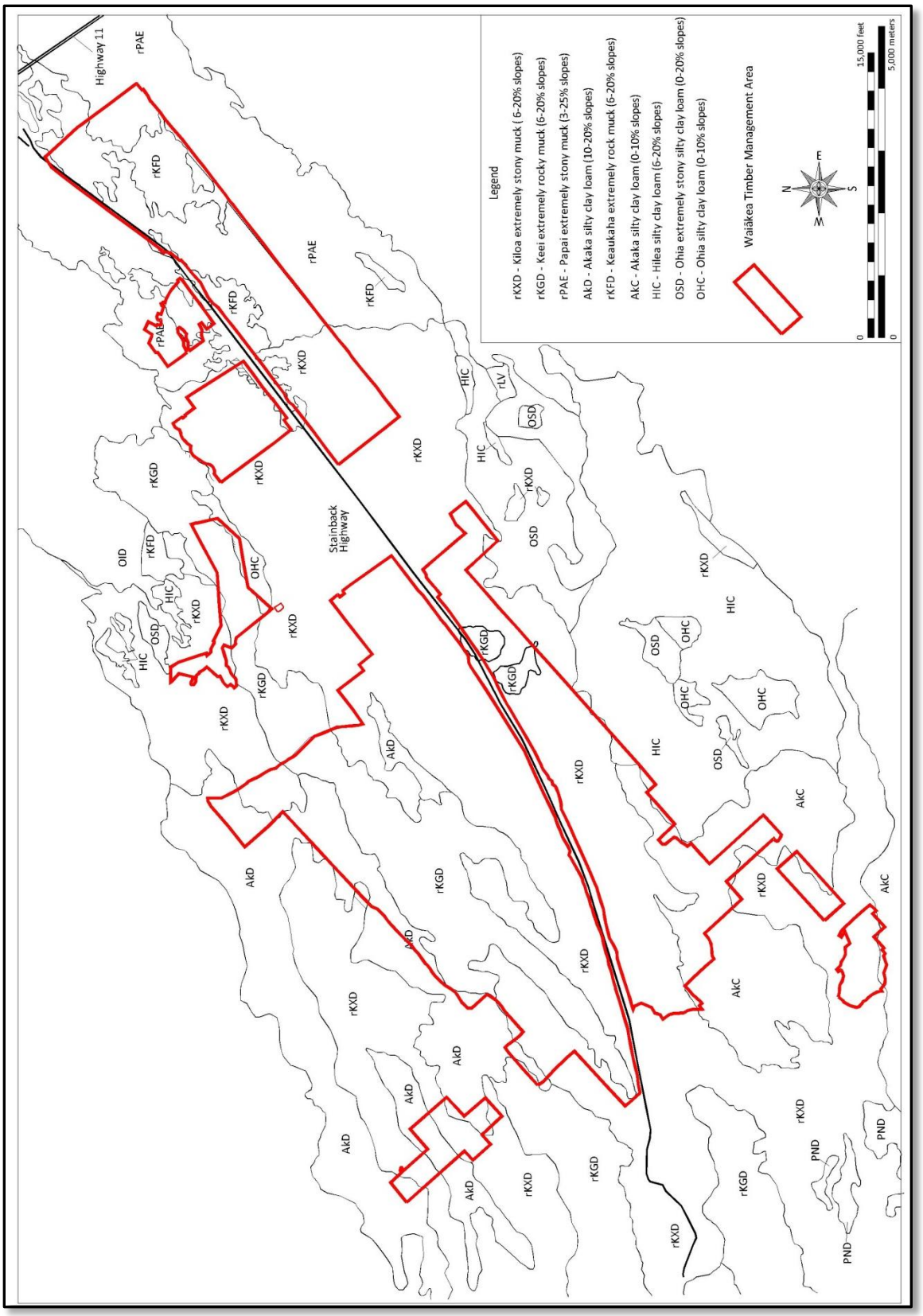

Figure 12. Soils in the Waiākea Timber Management Area (created from Sato *et al.* 1973)

The majority of these soils are shallow (8" to 10") muck deposits overlying either a'a or pahoehoe lava (11,169 acres or 89.3%). The remaining 1,580 acres (10.7%) consist of one to two layers of silt clay loam over fragmental a'a or pahoehoe lava, or a subsoil that dehydrates into aggregates. Eight of the nine soils are classified as suitable for woodlands, comprising 10,420 acres or 83.3% of the WTMA. Seven of the nine soils are suitable for pasture (10,594 acres, 84.73%) and four soils are suitable for the cultivation of sugarcane (617 acres, 4.9%). One soil type is suitable as watershed area (720 acres, 5.8%) and one is suitable for wildlife habitat (528 acres, 4.2%).

The underlying lavas in the WTMA were deposited from Mauna Loa Volcano between 200 and 10,000 years ago (**Table 5** – Wolfe and Morris 2001). The majority of the area is covered by lava flows that date to between 750 and 1,500 years ago (8,878-acres, 71%). Five to ten thousand (5,000-10,000) year old flows encompass approximately 1,940 acres (16%). Two hundred to seven hundred and fifty (200-750) year old flows cover 1,552 acres (12%) and 1,500 to 3,000 year old flows span 136 acres (1%). The distribution of the lava flows is depicted in **Figure 13**.

Table 5. Mauna Loa lava flows in the Waiākea Timber Management Area

Lava flow classification*	k1o	k2	K3	k4	Total
Age of lava flow deposited from Mauna Loa Volcano**	5,000-10,000	1,500-3,000	750-1,500	200-750	-
Acres within project area	1,940	136	8,878	1,552	12,506
% of project area	16	1	71	12	100%

** - data from Wolfe and Morris (2001)*

*** years before present*

The WTMA varies in elevation from approximately 360 ft at the northeastern end to nearly 3,300 ft at the northwestern end (**Figure 14**). **Table 6** presents a summary of elevation in the project area, using a 500 ft interval. The majority of the WTMA is located between 2,000-2,500 ft, comprising 30% of the project area or 3,701 acres. This is followed by the 2,500-3,000 ft elevation range (22%, 2,760 acres), the 1,500-2,000 ft range (18%, 2,196 acres) and the 500-1,000 ft range (14%, 1,715 acres). The smallest percentages of the project area are located at the lowest (0-500 ft; 4%, 507 acres) and highest portions (3,000-3,500 ft; 3%, 440 acres) of the WTMA.

Table 6. Elevation in the Waiākea Timber Management Area

Elevation range* (in feet AMSL)	Acres within WTMA	% of WTMA
0-500	507	4
500-1,000	1715	14
1,000-1,500	1187	9
1,500-2,000	2196	18
2,000-2,500	3701	30
2,500-3,000	2760	22
3,000-3,500	440	3
Total	12506	100

** data from USGS.com*

Rainfall in the WTMA is directly related to elevation, with precipitation increasing from 140-160 inches per year in the seaward, southeastern portion of the area at less than 800 ft elevation, to more

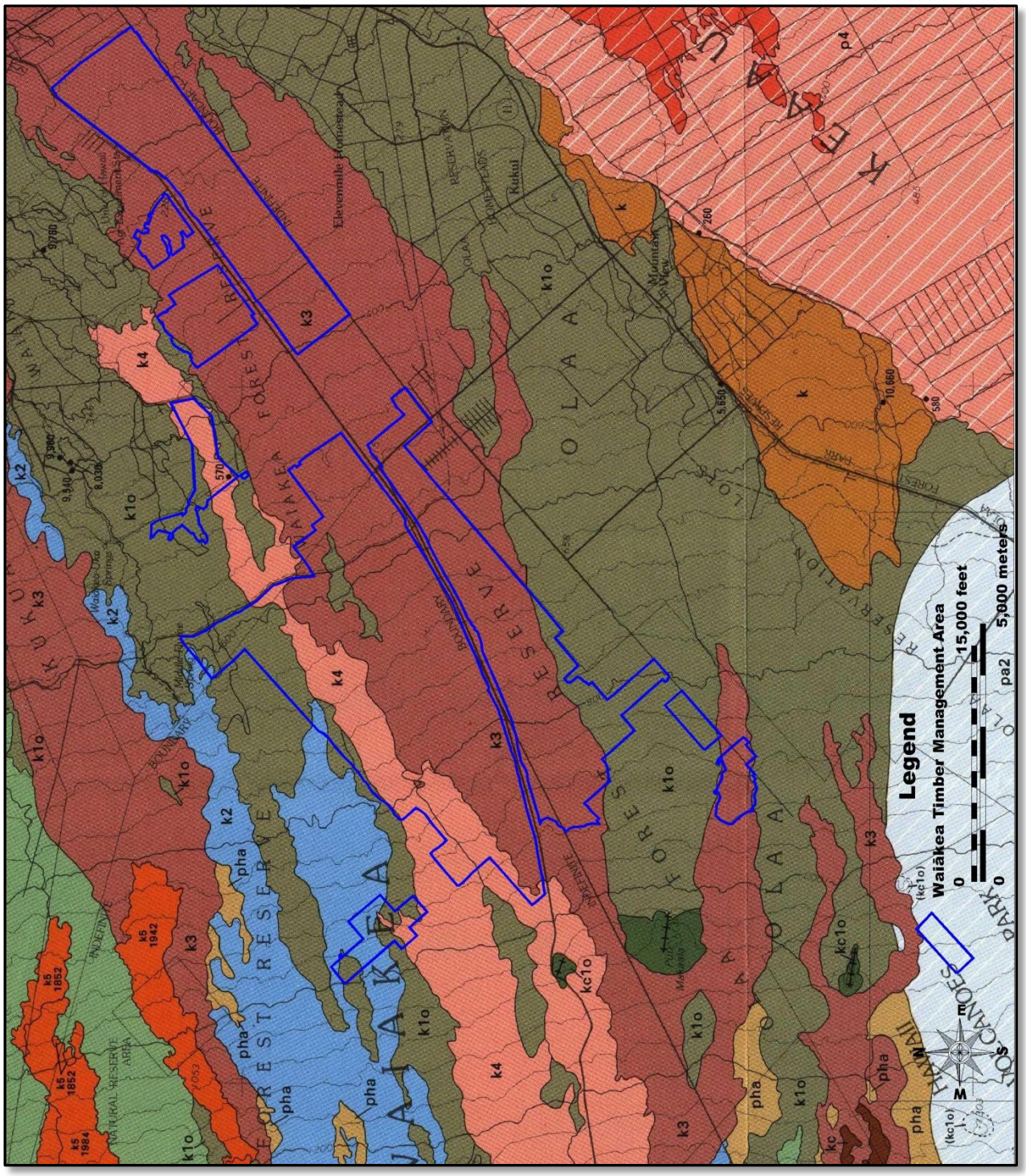

Figure 13. Lava flows in the Waiākea Timber Management Area (modified from Wolfe and Morris 2001)

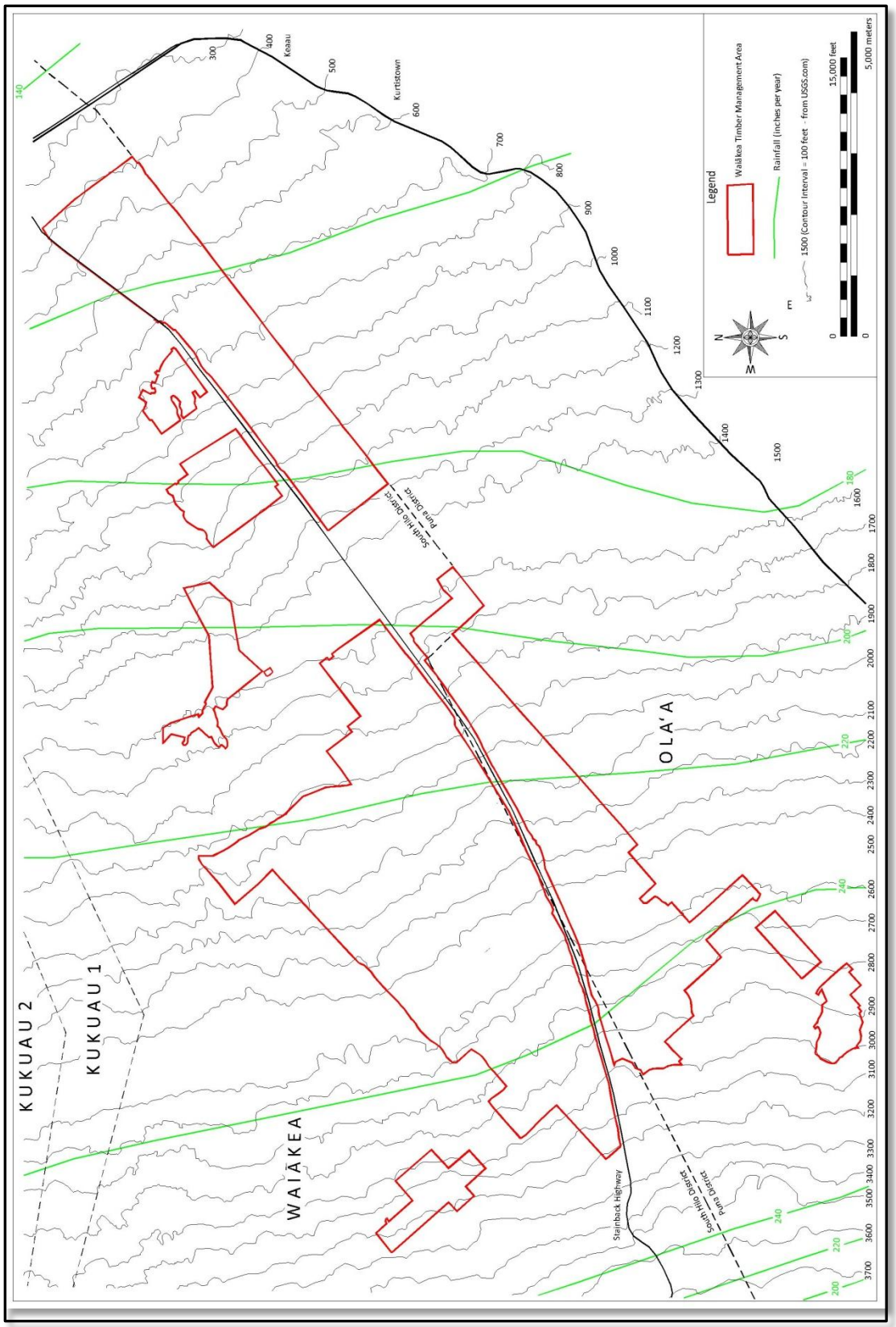

Figure 14. Elevation and rainfall in the Waiākea Timber Management Area

than 240 inches in the inland portion at more than 2,600 ft elevation (see **Figure 14** and **Table 7**). Most of the WTMA (5,352, 43%) receives between 220-240 inches of rainfall per year. This is followed by areas receiving 200-220 inches (19%, 2,329 acres), 160-180 inches (14%, 1,810 acres) and more than 240 inches (11%, 1,396 acres). Approximately 5% of the project area (620 acres) receives 180-200 inches of rainfall a year, and 8% (999 acres) receives 140-160 inches.

Table 7. Rainfall in the Waiākea Timber Management Area

Rainfall range* (inches per year)	Acres within WTMA	% of WTMA	Elevation range (in feet AMSL)
140-160	999	8	>800
160-180	1810	14	600-1,575
180-200	620	5	800-1,900
200-220	2329	19	1,200-2,200
220-240	5352	43	1,900-2,600
240+	1396	11	<2,600
Total	12506	100	

** data from ESRI.com*

McEldowney (1979) used historic documentary and limited site inventory evidence to develop a traditional Hawaiian land use and settlement pattern model for the Hilo area that is applicable to the WTMA. The model consists of five elevationally-defined zones: Coastal Settlement, Upland Agricultural, Lower Forest, Rainforest, and Sub-Alpine or Montane. The Coastal Settlement Zone extended approximately 0.5 miles inland from the shoreline between sea level and 50 ft elevation. The zone was the most densely populated with both permanent and temporary habitations, high status chiefly residences, and *heiau*. Settlements were concentrated at Hilo Bay and sheltered bays and coves. Also present were fishponds and gardens where breadfruit, coconut, *kukui*, banana, *wauke*, sugar cane, sweet potato, and wet and dryland taro were cultivated. The ocean provided fish and other marine resources.

The Upland Agricultural Zone was situated between approximately 50 ft and 1,500 ft elevation. Settlement in the zone was characterized by scattered residences among economically beneficial trees and agricultural plots of dryland taro and bananas. Lava tubes were utilized for shelter. A pattern of shifting cultivation is believed to have converted the original forest vegetation to parkland of grass and scattered groves of trees. Wetland cultivation of taro occurred along streams.

The Lower Forest Zone ranged from 1,500 ft to 2,500 ft elevation. Timber and other forest resources such as medicinal plants, *olona*, and birds were gathered from the zone. Site types consisted of temporary habitations, trials, shrines, and minor agricultural features in forest clearings and along streams. Sites in the Rainforest Zone (2,500-5,000 ft elevation) and Subalpine or Montane Zone (5,000-9,000 ft) were limited to trails and associated temporary habitations. These zones were used for intra-island travel and gathering of valued resources including hardwoods, birds, and stone for tool making.

The WTMA ranges in elevation from approximately 360 feet in the seaward, eastern portion to 3,250 feet in the inland, western portion (**Figure 15**). This elevation range spans three of McEldowney's (1979) settlement pattern zones: the Upland Agricultural Zone, the Lower Forest Zone and the Rainforest Zone (**Table 8**).

The majority of the project area lies in McEldowney's Lower Forest Zone between 1,500 ft and 2,500 ft elevation (5,830-acres, 46% of project). This zone was the source for timber and other forest resources

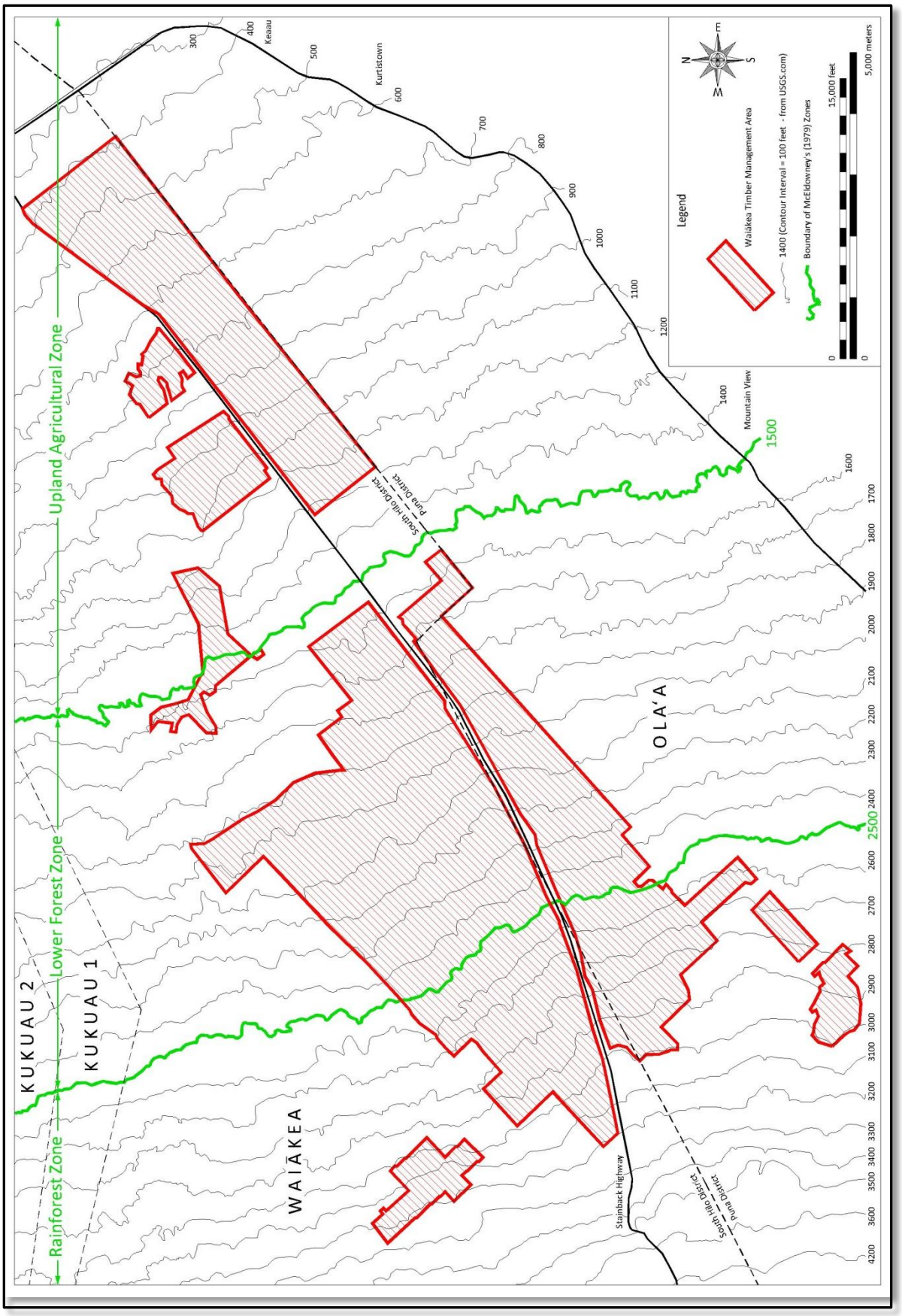

Figure 15. Elevation zones in the Waiākea Timber Management Area

Table 8. Project area elevation zones

McEldowney's (1979) Zone	Acres within project area	% of project area
Upland Agricultural (50-1,500 ft)	3,224	26
Lower Forest (1,500-2,500 ft)	5,830	46
Rainforest (2,500-5,000 ft)	3,452	28
Total	12,506	100

such as medicinal plants, *olona*, and birds. Predicted site types consist of temporary habitations, trials, shrines, and minor agricultural features in forest clearings and along streams.

The Rainforest Zone comprises 28% of the project area (3,452-acres). Sites in this area would likely be limited trails and associated temporary habitations. This zone was used for intra-island travel and gathering of resources including hardwoods and birds. Sites in the Upland Agricultural Zone (3,224-acres, 26%) would likely consist of trails and associated temporary habitation sites such as lava tubes.

Previous archaeological work

Three studies have been conducted in or immediately adjacent to the WTMA. These include a field inspection reported by Nagata (1985) and two inventory surveys conducted by Cultural Surveys Hawai'i, Inc. (CSH; Hammatt and Bush 1999a and 1999b). On February 12, 1985, a cave in TMK (3) 2-4-08:022, in the seaward portion of the WTMA (**Figure 16)** was examined by State staff archaeologist, Wendall Kam (Nagata 1985). This cave was discovered by the director of the Hawai'i County Economic Opportunity Council, Mr. George Yokoyama during examination of a planned agricultural area.

Although the cave was not mapped, it was described as approximately 150 feet long by 20 feet wide. Two adult human burials were found in the cave with no other evidence of cultural modification. The letter report states that "…the cave is relatively unstable, interior settling appears recent (i.e. ceiling collapse) and evidence of material filling the entry via the natural processes (i.e. water drainage and corresponding damage to the walls)…" It was recommended that a 75 foot buffer zone be established around the cave entrance and that all vehicular traffic in the area be restricted to prevent damage to the site. The cave was subsequently assigned State Inventory of Historic Places (SIHP) Site No. 50-10-35-18697.

In 1999, CSH conducted an archaeological inventory survey of a 10 mile long section of the Stainback Highway in conjunction with proposed improvements to the road (Hammatt and Bush 1999a). This survey covered an estimated 95 acre area that paralleled each side the existing highway, extending through the WTMA in a northeast by southwest direction. The project was conducted in three phases: (a) an aerial survey by helicopter; (b) a pedestrian survey that extended 20 to 40 feet beyond the pavement edge on either side of the road and (c) examination of several lava tubes located outside the road corridor.

No archaeological sites were found during the survey; however, 25 non-cultural features were identified. None of these features are within the boundaries of the WTMA (**Figure 17**). The majority of the features (17) consist of small lava blisters (Temporary Sites CSH-1, 2, 5-7, 9, 10, 12, 13, and 16-23), with the remainder comprised of four lava tubes (CSH-3, 4, 8 and 11), two sinkholes with associated lava tubes (CSH-14 and 15), a possible stone alignment (CSH-24) and a pavement area (CSH-25). The 23 blisters and tubes contained no indigenous cultural remains or modification and were interpreted as natural features. Most were breached during the construction of Stainback Highway. One of the sinkhole tubes (CSH-15) was used as a trash dump in recent years based on the presence of approximately 100 plastic bags of garbage.

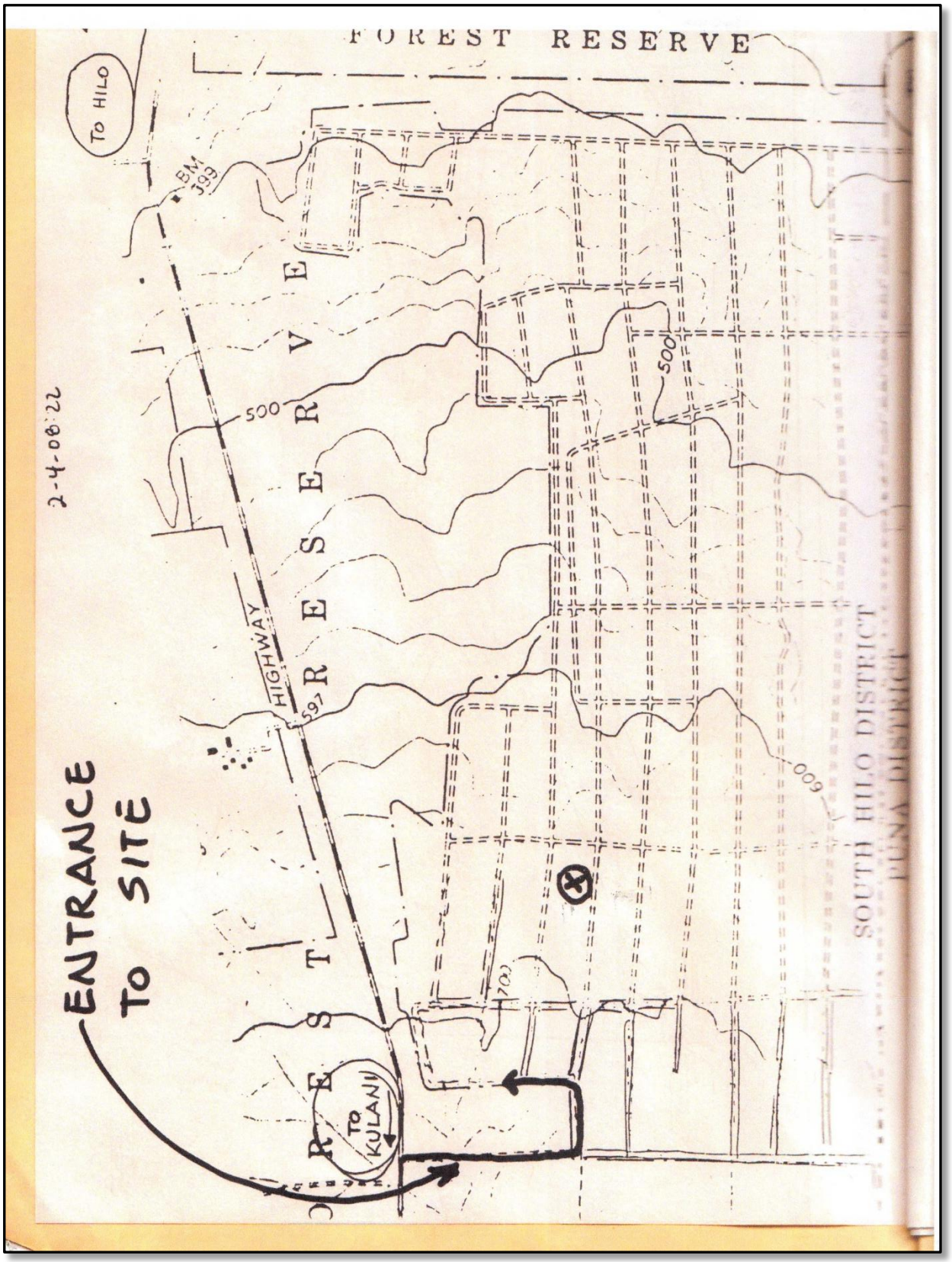

Figure 16. Reported location of Site 18697 burial cave

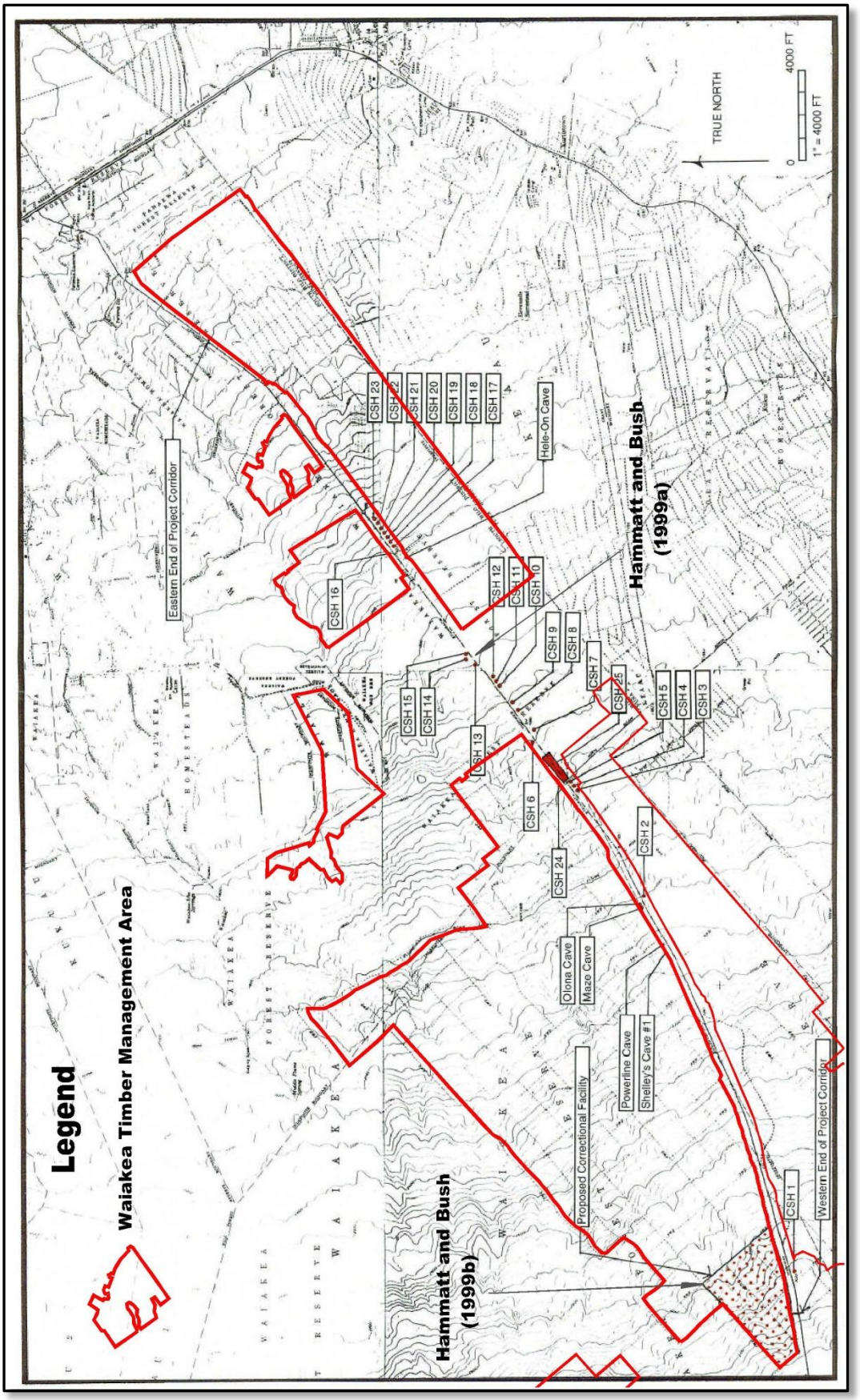

Figure 17. Cultural Surveys Hawaii, Inc. Stainback Highway site location map

CSH-24 is a circular stone alignment that Hammatt and Bush postulate may be a modern burial. A pot with flowers in it was present on top of the alignment with a note to "Dad" placed inside. A pig skull was noted adjacent to the flower pot. CSH-25 is adjacent to a section of the Stainback Highway that is 12 feet wider than the rest of the road. Research conducted by Hammatt and Bush (1999a:22) indicate that this wider section may have been a small aircraft landing strip associated with the Kulani Prison Camp.

Five additional lava tubes located outside the Stainback Highway corridor were also examined by Hammatt and Bush (1999a). These tubes were previously noted by entomologists conducting research in conjunction with a proposed new correctional facility to be located along the Stainback Highway (Howarth *et al.* 1999). The caves were named during the Howarth *et al.* study. The researchers named the caves "Powerline Cave", "Shelley's Cave #1", "Olona Cave", "Maze Cave" and "Hele-On Cave" (*see* **Figure 17**). Hammatt and Bush (1999a) explored each of these caves and no cultural remains or modifications were identified.

Hammatt and Bush (1999b) also conducted an inventory survey of the approximately 280 acre proposed New Hawai'i Island Correctional Facility, located along the northern side of Stainback Highway at the inland end of their Stainback Highway improvements project area (see **Figure 17**). This area is situated within the boundaries of the WTMA. The survey identified three lava tubes, but none had cultural remains or evidence of use. The remainder of the area was extensively impacted by bulldozer activity associated with reforestation.

A portion of the historic 'Ōla'a Flume extends through the central portion of the WTMA, roughly following the 1,800 ft contour (**Figure 18**). The main flume originated at the 'Ōla'a Flume Spring, located north of the WTMA in Punahou 2 Ahupua'a (**Figure 19**). The flume extended downslope to the 'Ōla'a Mill located seaward of Kea'au town, with numerous branches that provided irrigation water throughout the plantation. The 'Ōla'a Flume Trail/Road parallels the flume and was used to maintain the irrigation system. A section of the flume was identified during an archaeological survey conducted in conjunction with improvements to the Saddle Road and was designated SIHP Site 50-10-34-20870 (Langlas *et al.* 1997).

As depicted in **Figure 18***,* two flume houses (Upper and Lower) used to control the flow of water were located along the 'Ōla'a Flume. The Lower Flume House was situated in the WTMA in 'Ōla'a Ahupua'a at approximately 1,875 ft elevation. The Upper Flume House was situated outside the project area approximately 700 meters north of the WTMA.

A review of historic maps of the area indicate that a portion of the 'Ōla'a Back Road extends through or along the boundary of the WTMA. This road extended out of the Olaa Lots area and was likely used by the inhabitants of this subdivision. The presence of the road on the early 20th Century map of the indicates its historic origin.

RESEARCH DESIGN

The AIS field work consisted of a 5% sample survey of the project area. The 12,506-acre WTMA project area contains several areas that were excluded from the area to be sampled (**Figure 20**). These areas consist of 779 acres planted in native hardwoods and 28 acres of experimental hardwoods, which will not be harvested, 349 acres of block roads, 285 acres of former sugarcane lands, and a 35 acre staging area that was previously developed. The exclusion of these areas reduces the area to be sampled by twelve percent from 12,506-acres to 10,995 acres. The AIS 5% sample survey area encompasses 549 acres of the

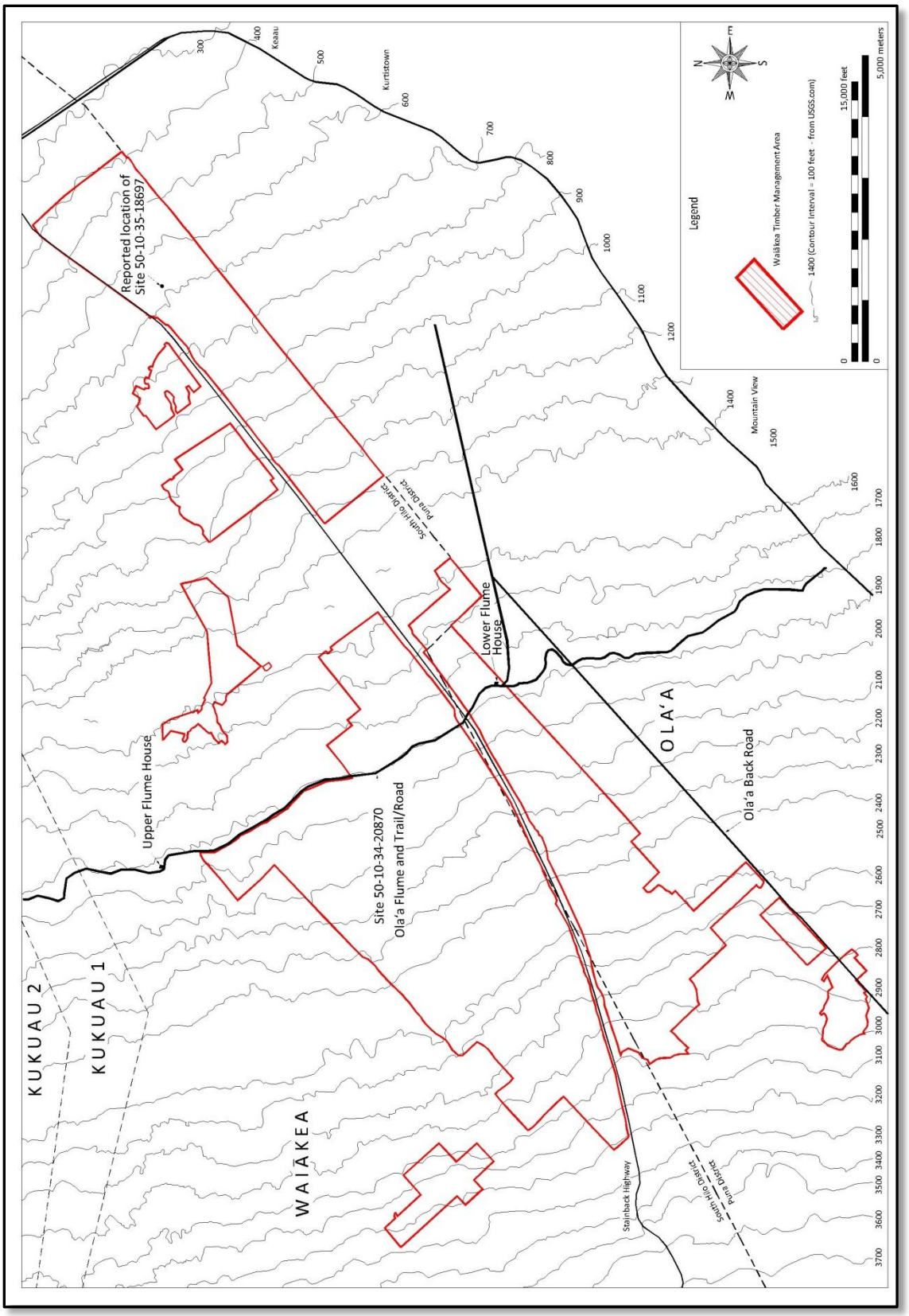

Figure 18. Known sites in the WTMA

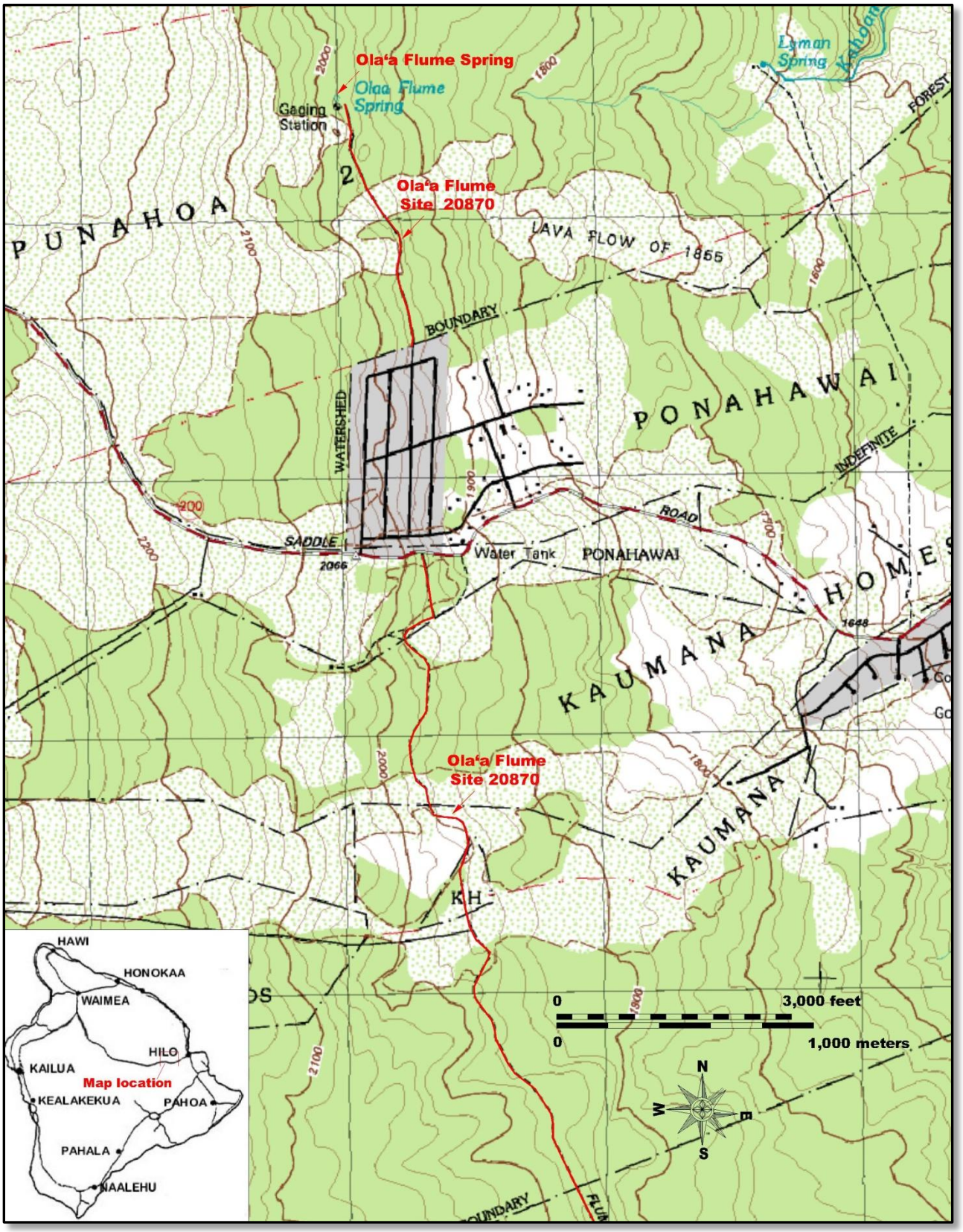

Figure 19. Portion of 1997 7.5' Piihonua quadrangle showing ʻŌlaʻa Flume and Spring

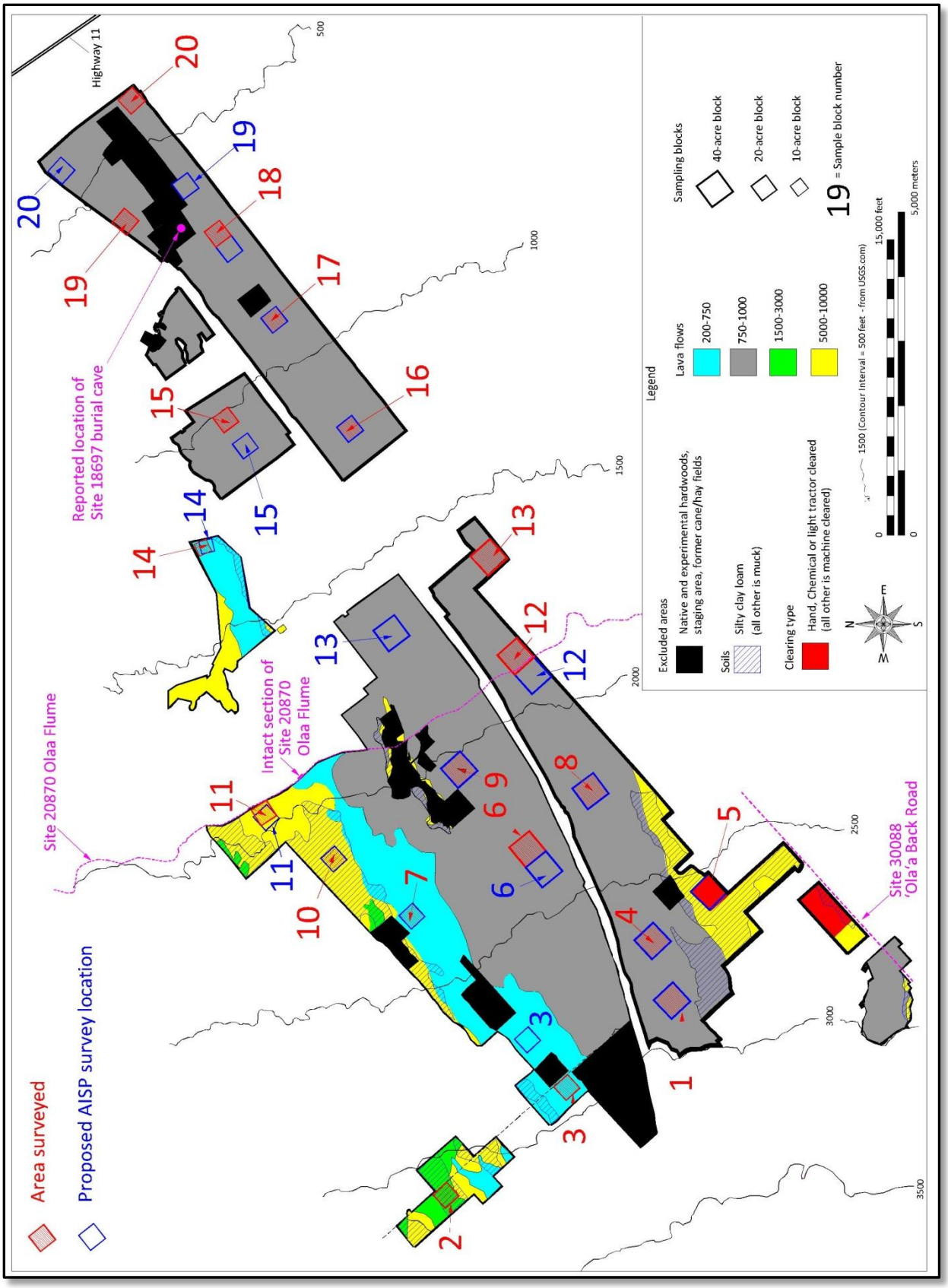

Figure 20. Environmental variables and proposed and surveyed sampling blocks

remaining 10,995 acre project area. DLNR-SHPD requested that two-thirds of the sample be located below 2,500 ft elevation and the remaining one-third located above 2,500 ft.

The AIS sample is a judgmental quadrat design that is based on obtaining a representative sample of three primary environmental variables: elevation, soil type, and lava flow age. Elevation-based sampling also captures variability in rainfall and temperature in the WTMA area where these variables are directly related to elevation. The proposed AIS sample also includes areas that were mechanically cleared for planting and areas cleared by other means. As discussed by McEldowney (1979), traditional Hawaiian settlement patterning in the Hilo area, including the WTMA can be characterized in terms of five elevationally-defined zones: Coastal Settlement, Upland Agricultural, Lower Forest, Rainforest, and Sub-Alpine or Montane. The project area contains portions of McEldowney's Upland Agricultural, Lower Forest, and Rainforest Zones.

According to Sato *et al*. (1973) the majority of the soils in the WTMA are shallow muck deposits overlying lava substrate (11,169 acres or 89.3%). The remaining 1,580 acres (10.7%) consist of one to two layers of silt clay loam over fragmental a'a or pahoehoe lava, or a subsoil of decomposed lava. The underlying lavas in the area were deposited from Mauna Loa Volcano between 200 and 10,000 years ago. The majority of the area is characterized by lava flows that date to between 750 and 1,500 years ago (8,878 acres, 71% of the project area). This is followed by 5,000-10,000 year old flows (1,940 acres, 16%), 200-750 year old flows (1,552 acres, 12%) and 1,500-3,000 year old flows (136 acres, 1%).

As indicated in **Table 2** nearly all of the areas planted in the WTMA were mechanically cleared. Only 124 acres were not machine-cleared consisting of 84 acres cleared by hand and 40 acres cleared either by hand, chemical or light tractor.

Table 9 summarizes environmental variables in the entire 12,506 acre WTMA that are potentially predictive for settlement patterning. These variables are soil type (shallow muck or silty clay loam), lava flow age, and McEldowney's elevation-based settlement zone. The mode of reforestation-related land clearing is also included because of its potential effect on site distribution. The table subdivides the data into areas below and above 2,500 ft elevation and gives the percentage composition based on the total acreage in each subdivision in 500 ft elevation range increments. These percentages are used to determine the acreage of the proposed AIS sample by elevation range increment. These acreages are rounded to multiples of 20 acres to facilitate fieldwork because much of the WTMA is divided into 40 acre blocks. The distribution of the environmental variables is depicted in **Figure 20**.

Table 9. Environmental variables in the WTMA

Elevation Zone	Elev. Zone Acreage	Elev. Zone Percent	AIS sample acreage by elevation zone %	AIS Sample Rounded to multiple of 20 acres	Acreage by McEldowney Zone			Soil type (acres)		Age (BP) and acreage of lava flows				Acres Cleared by hand, chemical or light tractor*
					Upland Agriculture	Lower Forest	Rainforest	Shallow muck	Silty clay loam	200-750	750-1000	1500-3000	5000-10000	
Below 2500 ft elevation (70% of AIS sample = 382 acres)														
0-500	507	5	**19**	**20**	487			507			507			
500-1000	1715	18	**69**	**60**	1612			1715			1715			
1000-1500	1187	13	**50**	**40**	1125			1167	20	161	993		33	
1500-2000	2196	24	**92**	**100**		2157		2069	127	107	1692		397	
2000-2500	3701	40	**153**	**160**		3673		3136	565	596	2426	56	623	
Sub-Total	**9306**	**100**	**382**	**380**	**3224**	**5830**		**8594**	**712**	**864**	**7333**	**56**	**1053**	
Above 2500 ft elevation (30% of AIS sample = 164 acres)														
2500-3000	2760	86	**141**	**140**			2969	2277	483	584	1431	11	734	124
3000-3500	440	14	**23**	**20**			483	298	142	104	114	69	153	
Sub-Total	**3200**	**100**	**164**	**160**			**3452**	**2575**	**625**	**688**	**1545**	**80**	**887**	**124**
Grand Total	**12506**	**200**	**546**	**540**	**3224**	**5830**	**3452**	**11169**	**1337**	**1552**	**8878**	**136**	**1940**	**124**

* All other areas machine-cleared

Using the elevation-based AIS sample acreage breakdown discussed above, 20 AIS sample survey blocks were positioned based on elevation, lava flow age and soil type (**Table 10**). The blocks range from 10 to 40 acres in area and comprise a total of 550 acres. The locations of the blocks proposed in the AIS plan were approximate and were based on data currently available. The precise location of the blocks was adjusted in several instances during the AIS survey based on accessibility and other field conditions.

Table 10. Summary of proposed sample blocks

Sampling block	Acreage	Elevation range (ft)	Soil	Lava flow age (BP)	Clearing type
1	40	2500-3000	Muck	750-1000	Machine
2	20	>3000	Silty clay loam	1500-3000	Machine
3	20	2500-3000	Muck	200-750	Machine
4	40	2500-3000	Muck	750-1000	Machine
5	40	2500-3000	Silty clay loam	5000-10000	Hand, chemical or light tractor
6	40	2000-2500	Muck	750-1000	Machine
7	20	2000-2500	Muck	200-750	Machine
8	40	2000-2500	Muck	750-1000	Machine
9	40	2000-2500	Muck	750-1000	Machine
10	20	2000-2500	Silty clay loam	5000-10000	Machine
11	20	1500-2000	Muck	5000-10000	Machine
12	40	1500-2000	Muck	750-1000	Machine
13	40	1500-2000	Muck	750-1000	Machine
14	10	1000-1500	Muck	200-750	Machine
15	20	1000-1500	Muck	750-1000	Machine
16	20	1000-1500	Muck	750-1000	Machine
17	20	500-1000	Muck	750-1000	Machine
18	20	500-1000	Muck	750-1000	Machine
19	20	500-1000	Muck	750-1000	Machine
20	20	<500	Muck	750-1000	Machine
Total	**550**				

Table 11 compares the acreage and percentage composition by environmental variable for the entire WTMA with the proposed sample for the AIS. The percentages demonstrate the representativeness of the proposed AIS sample.

Table 11. Comparison of environmental variables in WTMA and proposed AIS sample

AIS sample acreage compared with overall acreage by sample variables	Acreage by McEldowney Zone			Soil type (acres)		Age (BP) and acreage of lava flows				Acres Cleared by hand, chemical or light tractor*
	Upland Agriculture	Lower Forest	Rainforest	Shallow muck	Silty clay loam	200-750	750-1000	1500-3000	5000-10000	
Total acres	3224	5830	3452	11169	1337	1552	8878	136	1940	124
% of WTMA	26	46	28	89	11	12	71	1	16	0.99
Acres in proposed sample	130	260	160	470	80	50	400	20	80	40
% of proposed sample	24	47	29	85	15	9	73	4	14	7

The Research Design in the AISP also indicated that efforts would be made to relocate several previously identified sites in the WTMA. These consist of the ʻŌlaʻa Flume (Site 50-10-34-20870), the Site 50-10-35-18697 burial cave, and the ʻŌlaʻa Back Road. These sites are discussed in detail in the following Findings section and their reported locations are presented in **Figure 20**.

Sample blocks examined during project

The survey examined 20 sample blocks that ranged in area from 10 to 40 acres. The environmental characteristics of the blocks are summarized in **Table 12**. These characteristics are elevation, McEldowney elevation-defined zone, vegetation, soil type, lava flow age, and method of clearing prior to tree planting.

As stated, the locations of several survey sample blocks were adjusted during the AIS fieldwork. These adjustments were made facilitate access, ground visibility, and other conditions. The proposed location of the survey blocks from the AISP and the locations surveyed during the fieldwork are presented in **Figure 20**. The environmental characteristics of the survey blocks are discussed below.

The survey identified nine non-cultural, subterranean features in Blocks 1, 4, 6, 7 and 19. These features are designated as NCC-1 through NCC-9 (Non-Cultural Cave) and consist of four lava blisters, one lava tube, one sinkhole with an overhang in it, and 3 fissures containing overhang areas (**Table 13**). These features were carefully examined during the AIS fieldwork and no cultural remains, modifications or evidence of use are present. The ten NCCs are discussed below, in the block discussion in where they are located.

Block 1 is a 40 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 2,840 to 2,920 feet. The block is located along the southwestern side of "P" Road, 295 meters (0.18 miles) southeast of the Stainback Highway (**Figure 21**). It is bordered by unnamed, mostly overgrown dirt roads along the northwest, southwest and southeast sides.

The canopy vegetation in this block includes Australian toon (*Toona ciliata*), tropical ash (*Fraxinus uhdei*), *ohia* (*Metrosideros polymorpha*), and jacaranda (*Jacaranda mimosaefolia*) with an understory of *uluhe* (*Dicranopteris spp.*), *hapu'u* fern (*Cibotium spp*.), strawberry guava (*Psidium cattleianum*), and bamboo orchid (*Arundina graminifolia*). An overview of Block 1 is depicted in **Figure 22**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 1 was previously cleared by machine.

The survey of Block 1 identified a non-cultural sinkhole in the northeastern corner that contains a slight overhang (NCC-4). A modern "Owens Illinois" glass jug with a screw top was noted 205 meters to the southeast of NCC-4.

Block 2 is a 20 acre survey area located in the southwestern half of the WTMA between approximately 3,110 and 3,190 feet elevation. The block is located along the southwestern side of "P" Road, 3,850 meters (2.39 miles) northwest of the Stainback Highway (**Figure 23**). The canopy vegetation includes Australian toon, tropical ash and *ohia* with an understory of *uluhe*, *hapu'u*, strawberry guava and Koster's curse (*Clidemia hirta*). Block 2 vegetation is depicted in **Figure 24**. The soil is Akaka silty clay loam on 10-20% slopes with the underlying lava deposited 1,500 to 3,000 years ago. According to DOFAW records, Block 1 was previously cleared by machine.

Block 3 is a 20 acre survey area located in the southwestern half of the WTMA between approximately 2,890 and 2,950 feet elevation. The block is located along the southwestern side of "P" Road, 1,350 meters (0.83 miles) northwest of the Stainback Highway (**Figure 25**). It is bordered by an unnamed, accessible dirt road along the southeast side. The AISP-proposed location of Block 3 is 670 meters northeast of its surveyed location. It was relocated during the survey fieldwork because of difficult access to the AISP-proposed location.

Table 12. Summary of Sample Blocks

Sampling block	Acreage	Elevation (ft)	Location	McEldowney (1979) Zone	Canopy vegetation	Understory vegetation	Soil	Lava flow age (BP)	Clearing type
1	40	2,840-2,920	Original	Rainforest	Austrailian toon, Tropical ash, *Ohia, Jacaranda*	*Uluhe, hapu'u,* strawberry guava, bamboo orchid	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
2	20	3,110-3,190	Original	Rainforest	Austrailian toon, Tropical ash, *Ohia*	*Uluhe, hapu'u,* strawberry guava, Koster's curse	Akaka silty clay loam (10-20% slopes)	1,500-3,000	Machine
3	20	2,890-2,950	Revised	Rainforest	Eucalyptus, Austrailian toon, Tropical ash	*Hapu'u,* strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	200-750	Machine
4	40	2,610-2,740	Original	Rainforest	Tropical ash, *Ohia,* Jacaranda	*Uluhe, hapu'u,* strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
5	40	2,520-2,660	Original	Rainforest	Austrailian toon, Queensland maple, *Ohia*	*Hapu'u,* strawberry guava, Koster's curse	Akaka silty clay loam (0-12% slopes)	5,000-10,000	Hand, chemical or light tractor
6	40	2,340-2,405	Revised	Lower Forest	Eucalyptus	*Uluhe, hapu'u,* strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
7	20	2,250-2,310	Original	Lower Forest	Eucalyptus, Austrailian toon, *Ohia*	*Hapu'u,* strawberry guava, Koster's curse, palm grass	Keei extremely rocky muck (6-20% slopes)	200-750	Machine
8	40	2,150-2,240	Original	Lower Forest	Eucalyptus	*Hapu'u,* strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
9	40	2,000-2060	Original	Lower Forest	Eucalyptus	*Hapu'u,* strawberry guava, Koster's curse, palm grass	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
10	20	2,060-2,100	Original	Lower Forest	Eucalyptus, *Ohia*	*Uluhe, hapu'u,* palm grass	Akaka silty clay loam (10-20% slopes)	5,000-10,000	Machine
11	20	1,910-1,980	Revised	Lower Forest	Austrailian toon, *Ohia, Koa*	*Uluhe*, strawberry guava, molasses grass	Kiloa extremely stony muck (6-20% slopes)	5,000-10,000	Machine
12	40	1,840-1,900	Revised	Lower Forest	Eucalyptus, *Ohia*	*Uluhe,* strawberry guava, Koster's curse, bamboo orchid	Kiloa extremely stony muck (6-20% slopes) and Keei extremely rocky muck (6-20% slopes)	750-1,000	Machine
13	40	1,600-1,670	Revised	Lower Forest	Eucalyptus	Strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
14	10	1,170-1,220	Revised	Upland Agricultural	Eucalyptus	*Uluhe*, strawberry guava, Koster's curse, Rose myrtle	Keei extremely rocky muck (6-20% slopes)	200-750	Machine
15	20	1,000-1,050	Revised	Upland Agricultural	Queensland maple, Eucalyptus, Austrailian toon, *Ohia*	*Uluhe*, strawberry guava, Koster's curse, Rose myrtle	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
16	20	1,170-1,230	Original	Upland Agricultural	Eucalyptus	*Uluhe,* strawberry guava, Koster's curse	Kiloa extremely stony muck (6-20% slopes)	750-1,000	Machine
17	20	860-905	Original	Upland Agricultural	Eucalyptus	*Uluhe,* strawberry guava, Koster's curse	Papai extremely stony muck (3-25% slopes)	750-1,000	Machine
18	20	680-730	Revised	Upland Agricultural	Eucalyptus	Koster's curse, *lauae*	Papai extremely stony muck (3-25% slopes) and Keaukaha extremely rocky muck (6-20% slopes)	750-1,000	Machine
19	20	560-605	Revised	Upland Agricultural	*Ohia,* Palm	*Hapu'u,* strawberry guava, Koster's curse	Papai extremely stony muck (3-25 % slopes)	750-1,000	Machine
20	20	395-440	Revised	Upland Agricultural	Eucalyptus	*Hapu'u,* strawberry guava, Koster's curse	Papai extremely stony muck (3-25 % slopes)	750-1,000	Machine
Total	**550**								

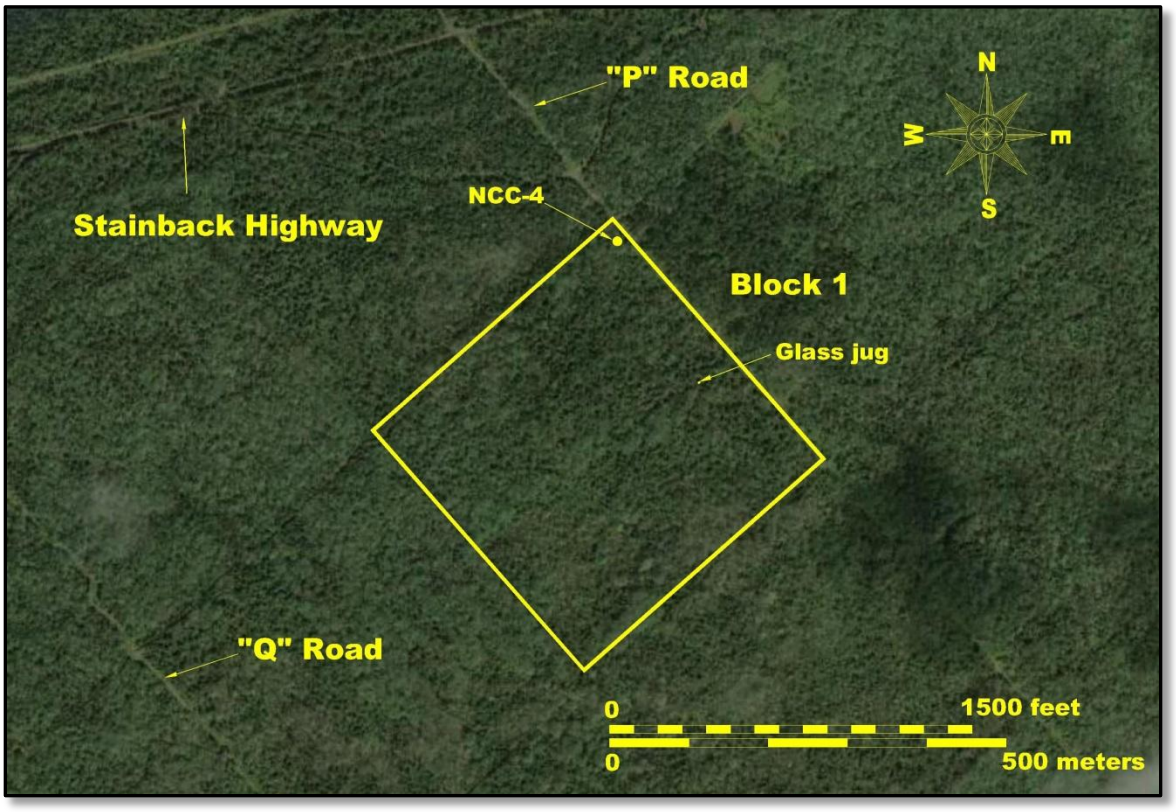

Figure 21. Aerial view of Block 1 (from Google Earth)

Figure 22. Block 1 vegetation (view to southwest)

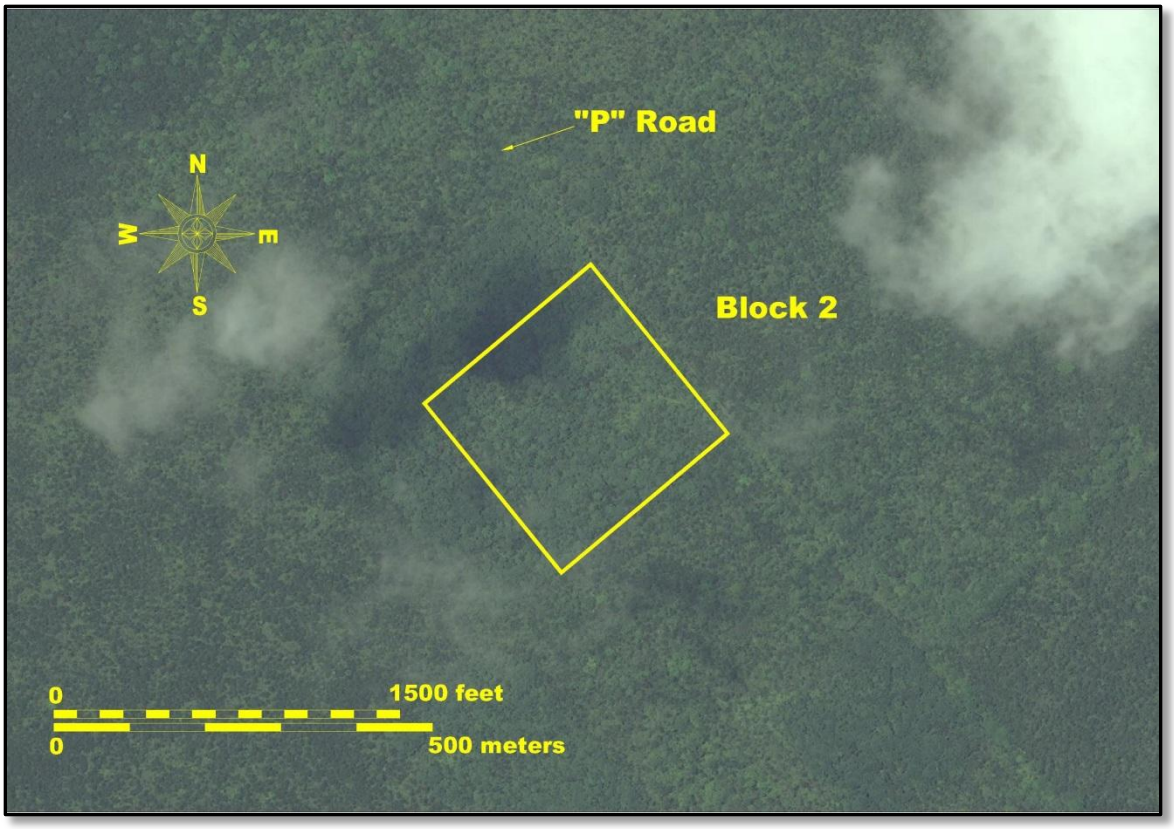

Figure 23. Aerial view of Block 2 (from Esri.com)

Figure 24. Block 2 vegetation (view to northeast)

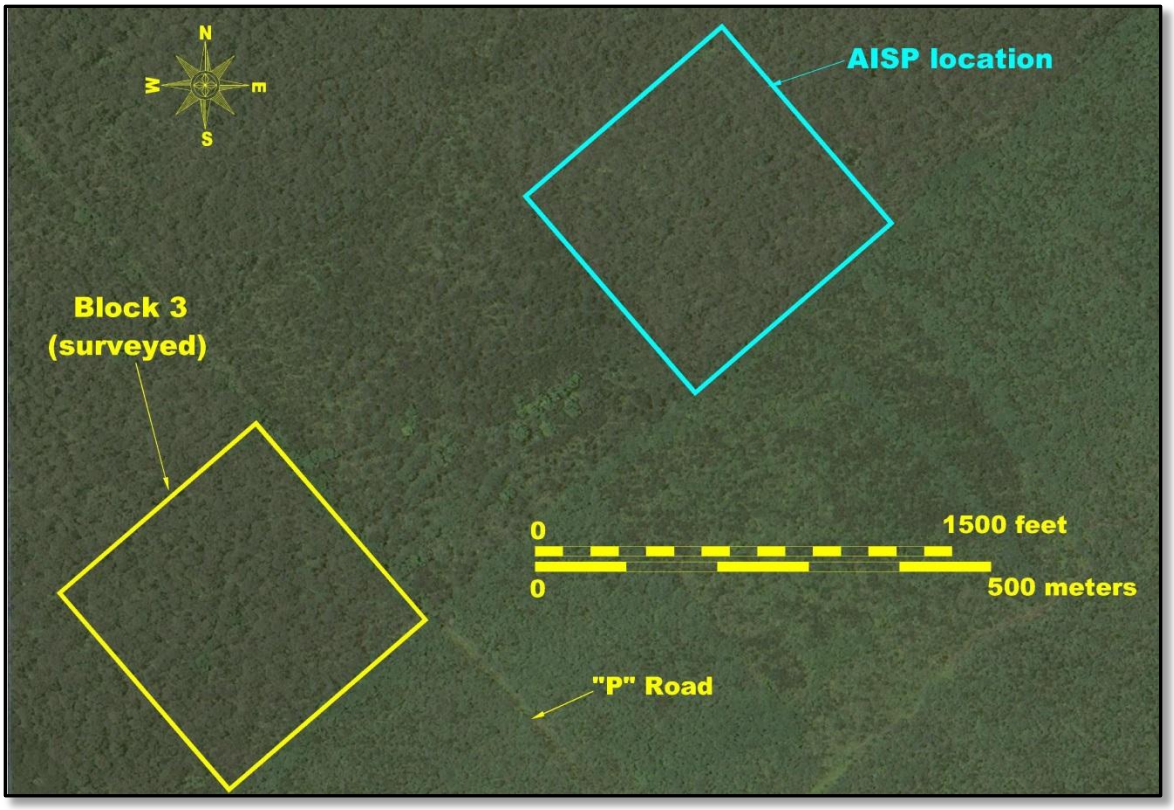

Figure 25. Aerial view of Block 3 (from Esri.com)

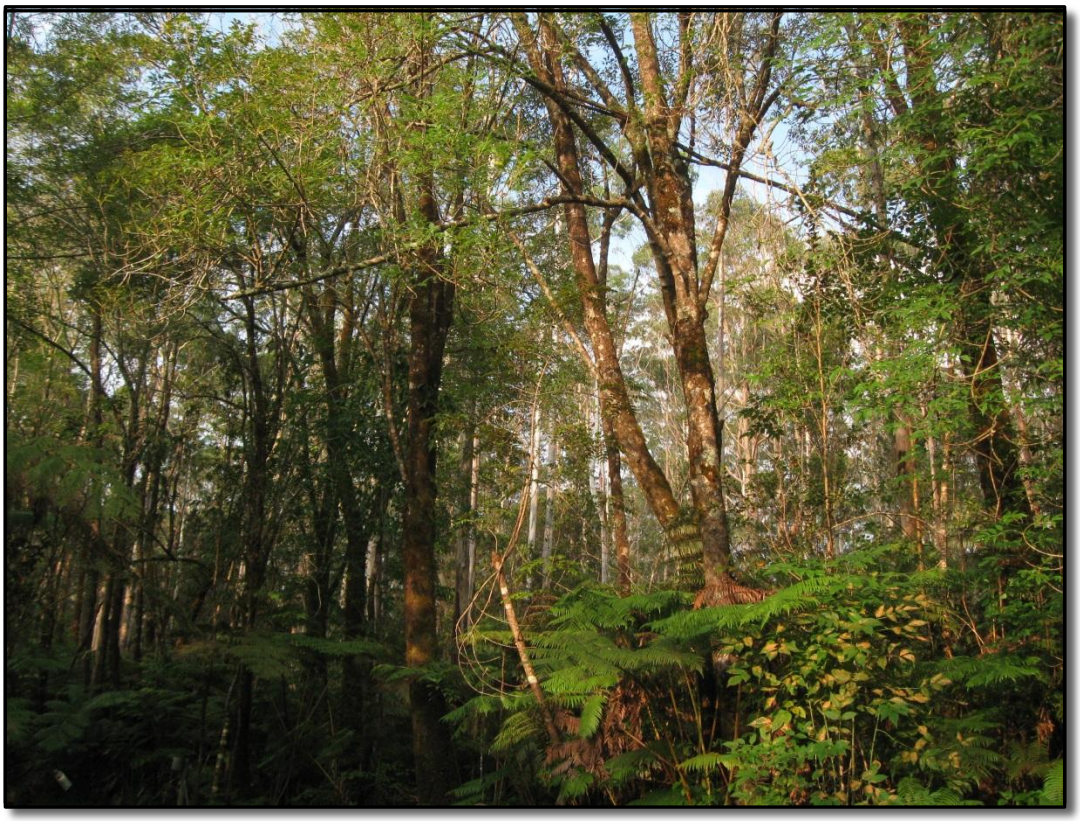

Figure 26. Block 3 vegetation (view to northeast)

Table 13. Summary of Non-cultural caves

NCC No.	Cell	Type	Easting	Northing
1	6	Fissure with overhang	272446	2167162
2	6	Fissure with overhang	272488	2167432
3	6	Fissure with overhang	272459	2172428
4	1	Sinkhole with overhang	269923	2165494
5	4	Lava blister	270687	2165451
6	4	Lava blister	270666	2165456
7	7	Lava tube	271346	2169164
8	7	Lava blister	271272	2169221
9	19	Lava blister	282256	2173163

The canopy vegetation in Block 3 includes eucalyptus (*Eucalyptus* spp.), Australian toon, and tropical ash with an understory of *hapu'u*, strawberry guava, and Koster's curse. Block 3 vegetation is shown in **Figure 26**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 200 to 750 years ago. According to DOFAW records, Block 3 was previously cleared by machine.

Block 4 is a 40 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 2,610 to 2,740 feet. The block is located along the southeastern side of an unnamed accessible dirt road, 400 meters (0.25 miles) northeast of Block 1 (**Figure 27**). The remaining sides of the block are bordered by overgrown dirt roads.

The canopy vegetation includes tropical ash, *ohia* and jacaranda with an understory of *uluhe*, *hapu'u* fern, strawberry guava, and Koster's curse. Block 4 vegetation is depicted in **Figure 28**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 4 was previously cleared by machine.

The survey of Block 4 identified two small, non-cultural lava blisters (NCC-5 and NCC-6 – see **Figure 27**). These natural features are located in the west-central portion of the block.

Block 5 is a 40 acre survey area located in the southwestern half of the WTMA between approximately 2,520 and 2,660 feet elevation. The block is located along the southeastern side of an unnamed, mostly overgrown dirt road, 400 meters (0.25 miles) northeast of "P" Road (**Figure 29**). The remaining sides of the block are bordered by overgrown dirt roads.

The canopy vegetation in this block includes Queensland maple (*Flindersia brayleyana*), Australian toon and *ohia* with an understory of *hapu'u* fern, strawberry guava and Koster's curse. Block 5 vegetation is depicted in **Figure 30**. The soil is Akaka silty clay loam on 0-12% slopes with the underlying lava deposited 5,000 to 10,000 years ago. According to DOFAW records, Block 5 was cleared either by hand, with chemicals or by light tractor.

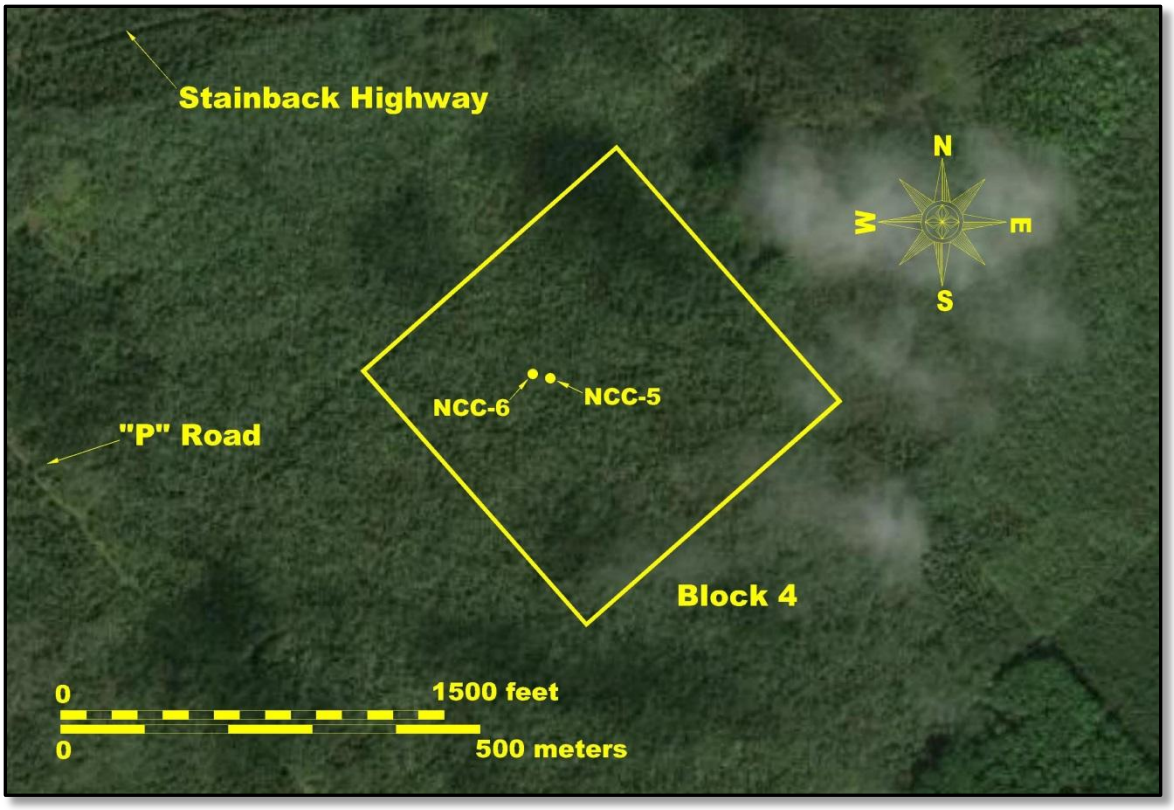

Figure 27. Aerial view of Block 4 (from Google Earth)

Figure 28. Block 4 vegetation (view to west)

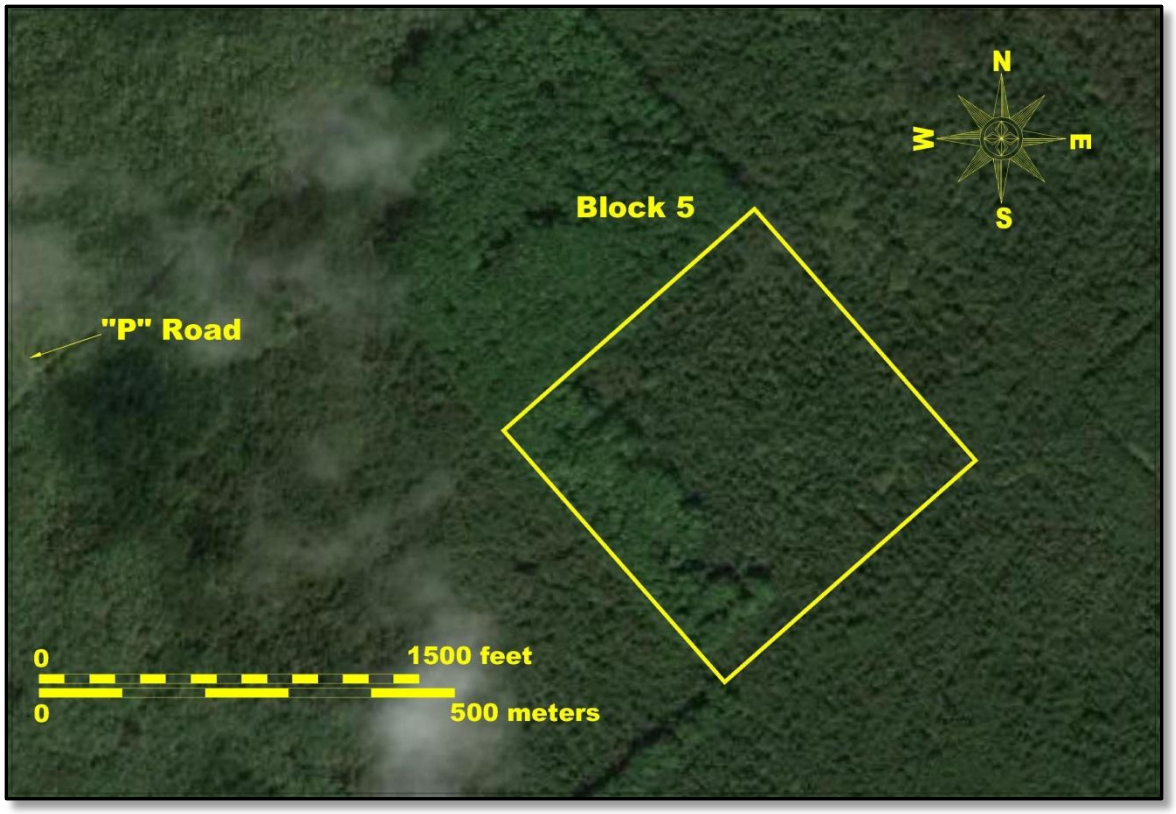

Figure 29. Aerial view of Block 5 (from Google Earth)

Figure 30. Block 5 vegetation (view to east)

Block 6 is a 40 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 2,340 to 2,405 feet. The block is located along the southwestern side of "L" Road, adjacent to the parking area for the ATV/dirt bike park. The block is situated 490 meters (0.3 miles) northwest of the Stainback Highway (**Figure 31**). It is bordered on the southwest by an unnamed, accessible dirt road. The proposed location of Block 3 in the AIS plan was 402 meters to the southwest of its surveyed location, adjacent to "M" Road. It was relocated because the AISP-proposed location was extensively disturbed.

The canopy vegetation in this block includes eucalyptus with an understory of *uluhe, hapu'u*, strawberry guava and Koster's curse. Block 6 vegetation is depicted in **Figure 32**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 6 was previously cleared by machine.

Block 7 is a 20 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 2,250 to 2,310 feet. The block is located along the northeast side of "L" Road and is 2,680 meters (1.66 miles) northwest of the Stainback Highway (**Figure 33**). The block is bordered by an unnamed, accessible dirt road along the southeast side.

The canopy vegetation in this block includes eucalyptus, Australian toon and *ohia* with an understory of *hapu'u*, strawberry guava and Koster's curse and palm grass (*Setaria palmifolia*). Block 7 vegetation is depicted in **Figure 34**. The soil is Keei extremely rocky muck on 6-20% slopes with the underlying lava deposited 200 to 750 years ago. According to DOFAW records, Block 7 was previously cleared by machine.

The survey of Block 7 identified a small, non-cultural lava blister (NCC-8) and a large, linear lava tube (NCC-7 – see **Figure 33**). Both features were thoroughly examined during the project and no cultural remains or evidence of use is present.

Block 8 is a 40 acre survey area located in the southwestern half of the WTMA between approximately 2,150 and 2,240 feet elevation. The block is located along the northeast side of an unnamed dirt road, 390 meters (0.24 miles) southeast of the Stainback Highway (**Figure 35**). It is bordered on the southeast by unnamed, accessible dirt road. The canopy vegetation in this block includes eucalyptus with an understory of *hapu'u*, strawberry guava and Koster's curse. Block 8 vegetation is depicted in **Figure 36**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 8 was previously mechanically cleared.

Block 9 is a 40 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 2,000 to 2,060 feet. The block is located along the southwest side of "J" Road, 870 meters (0.54 miles) northwest of the Stainback Highway (**Figure 37**). It is bordered on the remaining sides unnamed, overgrown dirt roads. The canopy vegetation in this block includes eucalyptus with an understory of *hapu'u*, strawberry guava, Koster's curse and palm grass (**Figure 38)**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 9 was previously cleared by machine.

Block 10 is a 20 acre survey area located in the southwestern half of the WTMA between approximately 2,060 and 2,100 feet elevation. The block is located along the northeast side of "J" Road, 3,295 meters (2.04 miles) northwest of the Stainback Highway (**Figure 39**). It is bordered on the southeast side by an unnamed, overgrown dirt road. The canopy vegetation in this block includes eucalyptus and *ohia* with an

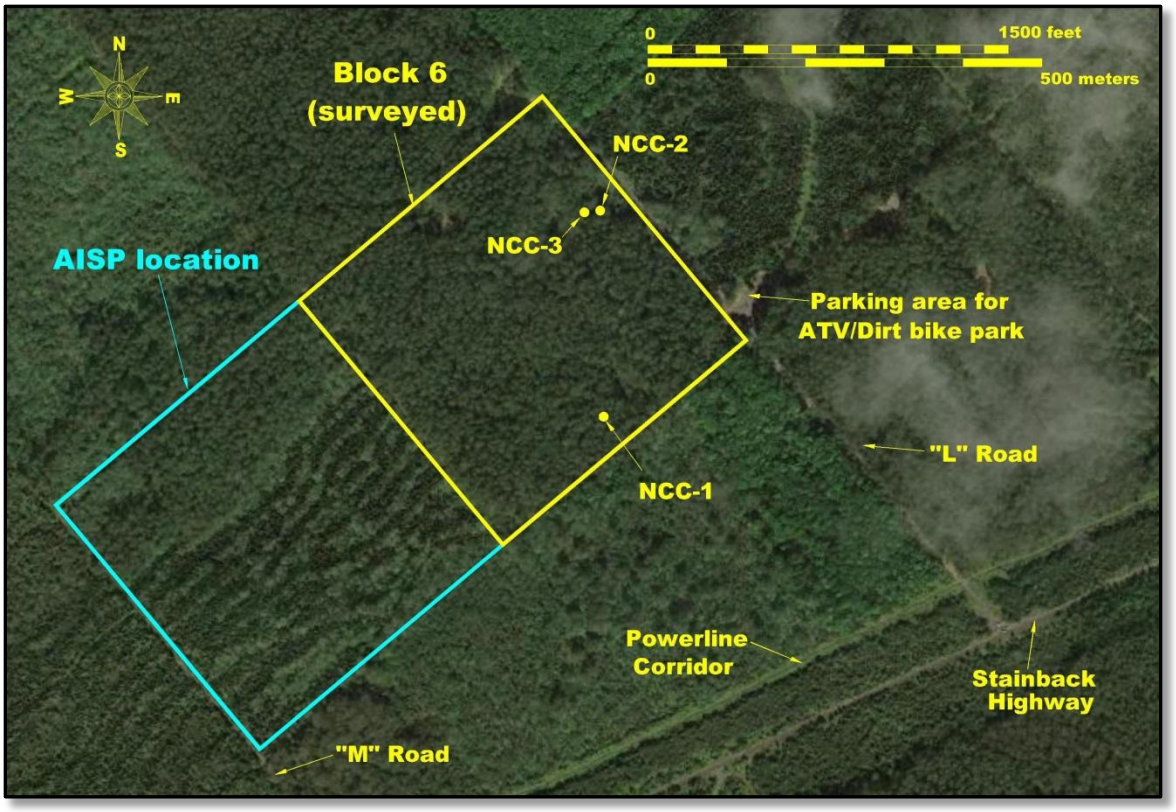

Figure 31. Aerial view of Block 6 (from Google Earth)

Figure 32. Block 6 vegetation (view to west)

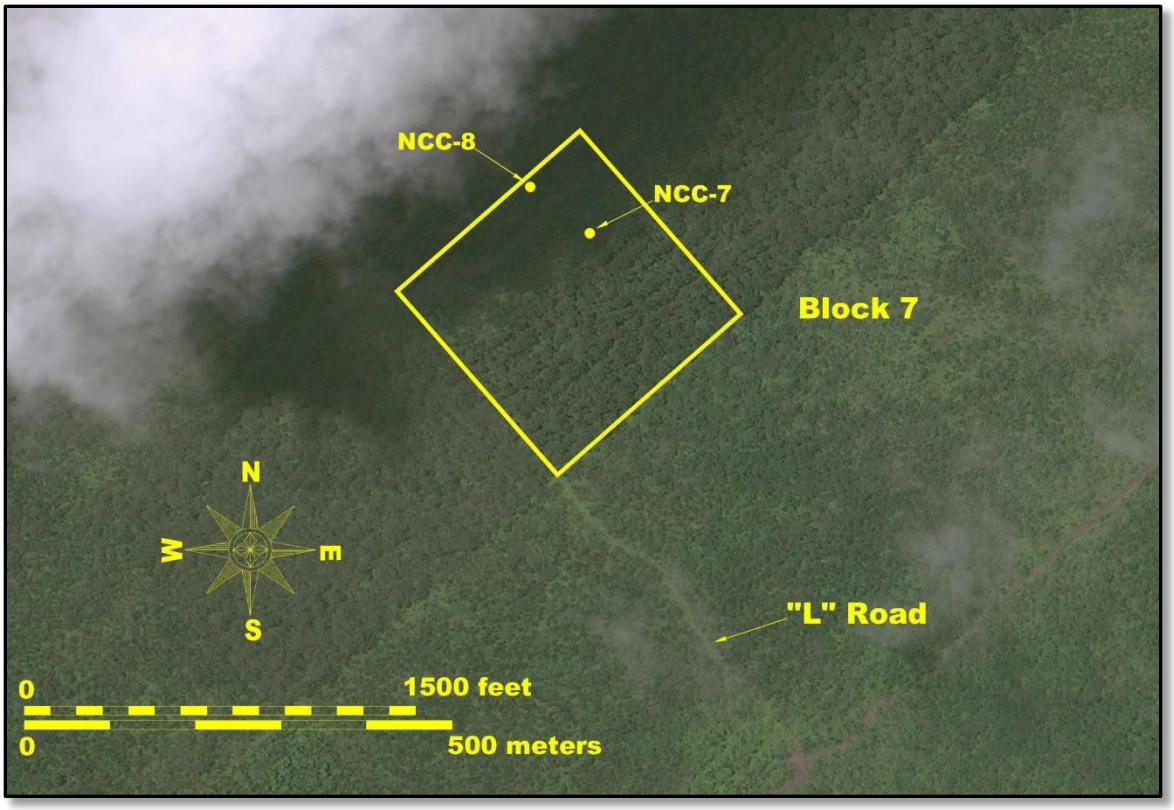

Figure 33. Aerial view of Block 7 (from Esri.com)

Figure 34. Block 7 vegetation (view to northeast)

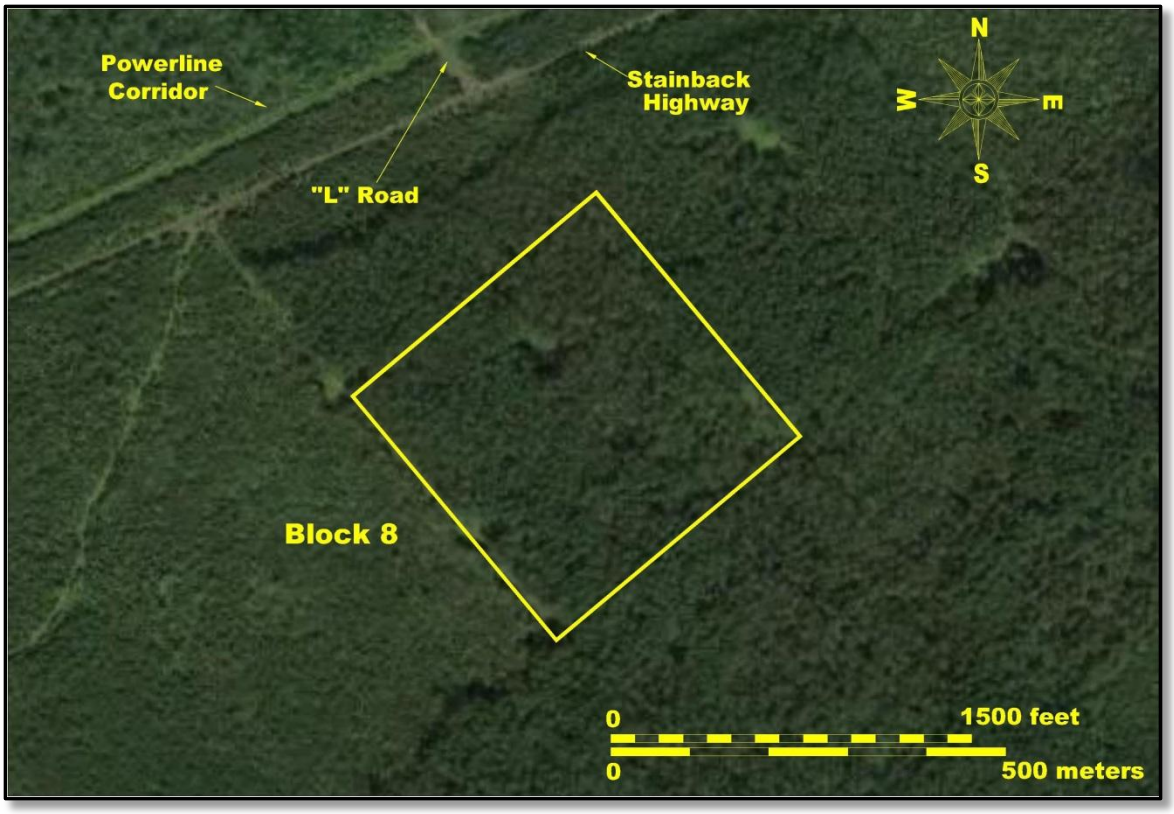

Figure 35. Aerial view of Block 8 (from Google Earth)

Figure 36. Block 8 vegetation (view to northeast)

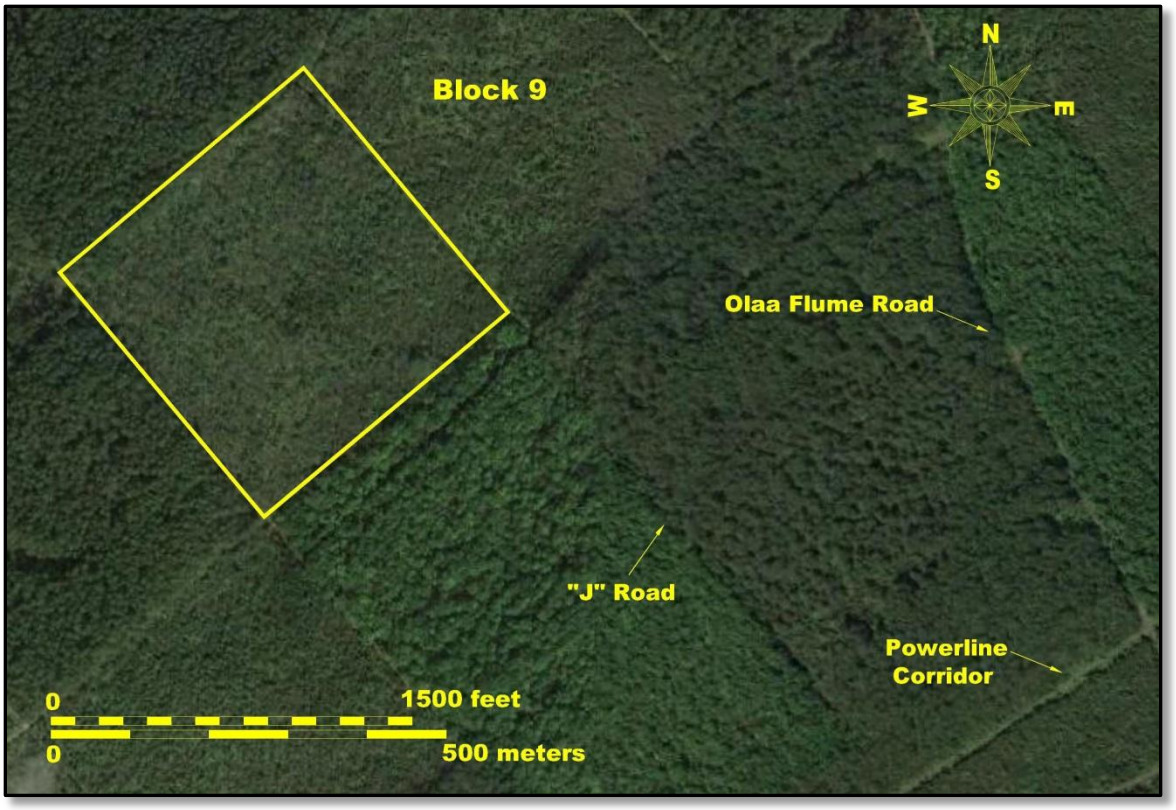

Figure 37. Aerial view of Block 9 (from Google Earth)

Figure 38. Block 9 vegetation (view to northeast)

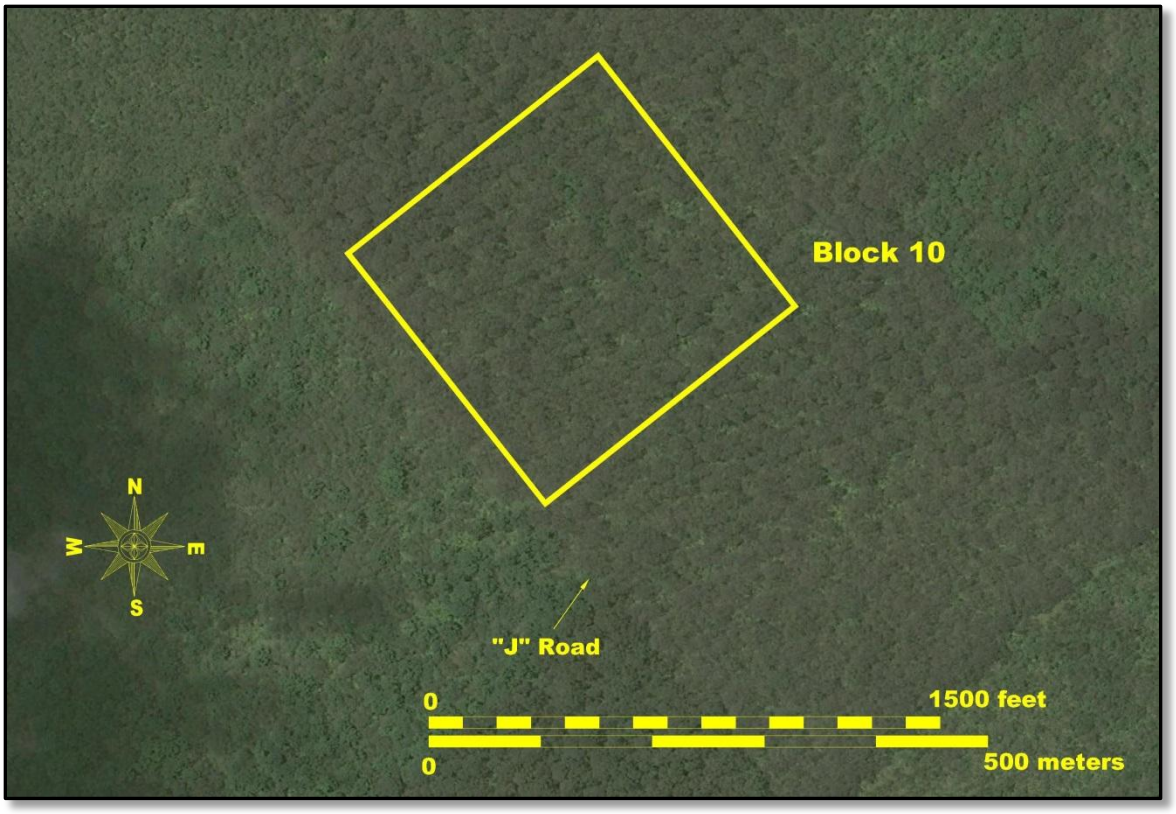

Figure 39. Aerial view of Block 10 (from Esri.com)

Figure 40. Block 10 vegetation (view to northeast)

understory of *uluhe, hapu'u*, and palm grass. Block 10 vegetation is depicted in **Figure 40**. The soil is Akaka silty clay loam on 10-20% slopes with the underlying lava deposited 5,000-10,000 years ago. According to DOFAW records, Block 10 was previously cleared by machine.

Block 11 is a 20 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 1,910 to 1,980 feet. The block is located along the southwestern side of the 'Ōla'a Flume Road, 3,860 meters (2.39 miles) northwest of the Stainback Highway (**Figure 41).** The proposed location of Block 11 in the AIS plan was 63 to 115 meters to the west of the flume road. It was relocated to its current position to utilize the flume road as a readily recognizable survey area boundary.

The canopy vegetation in this block includes Australian toon, *ohia* and *koa* (*Acacia koa*) with an understory of *uluhe,* strawberry guava and molasses grass (*Melinis minutiflora*). Block 11 vegetation is depicted in **Figure 42**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 5,000 to 10,000 years ago. According to DOFAW records, Block 11 was previously cleared by machine.

Block 12 is a 40 acre survey area located in the southwestern half of the WTMA between approximately 1,840 and 1,900 feet elevation. The block is located along the northeast side of the 'Ōla'a Flume Road, 450 meters (0.27 miles) northwest of the Stainback Highway (**Figure 43).** The proposed location of Block 12 in the AIS plan was on the southwestern side of the flume road. It was relocated to its current position because the AISP-proposed location appeared to be more disturbed.

The canopy vegetation in this block includes eucalyptus, *ohia* and Queensland maple with an understory of strawberry guava, Koster's curse and bamboo orchid. Block 12 vegetation is depicted in **Figure 44**. The soil is Kiloa extremely stony muck on 6-20% slopes and Keei extremely rocky muck on 6-20% with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 12 was previously cleared by machine.

The survey of Block 12 identified disturbed remnants of the Site 20870 'Ōla'a Flume. These remnants consist of fragments of the metal flume located in a bulldozer push pile (see **Figure 43**). This site is discussed in detail in the Findings section of this report.

Block 13 is a 40 acre survey area located in the southwestern half of the WTMA at elevations ranging from approximately 1,600 to 1,670 feet. The block is located along the northeast side of North Kulani Road, 1,005 meters (0.62 miles) southeast of the Stainback Highway (**Figure 45**). It is bordered on the southeast by N Road and on the northwest by an unnamed, overgrown dirt road. The proposed location of Block 13 in the AIS plan was 510 meters to the northwest of the Stainback Highway, adjacent to the overgrown "H" Road. It was relocated to its current position because of difficult access to the AISP-proposed location.

The canopy vegetation in this block includes eucalyptus with an understory of strawberry guava and Koster's curse. Block 13 vegetation is depicted in **Figure 46**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 13 was previously cleared by machine.

Block 14 is a 10 acre survey area located in the northeastern half of the WTMA at elevations ranging from approximately 1,170 to 1,220 feet. The block is located along the southwest side of Kulaloa Road, 525 meters 0.32 miles) south-southeast of Ainaola Road (**Figure 47**). This block was oriented perpendicular to an accessible dirt road along the northwest side. The proposed location of Block 14 in the AISP was adjacent to its current location to the south, oriented perpendicular to Kulaloa Road. It was

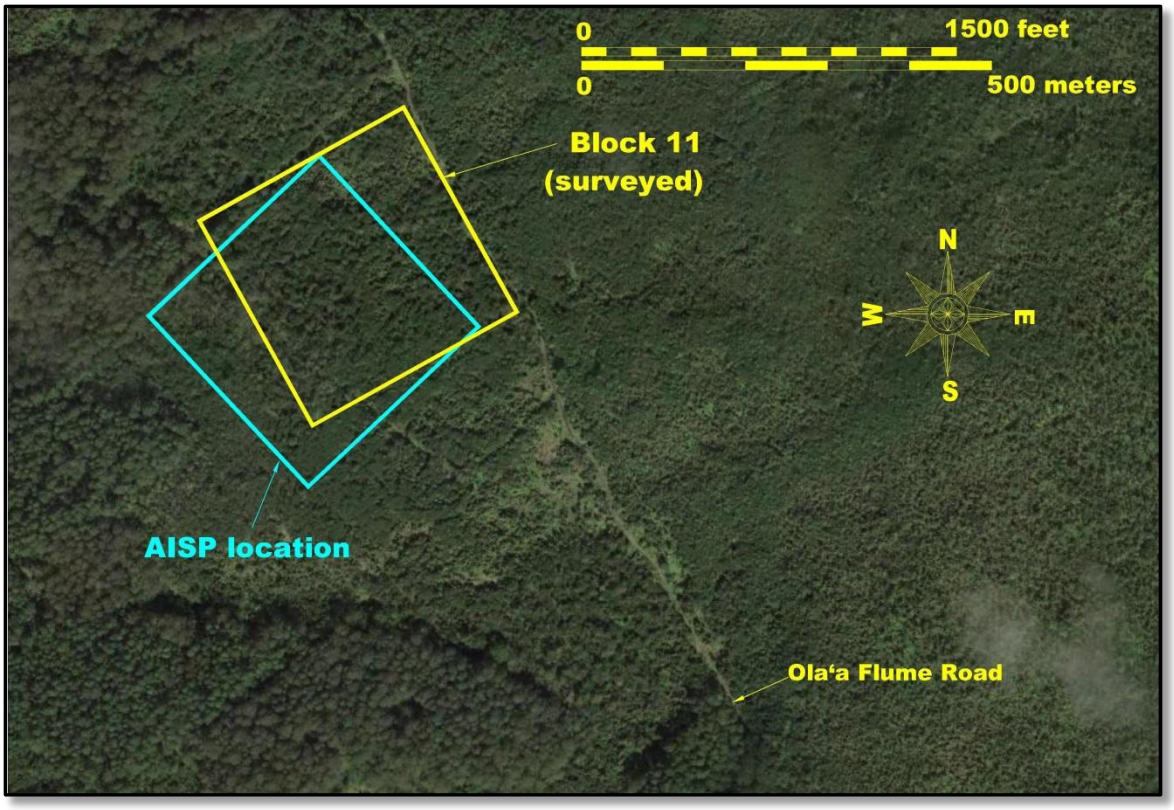

Figure 41. Aerial view of Block 11 (from Google Earth)

Figure 42. Block 11 vegetation (view to southwest)

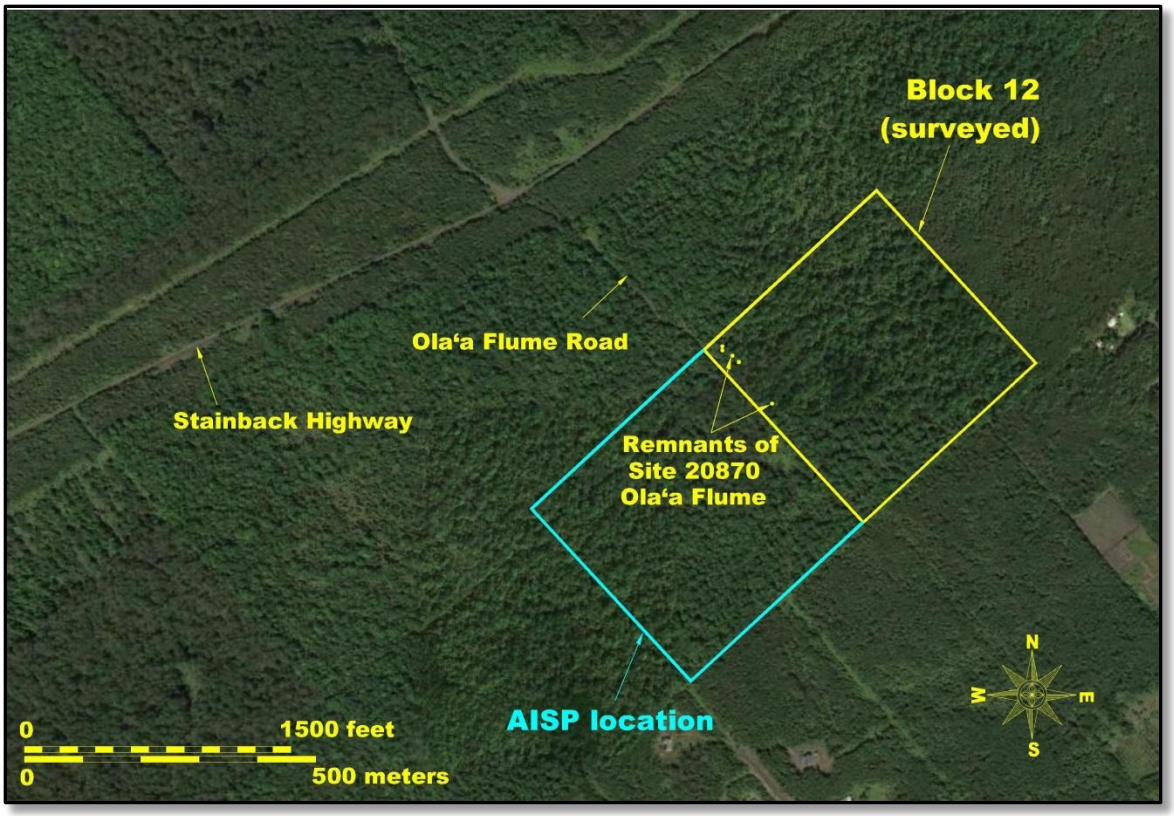

Figure 43. Aerial view of Block 12 (from Google Earth)

Figure 44. Block 12 vegetation (view to north)

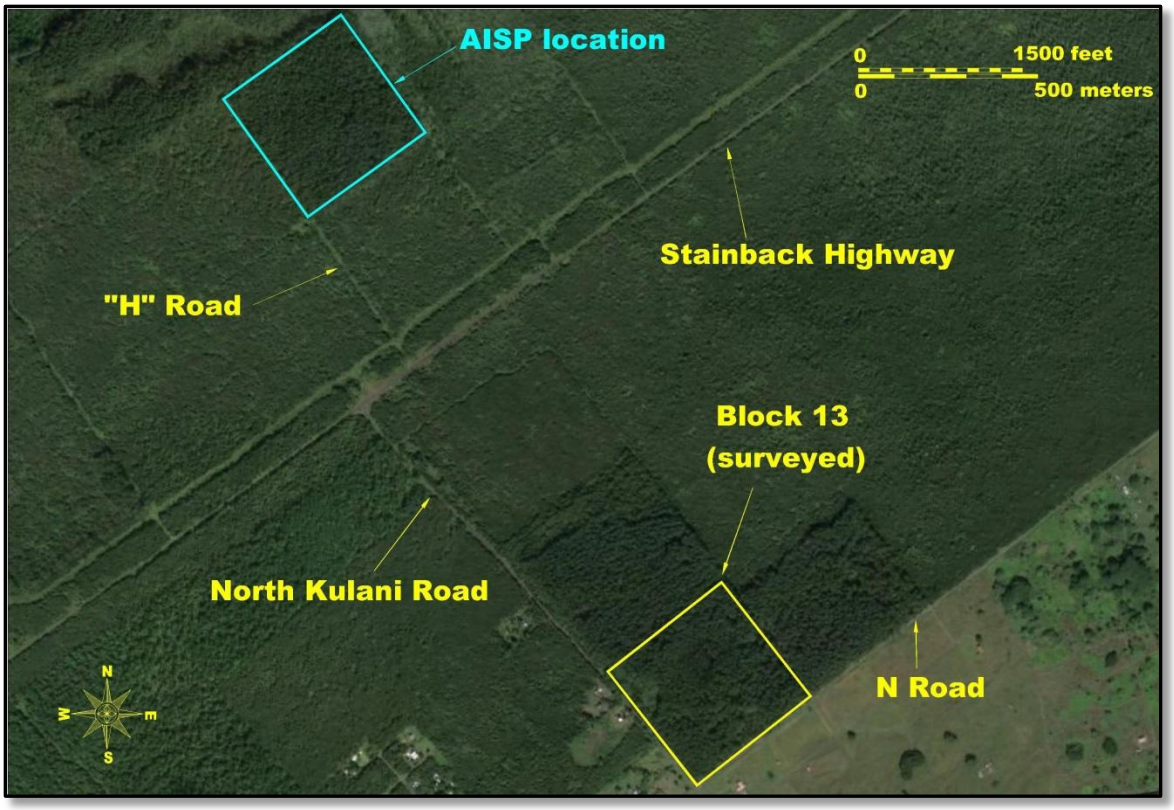

Figure 45. Aerial view of Block 13 (from Google Earth)

Figure 46. Block 13 vegetation (view to east)

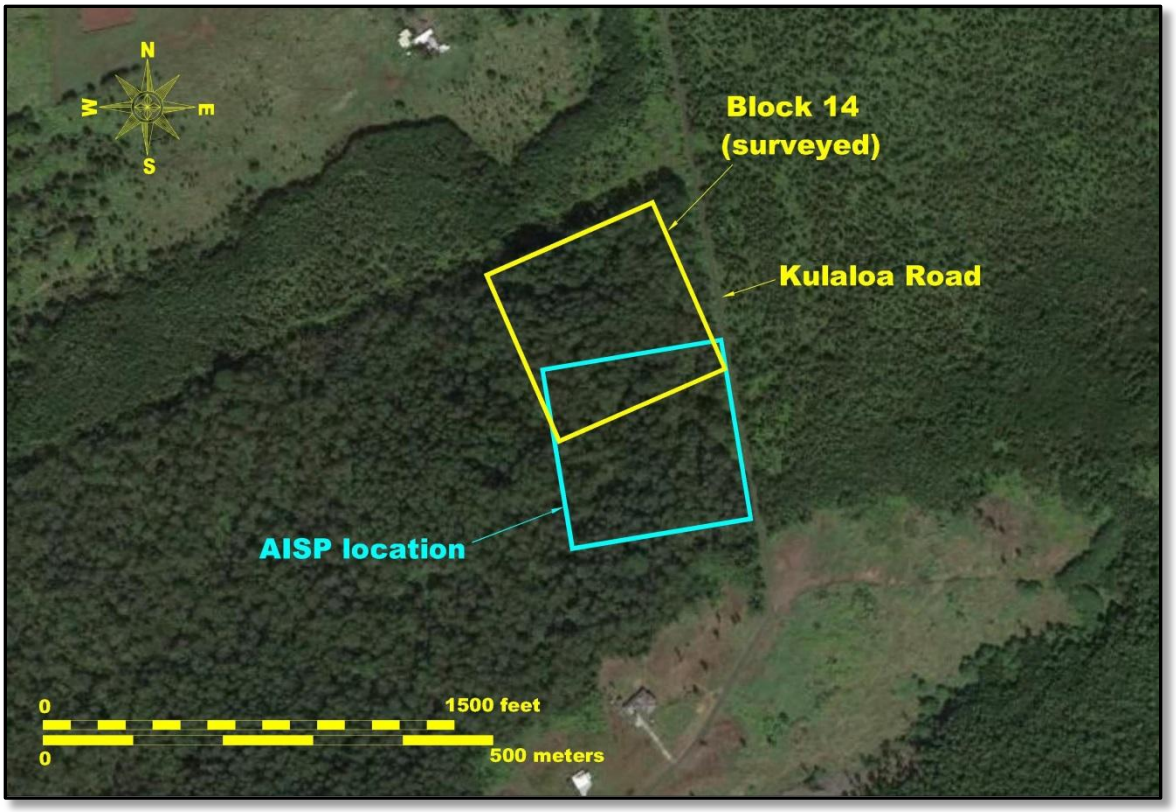

Figure 47. Aerial view of Block 14 (from Google Earth)

Figure 48. Block 14 vegetation (view to southwest)

was relocated to facilitate the survey by utilizing dirt road and Kulaloa Road as readily identifiable boundaries for the survey transects.

The canopy vegetation in this block includes eucalyptus with an understory of *uluhe,* strawberry guava, Koster's curse and rose myrtle (*Rhodomyrtus tomentosa*). The vegetation of Block 14 is depicted in **Figure 48**. The soil is Keei extremely rocky muck on 6-20% slopes with the underlying lava deposited 200-750 years ago. According to DOFAW records, Block 14 was previously cleared by machine.

Block 15 is a 20 acre survey area located in the northeastern half of the WTMA between approximately 1,000 and 1,050 feet elevation. The block is located along the southwest side of "B" Road, 505 meters (0.62 miles) northwest of the Stainback Highway (**Figure 49**). It is bordered on the northwest by an unnamed, overgrown dirt road. The proposed location of Block 15 in the AISP was 220 meters to the southwest, adjacent to the overgrown "C" Road. It was relocated to its current position because of difficult access to the proposed location.

The canopy vegetation in this block includes Queensland maple, eucalyptus, Australian toon and *ohia* with an understory of strawberry guava, Koster's curse and rose myrtle. Block 15 vegetation is depicted in **Figure 50**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 15 was previously cleared by machine.

Block 16 is a 20 acre survey area located in the northeastern half of the WTMA at elevations ranging from approximately 1,170 to 1,230 feet. The block is located along the northeast side of "D" Road, 560 meters (0.34 miles) southeast of the Stainback Highway (**Figure 51**). It is bordered on the northwest by an unnamed, overgrown dirt road. The canopy vegetation in this block includes eucalyptus with an understory of *uluhe,* strawberry guava and Koster's curse. The vegetation of Block 16 is depicted in **Figure 52**. The soil is Kiloa extremely stony muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 16 was previously cleared by machine.

Block 17 is a 20 acre survey area located in the northeastern half of the WTMA between approximately 860 and 905 feet elevation. The block is located along the southeast side of an unnamed overgrown dirt road, 400 meters (0.24 miles) northeast of "B" Road (**Figure 53**). The canopy vegetation in this block includes eucalyptus with an understory of *uluhe,* strawberry guava and Koster's curse. An overview of Block 17 is depicted in **Figure 54**. The soil is Papai extremely stony muck on 3-25% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 17 was previously cleared by machine.

Block 18 is a 20 acre survey area located in the northeastern half of the WTMA at elevations ranging from approximately 680-730 feet. The block is located along the northeast side of the Quarry Road, 775 meters (0.48 miles) southeast of the Stainback Highway (**Figure 55**). It is bordered on the northwest by an unnamed accessible road that parallels the southeast side of an abandoned quarry. Portions of the WTMA mountain bike trail system extend through this block. The proposed location of Block 18 in the AISP was on the southwest side of the Quarry Road, opposite its surveyed location. It was relocated because ground surface visibility appeared to be better.

The canopy vegetation in this block is eucalyptus with an understory of Koster's curse and *lauae* (*Phymatosorus grossus*). Block 18 vegetation is depicted in **Figure 56**. The soil is Papai extremely stony muck on 3-25% slopes and Keaukaha extremely rocky muck on 6-20% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 18 was previously cleared by machine.

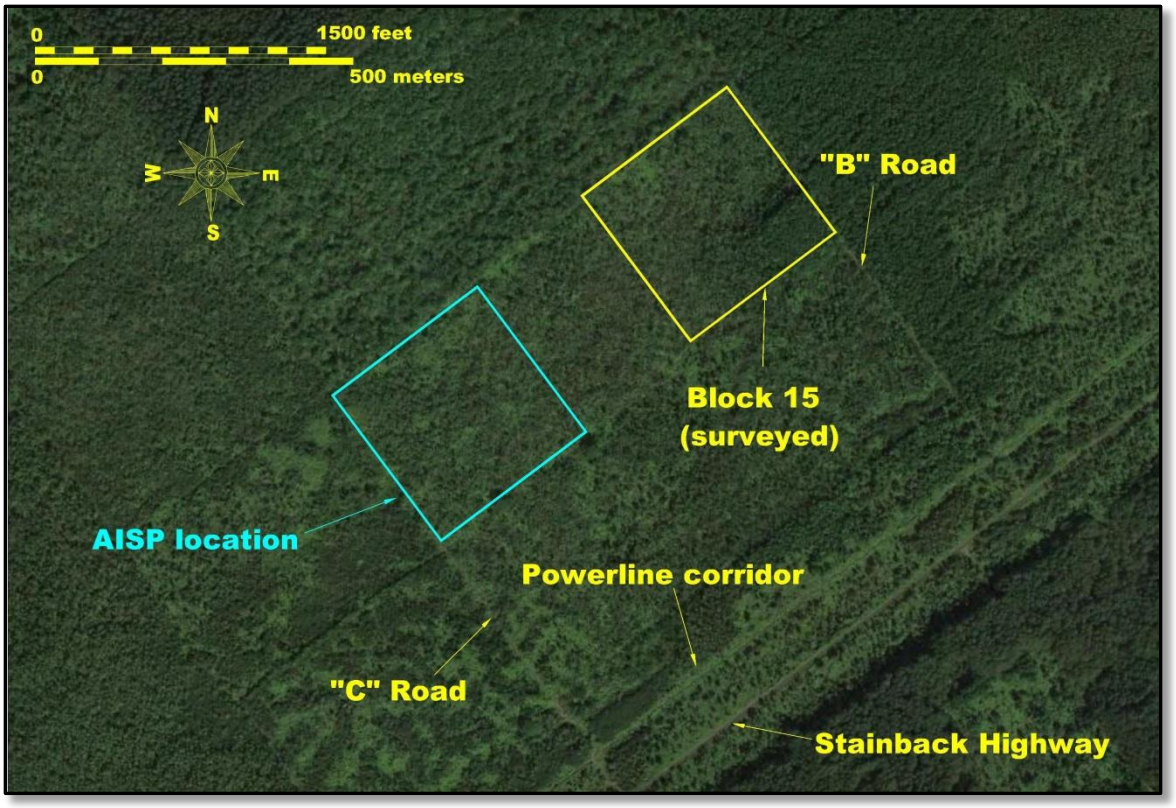

Figure 49. Aerial view of Block 15 (from Google Earth)

Figure 50. Block 15 vegetation (view to southwest)

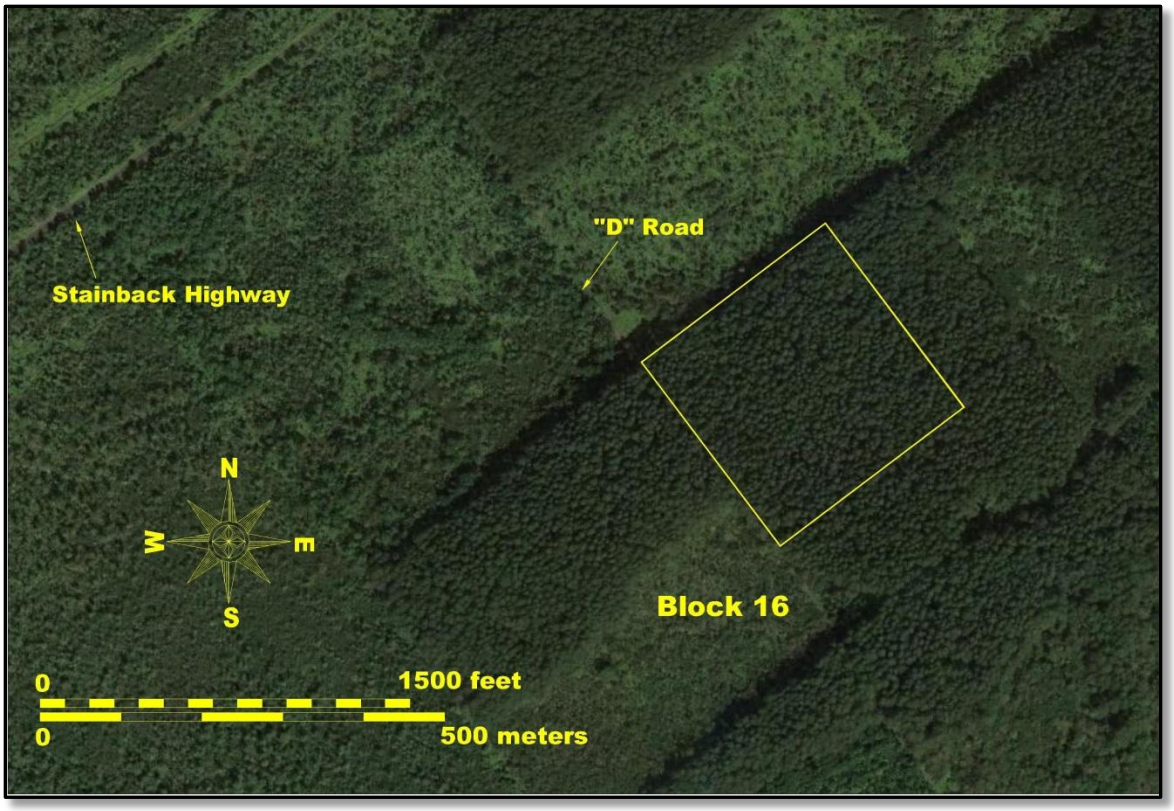

Figure 51. Aerial view of Block 16 (from Google Earth)

Figure 52. Block 16 vegetation (view to east)

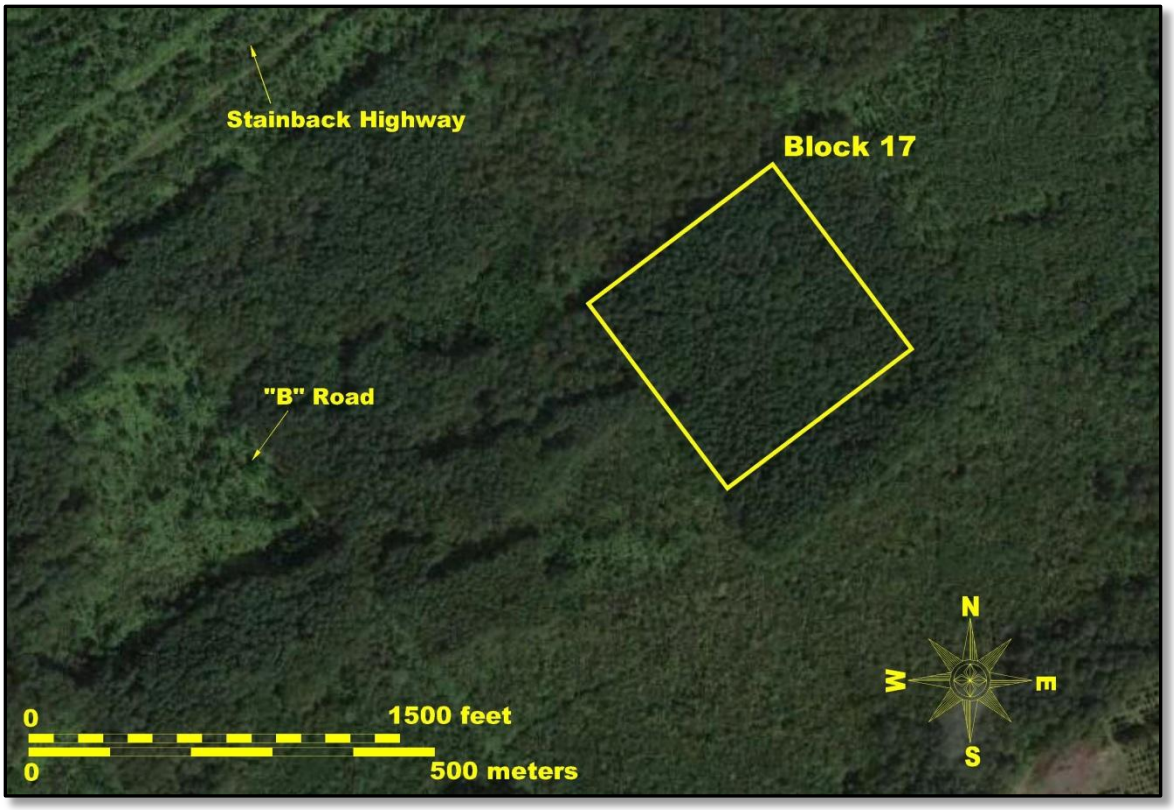

Figure 53. Aerial view of Block 17 (from Google Earth)

Figure 54. Block 17 vegetation (view to southeast)

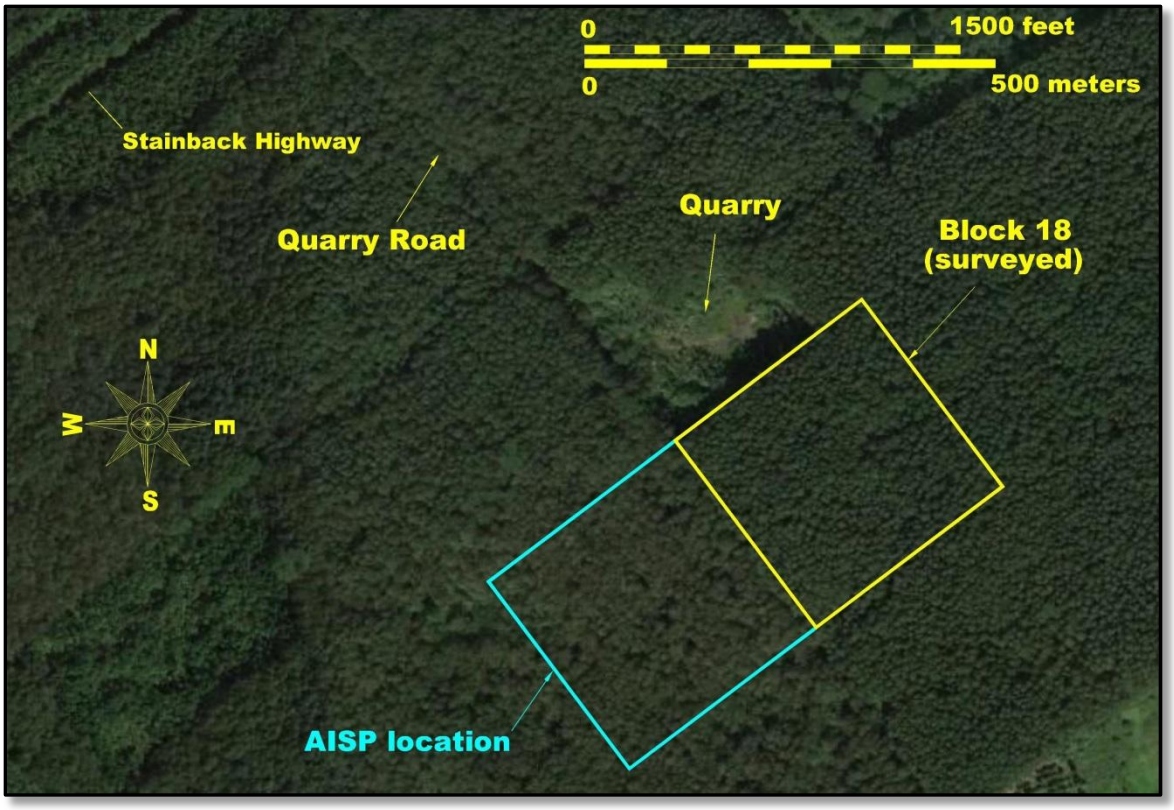

Figure 55. Aerial view of Block 18 (from Google earth)

Figure 56. Block 18 vegetation (from to east)

Block 19 is a 20 acre survey area located in the northeastern half of the WTMA between approximately 560 and 605 feet elevation. The block is located along the southeastern side of the Stainback Highway (**Figure 57**). The AISP-proposed location of Block 19 was 760 meters to the south-southwest, in an area with no access roads. It was relocated to facilitate access.

The canopy vegetation in this block is dominated by *ohia* with a grove of unidentified palm trees and an understory of *hapu'u,* strawberry guava and Koster's curse. The vegetation in Block 19 is depicted in **Figure 58.** The soil is Papai extremely stony muck on 3-25% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 19 was previously cleared by machine.

The survey of Block 19 identified a small non-cultural lava blister. NCC-9 is located along the southeastern boundary of the block.

Block 20 is a 20 acre survey area located in the northeastern half of the WTMA at elevations ranging from approximately 395 to 440 feet. The block is located in the southeastern corner of the project area and is bordered by overgrown, inaccessible dirt roads along the southeast and northeast sides. (**Figure 59**). The proposed location of Block 20 in the AIS plan was along the southeast side of the Stainback Highway, 1,220 meters north-northwest of its surveyed location. It was relocated to its current position due to the disturbed nature of the AISP-proposed location.

The canopy vegetation in this block is eucalyptus with an understory of *hapu'u,* strawberry guava and Koster's curse. Block 20 vegetation is depicted in **Figure 58**. The soil is Papai extremely stony muck on 3-25% slopes with the underlying lava deposited 750 to 1,000 years ago. According to DOFAW records, Block 20 was previously cleared by machine.

Field methods

The 20 sample blocks were subjected to 100% surface pedestrian survey with the surveyors spaced 10 meters apart. The ground surface visibility was fair to good. At the request of the DOFAW Hilo office staff, the survey transects were marked with biodegradable flagging tape. One site, an historic flume, was identified by the survey. This site was documented by preparing a scaled plan map, photographic documentation and completion of a standardized site form. The paved remnant of an historic road was also recorded by photographic documentation and the preparation of a site form. As stated, the survey also identified four lava blisters, one lava tube, one sinkhole with an overhang, and three fissures containing overhang areas (see **Table 13**). These natural features were thoroughly explored in accordance with Haun & Associates' Safety Plan pertaining to confined spaces.

The sample blocks were located in the field using the Magellan Mobile Mapper Global Positioning System (GPS) device using the NAD 83 datum. The accuracy of this GPS device for a single point is less than one meter. No subsurface testing was conducted during the project and no cultural remains were recovered for analysis.

CONSULTATION

The project was conducted in consultation with DOFAW and DLNR-SHPD. Agency consultation included meetings with DOFAW Forestry Program Manager Sheri Mann on July 19, 2013 in Honolulu, DOFAW Hawaii Branch Forestry Manager Steve Bergfeld in Hilo on August 21, 2013, and SHPD Archaeology Branch Chief Theresa Donham in Hilo on August 21, 2013. DOFAW Honolulu staff provided background reference documents, GIS mapping data on the WTMA, and details concerning the planned timber harvesting.

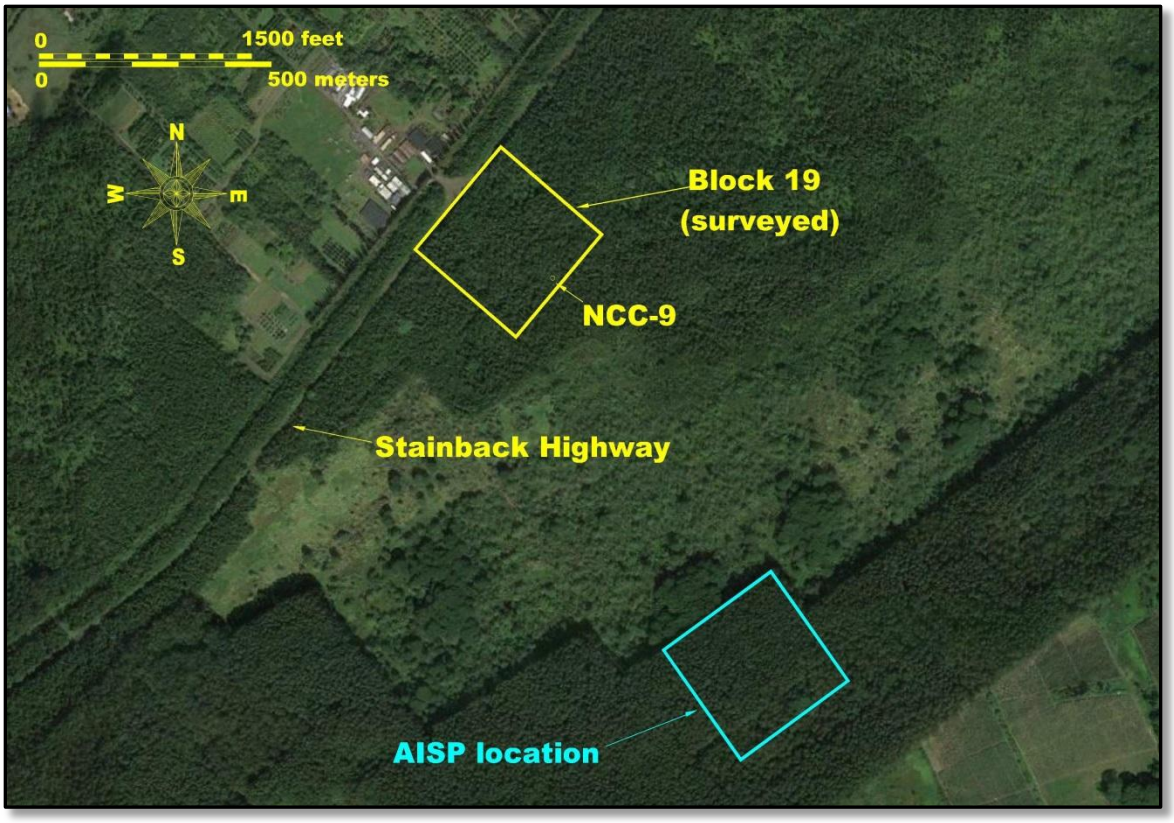

Figure 57. Aerial view of Block 19 (from Google Earth)

Figure 58. Block 19 vegetation (view to southeast)

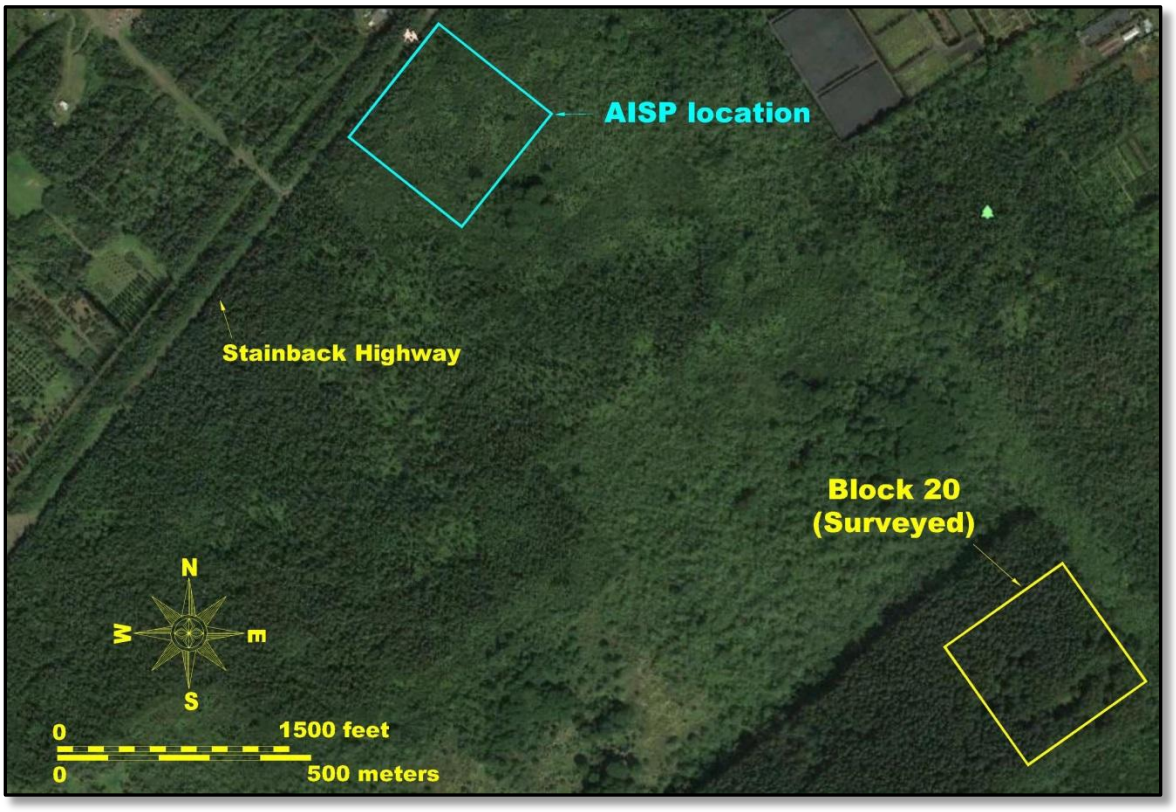

Figure 59. Aerial view of Block 20 (from Google Earth)

Figure 60. Block 20 vegetation (view to northeast)

DOFAW Hilo staff provided information on access, current public recreational use, and updated information on harvesting potential and future planting areas. SHPD staff provided information on previously identified sites in the vicinity of the project area and recommendations regarding the AIS sampling strategy.

Previous consultation

Kepa Maly of Kumu Pono Associates LLC previously conducted an interview with an individual with knowledge of the WTMA vicinity. Mr. Ralph Daehler was interviewed by phone on June 9, 2004 in conjunction with a cultural study of the Pu‘u Maka‘ala Natural Area Reserve located adjacent to the WTMA to the west. Mr. Daehler worked to develop the state’s reforestation program in the early 1960s and provided insight into the naming of a hill (*pu‘u*) and general background on the WTMA area. According to Maly and Maly:

> The name “Pu‘u Maka‘ala” was given to the *pu‘u* and forest area in 1961 or 1962, when Ralph Daehler was working on the Board of Agriculture and Forestry’s Reforestation Program. Mr. Daehler recalled that at the time, he was working with old quad maps and aerial photos, identifying areas in which reforestation projects could be developed, and through the photos—the *pu‘u* did not appear on old quad maps—he noticed this *pu‘u*, which looked very interesting to him. From the photo, it appeared to him that the hill would offer anyone who traveled to it, a great view of all the surrounding lands, and out to the coast of Hilo and Puna.
>
> Mr. Daehler looked around for *kama‘āina* to see if anyone knew the name of the *pu‘u*, but could find no one familiar with it. During this time, L.W. Bryan had been the Forester, and was just retiring, and Max Landgraf took over. Max’s nick name was *Maka* (eye), because he could see things all over. Mr. Daehler found that the word *ala* with *maka*, could mean wide open or imply a lookout point, so he settled on naming the site Pu‘u Maka‘ala (interpreted as Lookout Hill).
>
> Shortly thereafter, USGS was updating its’ quads and contacted him about the region in which the *pu‘u* is situated. He explained that he had found no name for the *pu‘u*, but that he had called it Pu‘u Maka‘ala for the forestry program. He recalled being surprised later, to find that on the next quadrangle, the name Pu‘u Maka‘ala appeared in print.
>
> Mr. Daehler never had the opportunity to actually travel to the *pu‘u*, as he was transferred to Kaua‘i a short while later. It had been his goal to establish a trail to the *pu‘u*, which he believed would be of interest, and provide travelers with a great view of the region. In his review of the maps and photos, he had determined a couple of possible approaches to the *pu‘u*. One of the approaches being from the old Olaa Back Road—which was all overgrown—and which ran out of the old Olaa Homesteads. He recalled also, that while researching the area, he had been surprised to learn that so much of ‘Ōla‘a had been subdivided into homestead lots, and that many of the homesteaders had been of Galician origin.
>
> Mr. Daehler also recalled that in those early years, the Board of Agriculture and Forestry had a strong component of land development for agricultural purposes. At the time the Board’s Reforestation Program began, a number of people had been calling for the Pana‘ewa-‘Ōla‘a forest lands to be cleared for agricultural purposes. The early reforestation program, through planting a number of fast growing introduced species,

helped to save much of the area for present-day and future conservation programs and public interest (Maly and Maly 2004:121).

Recent consultation

On February 6, 2014, Haun & Associates Project Supervisor Shawn Fackler conducted a telephone interview with Mr. Hiroshi "Lefty" Kawazoe. Mr. Kawazoe is 88 years old and worked for the Puna Sugar Company (ʻŌlaʻa Sugar Company) from 1947 to 1984. He served as the plant manager from 1982 to 1984. Mr. Kawazoe does not recall that the plantation had any involvement in the WTMA area and when asked about the Ola'a flume, he said he doesn't know too much about it because there was a special division that assigned crews to maintain it. He did say that the plantation stopped using the flume in 1956 in favor of using trucks to transport the sugar. He said the use of the railroad for sugar cane transport stopped around the same time.

FINDINGS

The 20 sample block survey revealed that all of the survey areas have been disturbed to varying degrees. Only one site is present, the disturbed remnant of an historic flume, situated in Block 12 (Site 50-10-34-20870). Documentary research indicated that two additional sites are located in the boundaries of the WTMA. These consist of a burial cave (Site 50-10-35-18697) and a portion of the historic ʻŌlaʻa Back Road (Site 50-10-43-30088). The sites are discussed below and their locations are depicted on **Figure 20**.

Site 50-10-34-20870

A portion of the historic ʻŌlaʻa Flume once extended through the central portion of the WTMA, roughly following the 1,800 ft contour (see **Figures 18** and **20**). As previously discussed, the flume originated at the ʻŌlaʻa Flume Spring, located north of the WTMA in Punahou 2 Ahupuaʻa (see **Figure 19**). It extended downslope to the ʻŌlaʻa Mill located seaward of Keaʻau town, with numerous branches that provided water throughout the plantation. The ʻŌlaʻa Flume Trail/Road parallels the flume and was used to maintain the system. A portion of this site was documented by Langlas *et al.* (1997) during a survey for Saddle Road improvements. The extent of this flume is depicted on a series of 1912 to 1930 U.S. Geological Survey maps of the area (**Figure 61**).

A relatively intact section of the flume was located just outside the boundaries of the WTMA, 10 feet east of the Ōlaʻa Flume Road (see **Figure 20**). This section is situated at approximately 1,800 feet elevation (GPS coordinates E 273635, N 2170654). It is a framework of milled lumber that supports a U-shaped corrugated metal flume (**Figure 62**). The framework consists of 2 inch by 6 inch horizontal boards that support the upper rim of the flume (**Figure 63** and **64**). Vertical 4 inch by 6 inch wooden posts are spaced 12 feet apart. Diagonal 3 inch by 4 inch boards extend between the vertical posts and the horizontal rim boards. A 4 inch by 6 inch horizontal board extends between the vertical posts, supporting the base of the metal flume.

The metal flume is made of 3 feet long by 45 inch wide U-shaped corrugated metal sections that are joined together with a flange and a 3/8 inch metal rod. The manufacturer's name and logo are printed on the exterior sides of the flume, reading "California Corrugated Culvert" over "Armco Iron Flume Company, Los Angeles, California (**Figure 65**). According to a May 8, 1901 edition of the *Hawaiian Star* newspaper, the construction on the Olaa Flume was completed on May 2, 1901 (Chronicling America 2014). Discharge records taken at Kaumana between 1918 and 1919 indicate that between 0.4 and 15.8 million gallons of water per day flowed through the flume (USGS 1923).

The Ōlaʻa Flume Road parallels the flume on the west side. This road is unpaved and ranges in width from 10 to 15 feet (3 to 4.5 meters). It was used to access the flume for maintenance and is currently in use as a transportation route through the area (**Figure 66**). According to former ʻŌlaʻa Sugar Company manager, "Lefty" Kawazoe, a special division from the sugar company was employed to maintain the flume.

The Armco Iron Flume Company produced a variety of irrigation products as indicated by advertisements in the San Francisco, California-based *Pacific Rural Press* newspaper (California Digital Newspaper Collection 2014). Advertisements depicting intact flumes and other products from 1915 and 1919 are depicted in **Figures 67** and **68**. The Armco products were sold in the Hawaiian Islands by the Honolulu Iron Works Company, as depicted in a 1916 advertisement in Kauai's *The Garden Island* newspaper (University of Hawaii, Manoa online library 2014 - **Figure 69**).

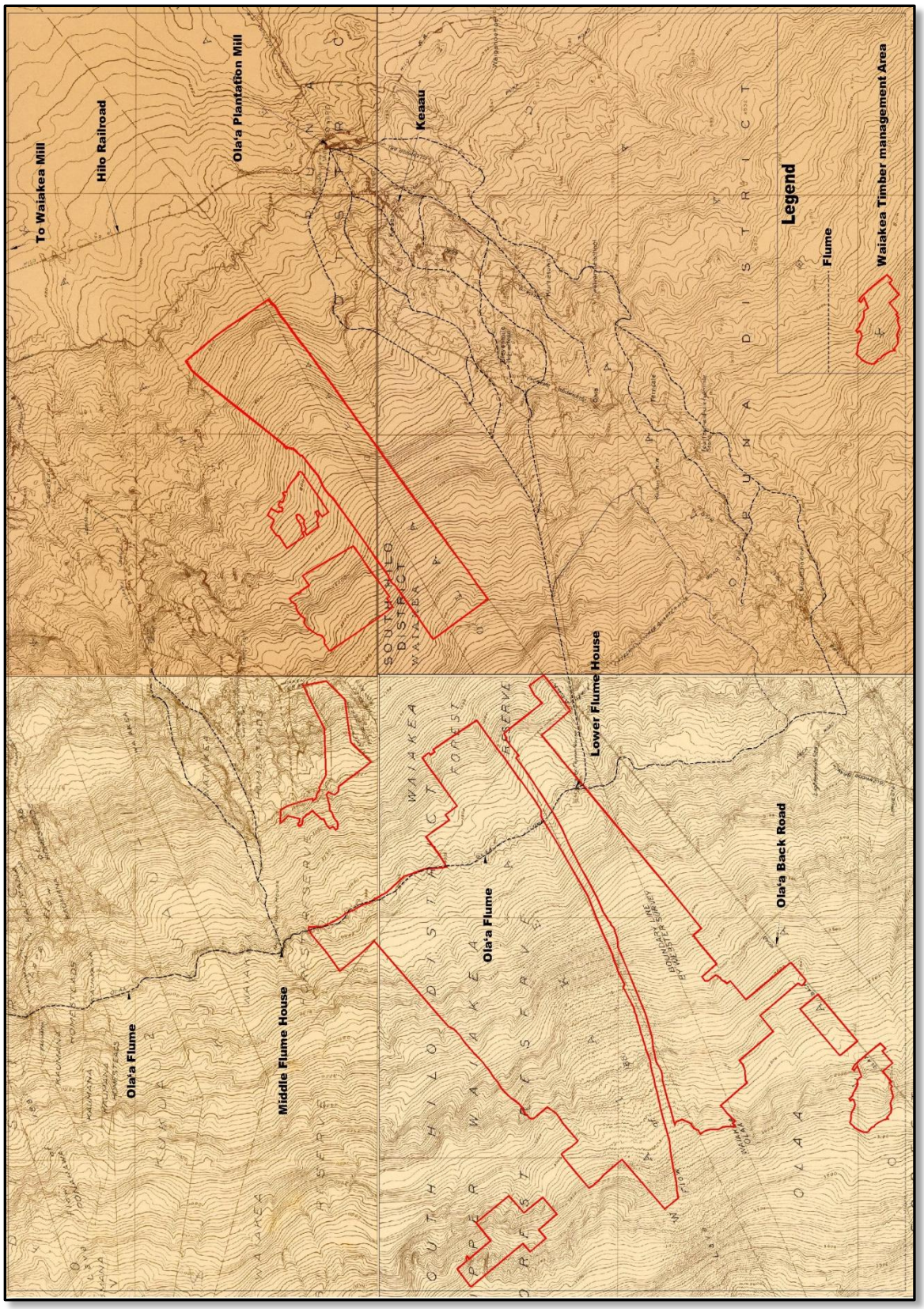

Figure 61. Compilation Map of 1912-1930 U.S. Geological Survey Maps

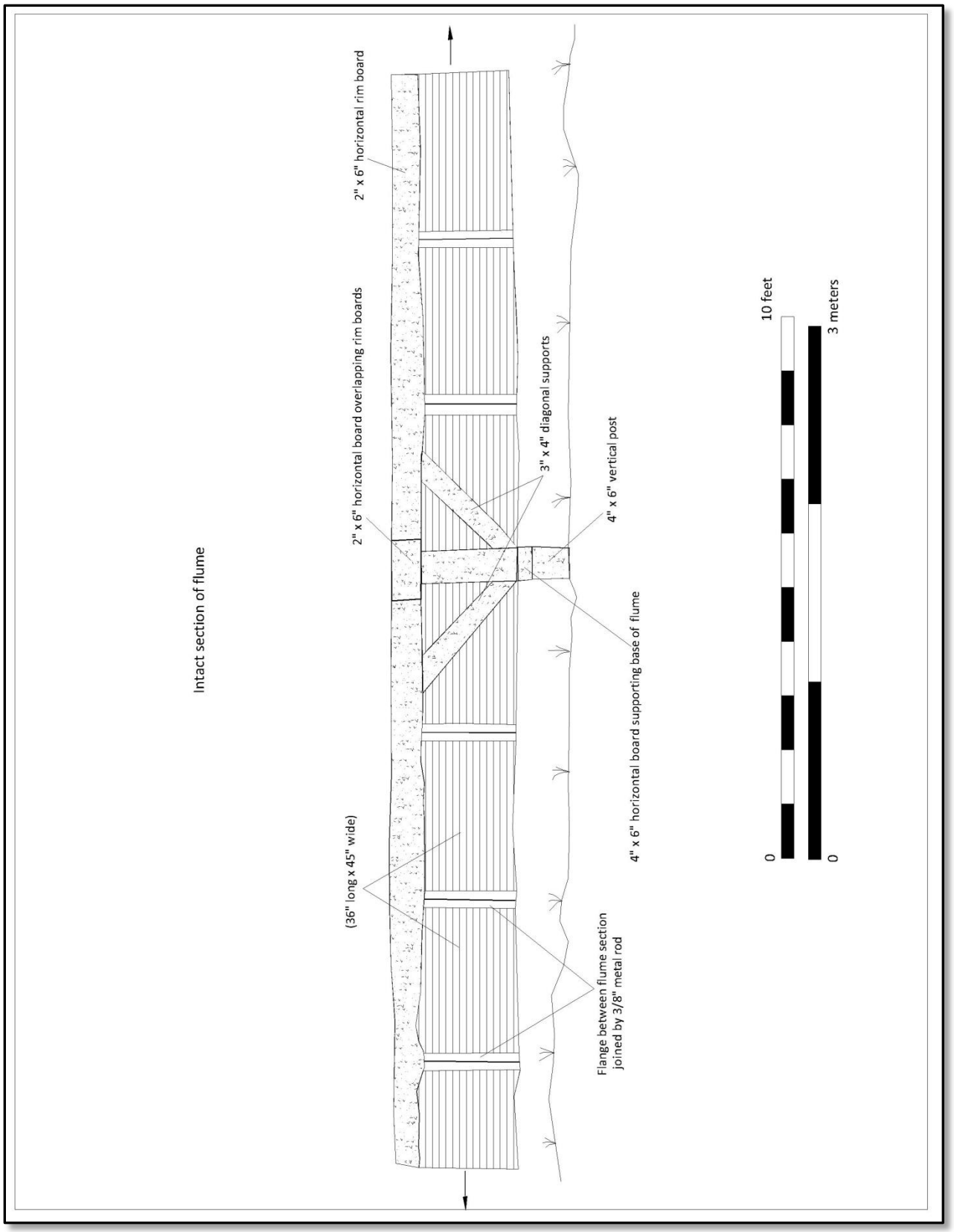

Figure 62. Intact section of Site 20870 'Ola'a Flume

Figure 63. Intact section of Site 20870 Flume (view to northeast)

Figure 64. Intact section of Site 20870 Flume (view to north)

Figure 65. Inscription on side of Site 20870 Flume (view to northeast)

Figure 66. 'Ola'a Flume Road, view to northwest

House. There is no doubt about the result."

We do not say that we consider these propositions either wise or practicable in this country. We will talk when we get ready; just now we are simply trying to sick the people onto the subject. We will say, however, that practically all European systems of rural credit have government aid in some form, and they all are operated through banks either established or endowed for that purpose and different in point of view and policies from the regular banking institutions under private ownership and capitalization. Now keep on going to it; staccato, as the musicians say, and which means like a stack of cats.

Farms as Public Utilities.

It is of course unfair either to praise or condemn the warring nations of Europe for imperious acts which they may commit under stress of present circumstances, but without doing that it is timely for the American land-owner, who has grown up to believe that he has a right to do what he will with his own so long as he keeps his title clear, to keep thinking of what rights might fade from his view, if he allows himself to drift too far toward nationalistic notions. If he throws himself too far into the Abraham's bosom of government credit, is he not likely to slip down into Abraham's lap of national ownership, and become thereby not a sovereign citizen but a public utility man? That is worth thinking about, for it is the position in which millions of European farmers now find themselves. It is not much of a shock to them because they have always been the playthings of their overlords, but for an American citizen it surely would be fierce. This is the way of it, as described by cable since our last issue: "The Federal Council has voted to adopt measures to insure the cultivation of the parts of East Prussia which were devastated by the Russians. Each land owner will be required to report to the local authorities whether he will be able to plant and cultivate his land. If unable to do so the authorities will undertake the task for the public account, paying for the use of the land or not, as they desire."

We are not criticising the action of the government in this matter: under the present conditions it may be a token of supreme efficiency, and it will give the prisoners something to do, growing crops on privately owned lands for public account, and paying the owner for the use of the land as they may desire. It is exercising the right of eminent domain without fussing with the courts. It is true that we do not have to go to the other side of the world to get a shock for our old belief that the government is best which governs least. It really looks as though a Californian might lose the right to pull on his shirt foreside aft, if he desires to. But while we are thinking about the matter of calling upon the government to do everything for us, it is well to consider even that. Do you desire to operate your farm as a public utility?

Queries and Replies.

Querists must give name and address.

Times for Budding and Grafting.

To the Editor: Please tell me through your columns the proper time to graft and to bud almonds, walnuts, peaches and plums.—F. A. P., Hughson.

The time for budding all deciduous trees is from maturing of good buds on the new wood (which begins with some kinds in June) all through the summer until the sap flow decreases so the bark of the stock does not lift freely. This latter condition may continue until September with some kinds in sufficiently moist soils. The time to graft begins after the fall of the leaves and continues until they start again—the easiest time being just before the buds swell for the new growth. This is a general statement. Particular applications of it to the different kinds of fruits and nuts and the methods which succeed best, are given in detail in "California Fruits and How to Grow Them." Success in budding and grafting consists in knowing all these details and in having learned by experience how to make use of them.

Chestnuts in California.

To the Editor: What about the commercial possibilities of chestnut culture in central California? Are there any large groves in the State, and how does the Japanese chestnut compare with the European? Is the chestnut exacting as to soil? Would light, sandy loam be suitable for their growth?—J. W. D., Aptos.

There may be said to be more possibilities than achievements so far. There are no groves which could be called large. Plantings must be considered scattering and the total acreage exceedingly small. In the foothills of Amador and on the plains of Merced county there are probably more trees than elsewhere, and the Italian people of Amador county have produced most nuts of the so-called Italian or Spanish variety. There is very little demand for chestnuts—just enough to keep the chestnut roasters of the San Francisco street corners busy, seems to measure the demand. The Japanese chestnut is most apt to bear and least valuable when you get it. It is a very large coarse nut, which may be of some value in pork making in the acorn districts. The chestnut trees of vigorous varieties grow well and make handsome trees for shade and ornament in many places, but their bearing is very shy. Maybe they will behave better when they get older. We see at present very little reason to consider the chestnut a commercial proposition.

Oxalis in Lawns.

To the Editor: Please tell me how to eradicate sour grass or oxalis from my lawn, and what the soil needs.—Subscriber, Morgan Hill.

We know no particular way except to keep pulling it out, lifting or loosening the sod with a table fork at each spot so that you get all the roots of the weed when you pull. Theoretically the use of lime is held to be discouraging to the growth of the plant. It will, however, kill the grass if you use too much.

Figure 67. ARMCO Iron Flume advertisement in 1915 Pacific Rural Press newspaper

April 12, 1919 PACIFIC RURAL PRESS 571

Committee. Meanwhile that committee has reported favorably Senator L. L. Dennett's bill, which is a duplicate of Miss Broughton's, though both have been amended differently.

Apple Standardization.

The new apple standardization act as proposed in bill 364 by Senator H. C. Jones has passed the Senate and is ready for the final vote in the Assembly. It defines apples that may go in the various grades and fixes the standard apple box at 10½x11½x18 inches inside measurement. Most of the changes from the old law are of a minor nature intended to enforce its original intent.

County Horticultural Commissioners.

Senator H. C. Jones' amendment to the county horticultural law as proposed in bill 361 has passed the Senate and is in the Assembly Agricultural Committee. The same Senator's bill, 362, providing better salaries for horticultural commissioners' deputies and inspectors, has traveled the same route.

Squirrel District Bill.

Assembly bill 409, by Carlton W. Greene, providing for squirrel extermination districts, has been amended slightly and approved by the Assembly. One of the amendments would encourage co-operation of the proposed squirrel commissioner with all other squirrel extermination agencies.

Somebody Ought to Eat Weeds.

Bill 35, by Senator L. M. King, which provided an effective way of getting roadside weeds cleaned up, was recommended by all committees concerned and passed by the Senate. The Assembly killed it and refused to bring it back to life by a reconsideration. Somebody ought to eat weeds for awhile.

Nursery Growers Register.

Penalty for failure of nursery growers to register with the State Horticultural Commissioner is provided in Senator F. H. Benson's bill 340, which has passed the Senate and been recommended by the Assembly Agricultural Committee.

Flood Storage and Distribution.

State-wide survey and construction of works for storage and distribution of flood waters is provided in Senator L. L. Dennett's bill 427, which has been passed by the Senate and is now in the Assembly Committee on Irrigation.

No Frost Insurance.

No satisfactorily workable frost insurance plan could be agreed upon with relation to Senator King's bill 687 and it will be allowed to sleep.

AGRICULTURAL NOTES.

Tomatoes are to be planted on land from which spinach is being cut for the canneries near Hayward, Alameda county.

About 14.1 per cent of last year's wheat crop remained on the farms March 1, as compared with 20.7 per cent for the five-year pre-war average.

There were only about 50,000 sacks of onions left in the State in the middle of March, according to H. G. Zuckerman of Stockton. A month earlier there were about 110,000 sacks. The reduction from February 15 to March 15 was due to Eastern buying for consumption. These were all cold storage holdings, the dry storage stock having been exhausted by mid-January. The crop last year was practically all grown on about 9000 acres in the delta and was chiefly Australian Brown. The crop was good in yield and quality. Planting for 1919 is over now, about 6000 acres having been put in. Plantings since March 15 stand rather doubtful show. Bermuda and Crystal Wax shipments from Coachella Valley will begin in about a month, and the recent movement has been a good omen for these Riverside county growers.

One hundred and fifty chestnut trees consigned to a grower from Japan were not allowed to enter California by the State quarantine guardian. The gentleman importing them was shown photographs of the ravages of the chestnut bark disease in the East and expressed his approval of the State's action in keeping out apparently healthy trees from a disease-breeding section.

PRINTED instructions which accompany Calco Grain Bins make it easy to erect this substantial, private storage bin without skilled labor.

A Calco Metal Grain Bin on your farm will save you the annual cost of jute sacks, loss from rats, rain and ruin. Capacities from 600 to 5450 bushels. Write for the free booklet, "Calco Grain Bins."

Armco Iron Flume

Lennon Type

GET away from your old, expensive, leaky wooden flume. Armco Iron flume is a water-tight, semi-circular, galvanized metal flume for conveying water—durable because made from rust-resisting Armco Iron. Simple to erect without skilled labor; greatest carrying capacity due to its smooth interior. Write for our big flume catalog.

Armco Iron Irrigation Gates

An inexpensive, reliable metal gate. Diameters from 8 inches to 15 inches. Furnished with or without bulkhead. Write for price list.

MODEL 161

MODEL 150

MODEL 153

Armco Iron Lateral Headgates

Easily operated, durable metal gates; diameters 8 to 36 inches. Hand or screw lift supplied with either type of bulkhead. For use under varying heads of water to a maximum of 6 feet. Details on price list—ask for one.

Gates are supplied in connection with rust-resisting Armco Iron corrugated pipe in any length required.

California Corrugated Culvert Company

LOS ANGELES
417 Leroy Street

AMERICAN ARMCO PRODUCT

BERKELEY
406 Parker Street

CALCO GRAIN BINS

Jr. Monarch Presses

(Portable, Belt or Horse Power)

Are guaranteed to excel any other baler made.

JUNIOR MONARCH HAY PRESS CO.

SAN LEANDRO, CAL.

Figure 68. ARMCO Iron Flume advertisement in April 1919 Pacific Rural Press newspaper

2 THE GARDEN ISLAND. TUESDAY, NOVEMBER 21, 1916.

THE GARDEN ISLAND
Issued Every Tuesday Morning
Luther Dermont Timmons - - - Editor
TUESDAY NOVEMBER 21

Playing Portuguese Against Orientals

Under the above heading a Portuguese newspaper of Honolulu takes exception to a recent editorial in this paper calling attention, first, to the complaints of an element of Kauai Portuguese against the higher charges for merchandise in the stores at present and, second, that our merchants were helpless in the matter. The editorial referred to was based upon a statement recently made by a customer to a merchant to the following effect: "The plantations pay us a large bonus and the stores take it back again." The Honolulu paper intimates that country storekeepers may be taking advantage of the present situation "to add on a cent or two to make an even nickel on the price of goods." Attention is also called to the fact that the living expenses of Portuguese is much higher than are those of certain other laboring classes in the Islands.

In THE GARDEN ISLAND'S editorial referred to the whole idea and aim was to induce people of this Island who do read the newspapers and keep posted on conditions, to go out of their way and take the time to explain to those less well informed the exact causes of the present high prices of many articles of merchandise. Cost figures on many articles to the consumer on this island are not even now nearly so high as they will be in the very near future. Cotton, for instance, has been going up lately by leaps and bounds, until it is now higher than at any time since the civil war in America. The inevitable result of this will be that in a few months all cotton goods in the stores will be at prices higher than most residents of the Islands have ever known.

We were not, in our editorial, defending the "high cost of living," but merely endeavoring to caution consumers of this Island that local merchants were not in any way to blame for conditions. (It may interest our contemporary to know that most of our independent stores are owned by Portuguese, and that the complaint quoted was by a Portuguese against a Portuguese storekeeper.)

We do not agree that country merchants are taking advantage of the situation to make a little extra money, but feel quite positive that just the opposite is the case on this Island. In many instances profits have been cut to relieve the less fortunate classes of customers from world conditions with which we now have to contend.

The point of our contemporary that the burden of present high prices falls more heavily upon the Portuguese than upon certain other elements of our working classes is well taken, and we hope it will be borne in mind by the public generally in considering this problem of the higher cost of living in the country districts.

The Deutschland And Her Mails

Unprecedented engines of war employed in the present great struggle in Europe has resulted in so many conflicting opinions as to what may and what may not be permissible under international law that the neutral part of the world hardly knows where it is at a large part of the time. Aircraft warfare created problems for what little there is of neutral Europe, while the submarine problem has been with us in America for more than two years.

Now we are faced with the question of whether the postoffice department should make a contract with the German undersea freighter Deutschland to carry the American mails to the Central Powers. The American position has always been that the legitimate mail and commerce of neutrals should not be interfered with by either side. The blockade of the North Sea has been recognized, however, as indicated by the failure of the American government to resist the detention and search of American vessels arriving in the war zone. At the same time it has been recognized for centuries that a blockade to be genuine and entitled to recognition must be effective, and it is entirely up to the blockaders to make it so. Insofar as the Deutschland is concerned the blockade does not appear to be effective, for the submersible has to date come and gone at will.

There is no question of the right and propriety of private enterprises of America shipping goods, money, bullion or anything they may like by the Deutschland; but there does seem to be a question in the minds of some as to whether a government friendly to both sides should officially route mails through to Germany in this unusual way. Blockade-running has always been indulged in, but never with the sanction of neutral governments. The crucial point with Germany's new undersea commercial route to America, however, is that there is not nor has there ever been any effective blockade on that particular science of communication.

The Y. M. C. A. Report

The annual year book of the Young Men's Christain Associations of North America is just off the press. The report shows growth in all departments. There are now eight hundred buildings in America at a cost of over ninety million dollars. Seven hundred thousand members are daily using the privileges of these well equipped club houses. To pay the bills these Associations spent $14,345,722 last year. The North American associations helped the work in Asia, South America and the Levant to the extent of $496,758 as compared with $453,191 the previous year.

To minister to the young men in the prison camps of Europe the Association is spending over a million dollars. A half million is being spent with the American troops on the Mexican border. Forty buildings, 80x40 feet costing $2500 to erect and equip, have been erected in eighteen camps. These structures overtop the cities of tents and are the center of social life in each camp.

During the first four months of the work on the Mexican border ten million sheets of paper, 5,000,000 envelopes, and 10,000 quarts of ink were furnished free to soldiers. Thirty moving picture machines gave constant use, 53 talking machines with 2,200 records were provided, sixty tons of magazines gathered and distributed. Twenty thousand New Testaments were given away and one hundred Gospel meetings a week held and crowded. Soldiers and officers say "Could not be without you." This work cost $1,500 a day. Mr. Frank Atherton represents Hawaii on the Y. M. C. A. International Committee.

The Y. M. C. A. movement has surely become one of vast proportions and is accomplishing an enormous amount of good. It should be encouraged and aided by everybody.

Red Cross Work

The sale of Red Cross stamps for the anti-tuberculosis cause is progressing in a most satisfactory manner. Mrs. C. A. Rice reports that people all over the island are responding in a generous spirit to this call, recognizing that here is an opportunity to give, even if in a small way, to a very worthy cause. Every dime or dollar will help in a fight against an evil which, if neglected, may menace the lives of every one.

The ladies who have charge of the sale in the different districts are as follows:

Hanalei	Miss Christopherson
Kilauea	Mrs. Myers.
Kealia	Mrs. G. P. Wilcox.
Lihue	Miss Weber.
Koloa	Mrs. Farley.
Eleele	Mrs. Alexander.
Makaweli	Mrs. Douglas Baldwin.
Waimea and Kekaha	Mrs. Knudsen and Mrs. Schultze.

Mr. Loomis' clubs are also busy making sales. Many of the leading stores on the island have the stamps on hand. If by any chance you are overlooked, please put yourself on record by applying to Mrs. C. A. Rice or to any of the above named ladies. Let us all help in making this the best stamp sale we have ever had on Kauai.

CONSIDERABLE SPACE is given nowadays by the press of the Islands to the subject of a possible change in the governorship of Hawaii. As a practical, business proposition: Do we want a change at all? On account of our mixed population, our diversity of ideas and ideals and the conflict of material interests at various angles it is impossible for a governor of Hawaii to delight everybody. Governor Pinkham has come nearer the mark, however, than any chief executive we have ever had, and on a basis of the modern by-word "safety first" we are inclined decidedly toward more of Governor Pinkham than a change which would be doubtful as to results at the very best.

IT IS CLAIMED that the Filipino who shot and killed a friend and wounded another man in Hanapepe a week ago got his idea from a motion picture which he had seen. In this community, with so many unenlightened, whose emotions are so easily aroused, great caution should be used in the matter of pictures. Pictorial suggestions likely to direct the mind toward murder or other wrong-doing should be eliminated entirely from programs. It should be possible to obtain classic and educational films—pictures that have something worth while on the mind. Surely productions that incite the ignorant to crime should not be brought here on any account.

THEY HAVE a very unique prohibition law in Tennessee. In fact it is not termed a prohibition law at all, but it works out that way. The enactment, which was submitted to the people, simply provides that intoxicating liquor shall not be sold within four miles of any church or school house. It turned out that there was only one, lone spot in the entire State four miles and more from a church or school house, and that place was so sparsely settled that the saloon keeper, if one cared to tackle the proposition, would probably have himself as his own best customer!

THE STANDARD of the principal pictures (those classed as "leaders") shown on Kauai in the past month or two has gone down. It is generally recognized that no one here is to blame for it. It may be that the parties at Honolulu are not to blame—that they are sending us the best they can procure. If that is true, however, they should let the public know about it.

FORMER PRESIDENT ROOSEVELT and wife plan to come to the Hawaiian Islands early in the year for a sight-seeing tour. It would be interesting to a great many if they could visit Kauai, and we suggest that the Special Guests Committee of the Chamber of Commerce extend them an invitation.

MAUI'S FAIR at the end of this month will be well worth visiting and we hope that many Kauai people may find it convenient to take it in. Maui and Hawaii are taking the lead in establishing the "fair" spirit in the Islands, and it would not hurt at all if it spread farther north to Kauai.

Figure 69. ARMCO Iron Flume advertisement in Nov. 1916 The Garden Island newspaper

The survey of Block 12 documented disturbed remnants of the Ōlaʻa Flume (see **Figure 43**). These remnants consist of five twisted fragments of the half pipe metal flume located in bulldozed pushpiles of soil and stone. Examples of these flume fragments are depicted in **Figures 70** and **71**. None of the wooden framework was present. The ʻŌlaʻa Flume Road extends along the southwestern side of Block 12 for approximately 100 meters, where it becomes overgrown and inaccessible by vehicle.

As depicted on **Figure 61,** two flume houses (Upper and Lower), which controlled the flow of water, were located along the ʻŌlaʻa Flume. The Lower Flume House was situated in the WTMA in Block 12. No remnants of this flume house are present in the block. The Upper Flume House was situated outside the boundaries of the WTMA to the north.

Site 50-10-43-30088

A review of historic maps of the area indicate that an historic road extended along the southeastern boundary of the WTMA (see **Figure 61**). The ʻŌlaʻa Back Road extended to the southwest from Fifteen and Three-Quarter Mile Road, which follows the present path of North Kulani Road. The ʻŌlaʻa Back Road connected the ʻŌlaʻa Lots to farm lands in the area. The ʻŌlaʻa Lots, located to the south of the WTMA, were established for homesteading under the Land Act of 1895. The road was assigned its SIHP site number during the present project

The ʻŌlaʻa Back Road still exists and is in use by local residents, although today the road is paved and is referred to as Ihope Road (**Figures 72** and **73**). According to Haun & Associates Cultural Specialist Solomon Kailihiwa, *ihope* is the Hawaiian word for "back", indicating that the road is still referenced as the "back road".

Site 50-10-35-18697

Site 50-10-35-18697 is a cave containing human remains located in the northeastern portion of the WTMA (see **Figure 20**). This cave was previously identified by the director of the Hawaiʻi County Economic Opportunity Council, Mr. George Yokoyama during examination of a planned agricultural area. The site was subsequently examined by State staff archaeologist, Wendall Kam (Nagata 1985). The reported location of the cave, from the Nagata letter report (1985) was presumably marked with an "**X"** within a circle on **Figure 16**.

On November 21, 2013, a crew of four Haun & Associates archaeologists attempted to relocate the Site 18697 cave. The reported location of the burial cave was transferred to the Magellan Mobile Mapper GPS device, using contour lines depicted on **Figure 16** and on current topographic maps of the area. This location is depicted on **Figure 74.** The crew then converged on this precise location; however the site is not present in this area. The crew then systematically surveyed the surrounding area, with crew members spaced at 10 meter intervals. The survey extended 50 meters from the reported location of the burial cave in all directions and encompassed an area of approximately 2.7 acres. No caves, lava tubes or blisters are present in this area.

On January 13, 2014, the crew made a second attempt to relocate the cave. **Figure 16** depicts a bold black line with an arrow at the end that leads into the area from Stainback Road. A pointer marks an area adjacent to the bold line that is labeled, "Entrance to Site". These two areas, labeled Alternate Area 1 and 2 on **Figure 74** were surveyed during this attempt to locate the site. **Alternate Area 1** is situated at the end of the bold black line with the arrow (see **Figure 74**). A 150 by 100 meter area (3.7 acres) was surveyed; however, no caves, lava tubes or blisters were found. **Alternate Area 2** is a 25 by 15 meter area (0.09 acres) area located at the end of the pointer labeled "Entrance to Site". The Alternate Area 2 is located where the Quarry Road passes over a large ravine between two ridges (**Figure 75**).

Figure 70. Displaced remnant of Site 20870 Flume in Block 12 (view to northeast)

Figure 71. Displaced remnant of Site 20870 Flume in Block 12 (view to north)

Figure 72. Ihope Road, former path of Site 30088 ʻŌlaʻa Back Road (view to southwest)

Figure 73. Ihope Road, former path of Site 30088 ʻOlaʻa Back Road (view to northeast)

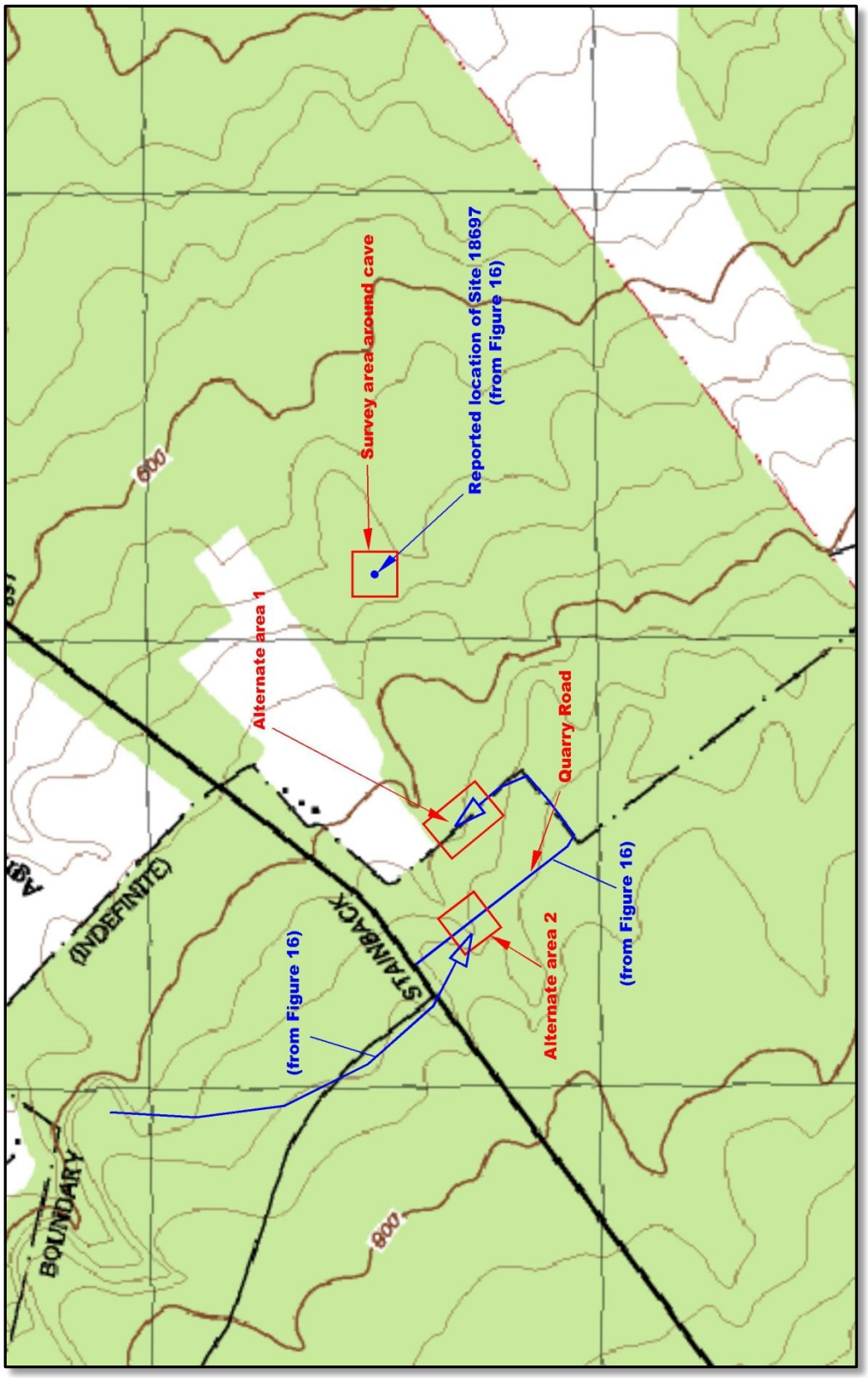

Figure 74. Portion of 7.5' 1995 Hilo Quadrangle showing reported and alternate locations for Site 18697

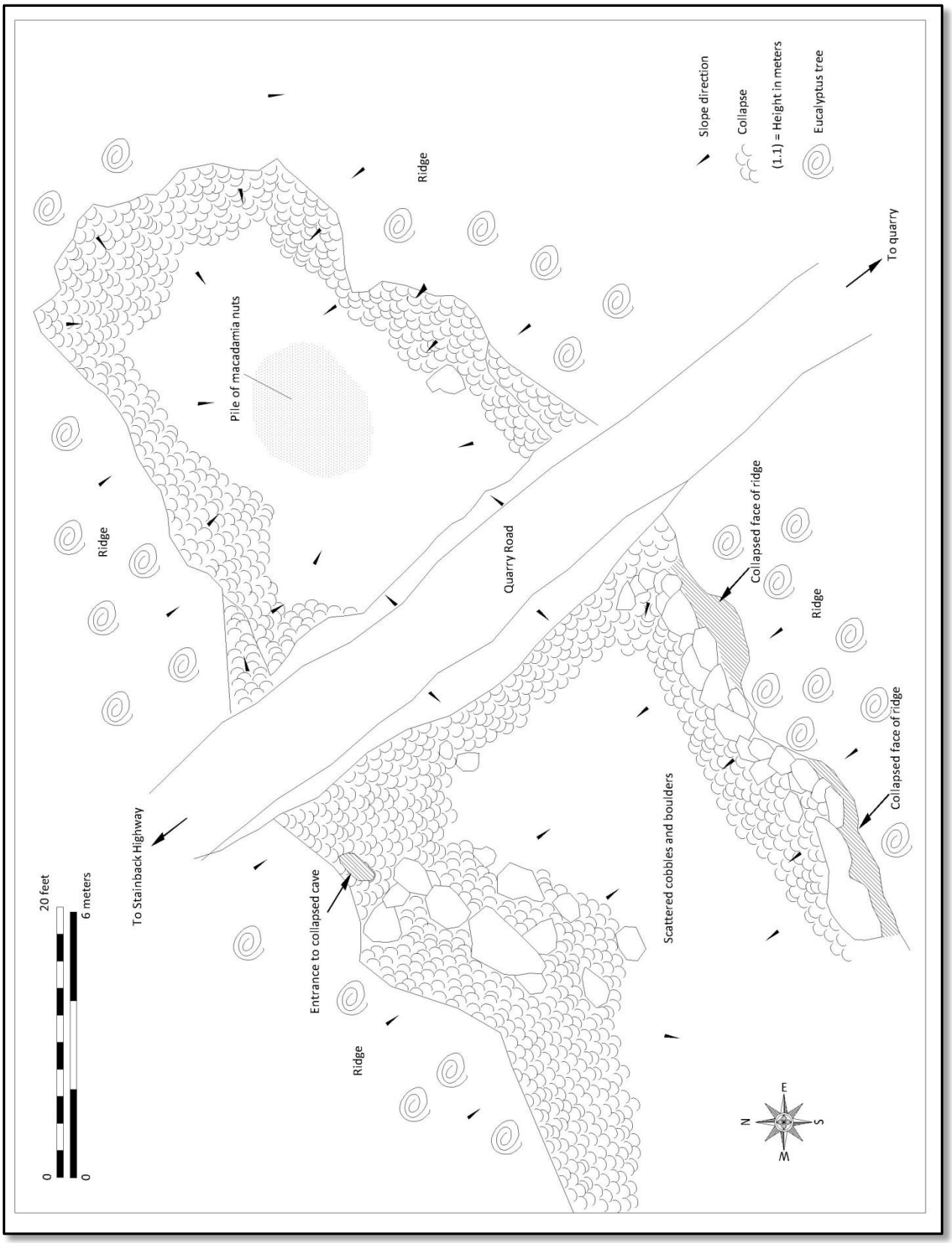

Figure 75. Plan map of Alternate Area 2

The survey of Alternate Area 2 identified two potential locations for Site 18697. Both are located on the southwest side of the road. One is a small cave below the northern ridge and the other is a large collapsed area below the south ridge.

The cave below the north ridge opens onto a small chamber with a low ceiling and a rubble floor. No cultural remains are present (**Figure 76**). The area below the southern ridge has large eucalyptus trees growing on the upslope side of it and large roots from these trees have sheered-off the entire face of the ridge in two locations. It is possible that these sheered-off slabs may conceal the cave. Overviews of this collapse are presented in **Figures 77** and **78**. No cultural remains are present in this area.

The ravine area is the most likely locale for the Site 18697 cave based on the original map and the area's topography, although no cave of comparable size to that reported in 1985 was found. The 1985 letter report states that at the time of first inspection the cave was "relatively unstable" with recent ceiling collapse and "evidence of material filling the entry via the natural processes (i.e. water drainage and corresponding damage to the walls)…" (Nagata 1985:1). This description and the current survey findings suggest that the entrance to the cave may have become sealed since it was first reported nearly 30 years ago.

Figure 76. Small blister below north ridge in Alternate Area 2 (view to northeast)

Figure 77. Sheered-off face below southern ridge in Alternate Area 2 (view to southwest)

Figure 78. Sheered-off face below southern ridge in Alternate Area 2 (view to southeast)

CONCLUSION

Discussion

The archaeological inventory survey covered a total of 556.49 acres in the WTMA. The surveyed areas consist of the 550 acres of sample blocks that were proposed in the AISP and an additional 6.49 acres surveyed during efforts to relocate the Site 18697 burial cave. The survey identified a badly disturbed remnant of the historic ʻŌlaʻa Flume and documented the ʻŌlaʻa Back Road that is currently in use as Ihope Road. No prehistoric sites or features were encountered.

The absence of prehistoric sites in the survey blocks is not unexpected based on the extensive ground disturbance that has occurred in the area since the early 1960s and the expected low site density predicted by McEldowney's (1979) settlement pattern model. Most of the WTMA was mechanically cleared, presumably by bulldozer based on DOFAW records. One sample block surveyed was listed as having been cleared using a combination of hand, chemical or light tractor (Block 5); however, the survey findings for this area indicate that it was extensively disturbed, evidenced by the abundant strawberry guava and other secondary vegetation species. This suggests that the block was cleared by light tractor or that it was impacted during a subsequent clearing episode.

DLNR-SHPD requested that two-thirds of the sample blocks be located below 2,500 ft elevation and that the remaining one-third be located above 2,500 ft. Of the 20 survey blocks examined, 15 were located below 2,500 ft elevation, comprising 390 acres (71%), and the remaining 29% was situated above 2,500 ft elevation.

The majority of the WTMA is located in McEldowney's (1979) Lower Forest Zone that extends between 1,500 ft and 2,500 ft elevation (5,830-acres, 46%). This zone was the source for obtaining natural resources such as timber, medicinal plants, *olona*, and birds. Predicted site types consist of temporary habitations, trials, shrines, and minor agricultural features in forest clearings and along streams. Of the 550 acres surveyed in the sample blocks 260 acres (47%) are located in the Lower Forest Zone.

McEldowney's Rainforest Zone comprises 28% of the WTMA, or 3,452-acres. Sites in this area were limited to trails and associated temporary habitations. This zone was used for intra-island travel and gathering of resources including hardwoods and birds. A total of 160 acres (29%) was surveyed in this zone.

Sites in McEldowney's Upland Agricultural Zone (3,224-acres, 26%) also consist of trails and associated temporary habitation sites such as lava tubes. The survey covered 130 acres in the Upland Agricultural Zone (24%).

The WTMA was certainly utilized prehistorically as evidenced by the previous identification of the Site 18697 burial cave in the seaward portion of the area; however, the majority of traditional land use in this area was for the procuring natural resources and temporary habitation associated with this activity. It is probable that the physical evidence of these activities would have been ephemeral and left little if any surviving physical evidence.

The survey did identify nine subterranean features in the sample blocks and one during the Site 18697 relocation efforts. These natural features were often wet due to high rainfall in the area and would not have made suitable habitation locations, even on a temporary basis. None of these features contain cultural remains or evidence of use.

Similar negative findings were encountered during previous archaeological work in and adjacent to the WTMA by Hammatt at Bush (1999a and 1999b). These surveys covered an estimated 375 acres in the WTMA, yielding no archaeological sites. A total of seven non-cultural lava tubes, two sinkholes with lava tubes, 17 lava blisters, a modern stone alignment and a possible gravel runway were however noted.

As discussed, two separate attempts were made to relocate the Site 18697 burial cave noted in 1985. These attempts consisted of surveying three potential cave locations and the surrounding areas. It is possible that Site 18697 is located in the ravine area adjacent to the Quarry Road, but the entrance is no longer present due to ceiling collapse and infilling since 1985. It is also possible that the cave was poorly plotted in 1985 and may be located in the general area of its reported location, but beyond the areas surveyed during the present project.

Significance assessments

Pursuant to DLNR (2003) Chapter 13-275-6, the initial significance assessments provided herein are not final until concurrence from the DLNR has been obtained. Sites documented during the survey are assessed for significance based on the criteria outlined in the Rules Governing Procedures for Historic Preservation Review (DLNR 2003:Chap 275). According to these rules, a site must possess integrity of location, design, setting, materials, workmanship, feeling, and association and shall meet one or more of the following criteria:

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

The sites in the project area possess integrity of location, design, setting, materials, workmanship, feeling, and association. Based on the above criteria, the remnant of the Site 20870 ʻŌlaʻa flume and the Site 30088 ʻŌlaʻa Back Road are assessed as significant under Criterion "d" (**Table 14**). These sites have yielded information important for understanding historic land use in project area. Site 20870 is also assessed as significant for its association with the broad pattern of sugar cane plantation agriculture in Hawaiʻi.

Table 14. Site significance and treatment recommendations

SIHP Site Number	Site Type	Site Function	No. of features	Age	Significance criteria*	Treatment recommendation
50-10-34-20870	Flume	Water transportation	1	Historic	A, D	No further work
50-10-43-30088	Road	Transportation	1	Historic	D	No further work

** - A = Contribution to history, D = Information content*

Treatment recommendations

The Site 20870 flume remnant and the Site 30088 ʻŌlaʻa Back Road (Ihope Road) are adequately documented and no further work or preservation is recommended (see **Table 14**). It is recommended that archaeological monitoring of any future land modification be conducted in a 500 square meter (61.7 acre) area centered on the reported location of the Site 18697 burial cave and oriented parallel to the Stainback Highway (**Figure 79**). This monitoring activity would be guided by an Archaeological Monitoring Plan submitted for DLNR-SHPD review and approval.

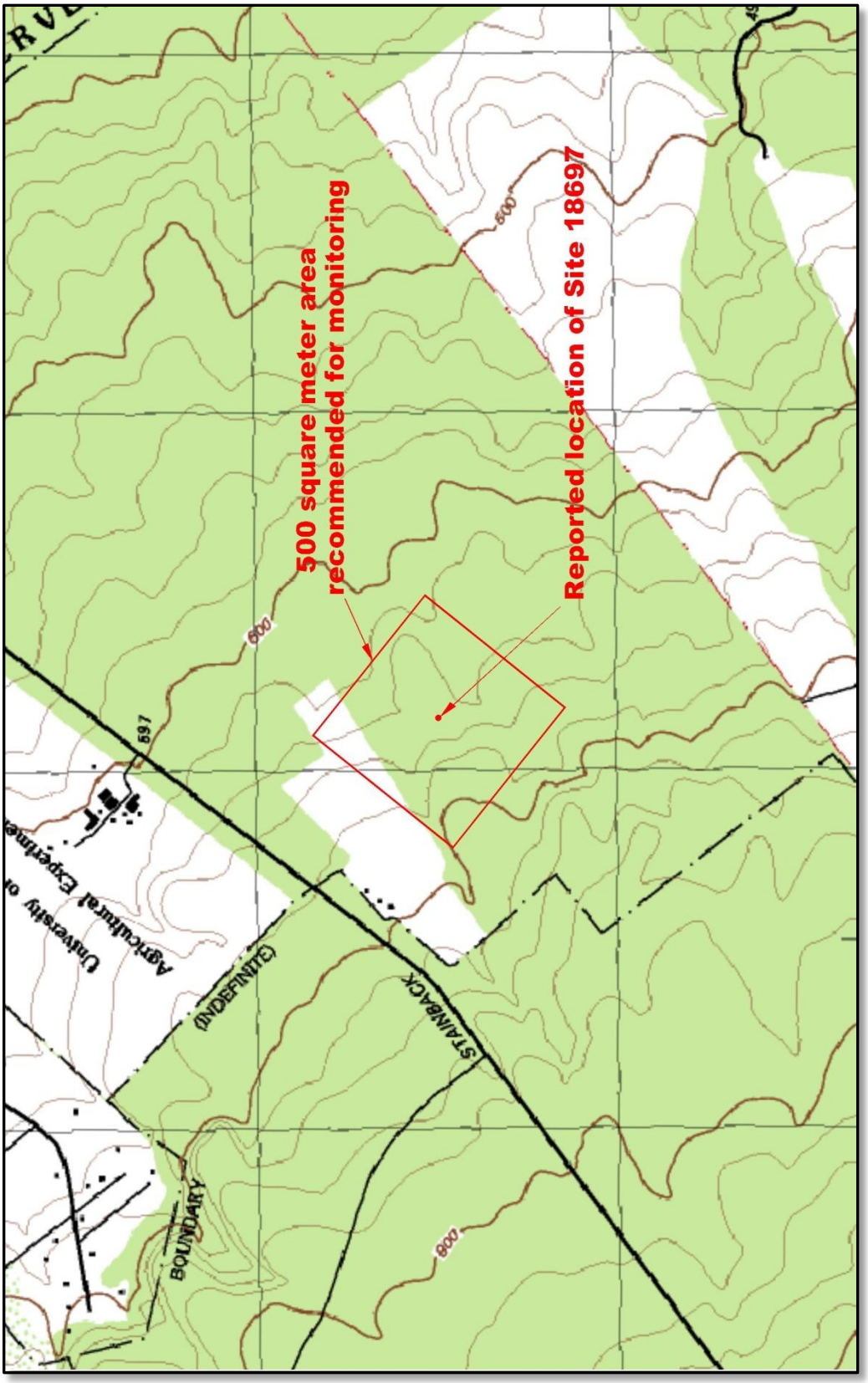

Figure 79. Portion of 7.5' 1995 Hilo Quadrangle showing area recommended for archaeological monitoring

REFERENCES

California Digital Newspaper Collection

2014 http://cdnc.ucr.edu/

Chronicling America website

2014 http://chroniclingamerica.loc.gov/

DLNR (Department of Land and Natural Resources)

2003 Hawai'i Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 13, State Historic Preservation Division Rules.

Division of Forestry

1961 Five-Year State Forest Planting Plan for State of Hawai'i. FY 1962-1966. Division of Forestry, Department of Agriculture and Conservation. March 1961.

1966 Forestry Planting Plan, Fiscal Years 1967-1971. State of Hawai'i, Department of Land and Natural Resources, Division of Forestry, February 1966.

1971 Forestry Planting Plan, Fiscal Years 1972-1976. State of Hawai'i, Department of Land and Natural Resources, Division of Forestry, July 1971.

ESRI website

2013 http://www.esri.com/

Hammatt, H. and A. Bush

1999a Archaeological Inventory Survey for the proposed Stainback Highway Improvement Project, Waiākea, South Hila, Island of Hawai'i (TMK 2-4-008). , Cultural Surveys Hawai'i, Inc., Kailua.

1999b Archaeological Inventory Survey for the Proposed New Hawai 'i Island Correctional Facility, Waiākea, South Hila, Island of Hawai'i (TMK 2-4-00S:por. 1), Cultural Surveys Hawai'i, Inc., Kailua.

Haun, A., and D. Henry

2013 Plan for Archaeological Inventory Survey, Waiākea Timber Management Area located in Waiākea and 'Ōla'a Ahupua'a, South Hilo and Puna Districts, Island of Hawai'I (TMK: [3] 1-8-012: portion of 001; 2-4-008: portions of 001, 006, 010, and 022). Haun & Associates report 938-101813 prepared for Department of Land and Natural Resources Division of Forestry and Wildlife

Howarth, F, R. Cowie, D. Preston, R. Englund, R. Rundell, F. Stone and S. Montgomery

1999 Proposed New Hawai'i Correctional Facility, Waiākea, South Hilo, Island of Hawai'i, Assessment of Potential Impacts on Invertebrates (Snails, Insects and other Anthropods) of Proposed Improvements to Stainback Highway. Bishop Museum Report to Wilson Okamoto, Inc., Honolulu.

Langlas, C., T. Wolforth, J. Head and P. Jensen

1997 Archaeological Inventory Survey and Historic and Traditional Cultural Assessment of the Hawai'i Defense Access Road A-AD-6 (1) and Saddle Road (SR) 200 Project, Districts of South Kohala, Hamakua, North Hilo and South Hilo, Island of Hawaii. PHRI Report 1522-022897 prepared for RUST Environmental & Infrastructure, Inc.

McEldowney, H.

1979 Archaeological and Historical Literature Search and Research Design: Lava Flow Control Study, Hilo, Hawai'i. Prepared for the U.S. Army Engineer District, Honolulu. Department of Anthropology. Bishop Museum.

Maly, K and O. Maly.

2004 *He Mo'olelo 'Āina*: A Cultural Study of the Pu'u Maka'ala Natural Area Reserve, Districts of Hilo and Puna, Island of Hawai'i. Kumu Pono Associates, LLC Report HINARS80-Makaala. Prepared for Department of Land and Natural Resources, Natural Area Reserves, Hilo, HI.

Nagata, R.H

1985 Letter report: Field Inspection of Cave Site, Fodder Growing Project (CDUA-HA 1736) Parcel, Panaewa, South Hilo, Hawai'i (TMK: 2-4-08:22).

Richmond, G.

1963 Species Trials at the Waiākea Arboretum, Hilo Hawai'i. U.S. Forest Service Research Paper PSW-4. Pacific Southwest Forest and Range Experiment Station, Berkeley, California Forest Service, U.S. Department of Agriculture

Sato, H.H., E.W. Ikeda, R. Paeth, R. Smythe, and M. Takehiro Jr.

1973 *Soil Survey of the Island of Hawai'i.* U.S. Dept. of Agriculture, Soil Conservation Service and University of Hawai'i Agricultural Experiment Station. Washington D.C. Government Printing Office.

State of Hawai'i

1998 Forest Management Plan for the Waiākea Timber Management Area. Prepared by State of Hawai'i, Department of Land and Natural Resources, Division of Forestry and Wildlife.

United States Geologic Survey (USGS) website

2013 http://www.usgs.gov/

United States Geological Survey (USGS)

1923 Department of the Interior, United States Geological Survey, Water Supply Paper 515, Surface Water Supply of Hawaii, July 1, 1918 to July 30, 1919.

University of Hawai'i at Manoa Library website

2014 http://evols.library.manoa.hawaii.edu

Waihona 'Aina Corporation

1998 The Mahele Database, waihona.com.

Wolfe, E., and J. Morris

2001 Geological Map of the Island of Hawai'i. U.S. Department of the Interior. U.S Geological Survey

APPPENDIX A – DLNR-SHPD ACCEPTANCE LETTER

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ESTHER KIA'AINA
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

HISTORIC PRESERVATION DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

601 Kamokila Boulevard, Suite 555
Kapolei, HI 96806

October 4, 2013

Sheri S. Mann
Forestry Program Manager
Division of Forestry and Wildlife
(Sheri.S.Mann@hawaii.gov)

LOG NO: 2013.5274
DOC NO: 1309SN26
Archaeology

Dear Ms. Mann:

SUBJECT: **Chapter 6E-8 Historic Preservation Review –**
Plan for Archaeological Inventory Survey, Waiākea Timber Management Area
Waiākea and Ola'a Ahupua'a, South Hilo and Puna Districts, Island of Hawai'i
TMK: (3) 1-8-012:001 (por) and (3) 2-4-008:001, 006, 010, and 020 (por)

Thank you for the opportunity to review this draft titled: *Plan for Archaeological Inventory Survey, Waiākea Timber Management Area, Waiākea and Ola'a Ahupua'a, South Hilo and Puna Districts, Island of Hawai'i, TMK: (31-8-012:001 (por) and (3) 2-4-008:001, 006, 010, and 020 (por),* A. Haun and D. Henry, September 2013. This draft was received via email September 4, 2013. The plan was prepared to support the proposed project development on 12,506 acres of lands within the Waiākea Timber Management Area for the Forestry Program, Division of Forestry and Wildlife (DOFAW). The project is to be licensed as a part of the Commercial Harvest and Reforestation Project and proposes to harvest non-native timber and non-native timber products from the proposed areas within the project area and reforest the harvested areas with commercial tree species.

The background research that was conducted as a part of this AISP indicates that there are three known archaeological sites within this project area – a burial cave and a historic flume with associated road. The management area was mechanically cleared during initial planting; expectations are that if historic properties are present, they will be subterranean. The AISP proposes the documentation of the previously identified sites within the project area as well as a 5% sample survey comprised of 20 survey blocks ranging from 10 to 40 acres in area. The plan indicates that several areas of the WTMA will be excluded from the survey. These areas include 814 acres planted with native hardwoods, 28-acres of experimental hardwoods that will not be harvested, 349 acres of block roads, 285 acres of former sugarcane lands, and a previously developed 35-acre staging area. The resulting total survey area is 10,995 acres, 549 acres of which will be intensively surveyed. The sampling is stratified by elevation, with 2/3 of the sampling (362 acres) located below 2,500 ft. elevation and the remaining 1/3 above 2,500 ft. elevation. The AISP sampling is a quadrat design based on specific environmental variables.

We believe that the methods that you have described will provide an accurate characterization of the distribution of historic resources of this project area. Should areas of concentrated historic properties be identified during the sampling survey, additional fieldwork may be needed to document the full extent of identified sites. We would like to convey the importance of community consultation in the early phases of this project, both to identify previously undocumented archaeological sites and to meet the requirements of HAR 13-276-5 (g). We recognize that information may be forthcoming that would require slight modifications in the sampling strategy.

This plan meets the standards for archaeological inventory survey plans that are set forth in HAR 13-275-5 (c). Please send one hardcopy of the document, clearly marked **FINAL**, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library. Please contact Sean Nāleimaile at (808) 933-7651 or Sean.P.Naleimaile@Hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Theresa K. Donham
Archaeology Branch Chief

cc: Alan Haun, Haun and Associates (ahaun@haunandassociates.com)

Appendix H: Comments received during Pre-consultation

Written comments were received from the following agencies, organizations, and individuals and copies of the original comments are reprinted in this Appendix.

Federal
Hawai‘i Volcanoes National Park

State
DLNR-State Historic Preservation Division
DLNR-Office of Conservation and Coastal Lands
Department of Hawaiian Home Lands
Department of Health
Department of Transportation

County of Hawai‘i
Planning Department
Department of Research and Development
Fire Department

Organizations
Mauna Kea Recreational Users Group
Big Island Mountain Bike Association

Individuals
John Crabbe

United States Department of the Interior

NATIONAL PARK SERVICE
Hawai'i Volcanoes National Park
Post Office Box 52
Hawaii National Park, Hawai'i 96718

IN REPLY REFER TO
HAVO 1.D. (1.7621)

April 11, 2012

Jan Pali
Division of Forestry and Wildlife
1151 Punchbowl Street Room 325
Honolulu, HI 96813

Subject: Pre-consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiākea Timber Management Area on the Island of Hawai'i

Thank you for your letter dated March 12, 2012 requesting comments on the proposed project to harvest non-native timber and non-timber forest products from the Waiākea Timber Management Area. At this time we do not foresee any impact of the proposed project on our existing projects, plans, policies, or programs.

Current planning and compliance documents for the park may be useful during development of the environmental assessment. This information can be found at http://www.nps.gov/havo/parkmgmt/plan.htm

Please keep us on the mailing list for this project and other projects in the vicinity of Hawai'i Volcanoes National Park.

Sincerely,

For

Cynthia L. Orlando
Superintendent

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

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

April 19, 2012

Log No. 2012.0703
Doc No. 1204TD05

MEMORANDUM

TO: Jan Pali, Forestry Watershed Planner
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, Hawai'i 96813

FROM: Theresa K. Donham, Archaeology Branch Chief

SUBJECT: **Chapter 6E-8 Historic Preservation Review – Environmental Assessment Notice**
Waiākea Timber Management Area (WTMA) Commercial Harvesting and Reforestation
'Ōla'a and Waiākea Ahupua'a, Puna and South Hilo Districts, Island of Hawai'i
TMK: (3) 1-8-012: portions of 001 and 003; 2-4-008: portions of 001, 006, 010, 019 and 022

This memo is in response to your request for information regarding the general history and land use of the subject area, including known historic properties and cultural sites that could be affected by the proposed action; cultural associations; and referrals of knowledgeable persons regarding the area. We received your memo March 14, 2012. The proposed action will involve harvesting of non-native timber that was planted for such purpose *circa* 1959-1068; and reforestation of the harvested areas with commercially valuable tree species. Approximately 12,000 acres is within the area selected for the project. An Environmental Assessment (EA) is being prepared in connection with the proposed action. The project area includes portions of the Waiākea Forest Reserve, the Upper Waiākea Forest Reserve and the 'Ōla'a Forest Reserve; elevation ranges from approximately 400 ft to 3,200 ft.

Our records indicate that we received a draft EA titled "Commercial Harvesting of Forest Products and Subsequent Reforestation of Waiakea Timber Management Area, Island of Hawaii" in March 1999. The project area identified at that time is similar to the current project area, with the exception of additional TMK parcels added for the current project (1-8-012:001, 2-4-008:006 and 019). The 1999 DEA indicates that in addition to timber removal and replanting, it is expected that old roads will need to be cleared for use and public roads (such as Stainback Highway) may need to be improved; temporary skid trails and landings will also be permitted. We assume that the current EA will provide detailed information regarding roads proposed for use and proposed improvements that will be needed in order to accommodate the operation.

Known Historic Properties

Archaeological inventory surveys were not conducted of the WTMA prior to the 1959-1968 plantings, and there have been limited studies in the area since. Due to a lack of systematic survey, it is not possible to accurately predict the occurrence or density of historic properties, particularly for the portions below 2,000 ft elevation. The 1999 DEA states on page 25 that, "Within the project area, there are no known historic or archaeological sites." Please note that this statement is not correct. Be advised that known historic properties are within the area indicated on the map attached to your memo. These include the following:

1. A known burial cave is present within Parcel 2-4-008:022. This cave (SIHP Site 50-10-35-18697) was reported to the Division in 1985 by the Hawaii County Economic Opportunity Council (Ralston Nagata letter to George Yokoyama March 7, 1985). At that time, a buffer zone of 75 feet radius was recommended

for the site, which is located at an elevation of approximately 650 ft. The exact location of this site should be reacquired and its condition should be assessed as part of the EA preparation. A formal preservation/burial treatment plan should be prepared for the site and reviewed by the Hawaii Island Burial Council if logging and/or replanting activities are to occur within this parcel.

2. The ʻŌlaʻa Flume (SIHP Site 50-10-34-20870) runs north-south through Parcel 2-4-008:001 at the 1,900 ft elevation. The main flume trough connected Ōlaʻa Flume Spring with the mill just below Keaʻau. Numerous offshoots were constructed along the main trough running downhill through the plantation area. Intact remnants of the main trough and other segments have been identified in the field. This site was determined eligible for listing in the National Register of Historic Places during site evaluation proceedings for Saddle Road improvements. Associated with this site is the ʻŌlaʻa Flume Trail/Road, which parallels the flume. This road alignment is depicted on USGS quadrangle maps and could potentially be impacted by timber activities in the forest reserve. A mitigation plan may need to be prepared for this site if project activities will occur on or near the site.
3. Evidence of intact agricultural and habitation features is present in the immediate vicinity of the Honua Facility on Stainback Highway, in the near vicinity of Parcel 022.
4. Surface features of indeterminate function have been observed by SHPD staff in the Waiākea Forest Reserve near Stainback Highway, below the Kulani Road junction.

Additional Considerations

A portion of the project area correlates with the traditional Hawaiian Upland Agricultural Zone described by McEldowney (1979). This zone is expected to contain traditional Hawaiian habitation sites with associated agricultural areas and groves of economically beneficial trees. The Upland Agricultural Zone begins roughly 0.5 mile inland from the coast and its upper reaches are around 1,500 ft elevation (McEldowney 1979:18). There is a higher probability of undisturbed agricultural features, habitation sites and burial sites within this elevation range. In addition to the above listed known sites, we have records indicating that additional burial caves are present at around 1,200 ft elevation, a short distance to the south of the project area. We therefore recommend that the portion of the project area (including road improvement areas) below 2,000-1,500 ft elevation be subjected to an inventory survey; this information should be used in preparation of the EA. Historic properties such as caves and other surface features could have been easily avoided during initial tree planting; however these sites could be impacted when heavy equipment is used to clear access roads for trucks and skid trails. We also recommend completion of a Cultural Impact Assessment that will identify other areas within the WTMA that may need on-ground inventory survey work prior to timber removal and replanting.

We have studies on file at the SHPD library that should be consulted regarding traditional Hawaiian and early historic era land use in and around the project area.

Please contact me at 933-7653 or Theresa.K.Donham@hawaii.gov if you have any questions or comments.

→ Jan Pali

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

Office of Conservation and Coastal Lands
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF: OCCL: AJR

COR: HA-12-196

MAR 22 2012

MEMORANDUM

TO: Jan Pali, Forestry Watershed Planner
DLNR - Division of Forestry and Wildlife

FROM: Sam Lemmo, Administrator
DLNR – Office of Conservation and Coastal Lands

SUBJECT: **Pre-consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of the Waiākea Timber Management Area (WTMA)**
Waiākea, South Hilo, County of Hawaii
TMK(s): (3) 1-8-012:001; 003 (por)
TMK(s): (3) 2-4-008:001; 006; 010; 019; 022 (por)

Dear Jan Pali,

The Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) is in receipt of your letter regarding a pre-consultation for the WTMA Draft Environmental Assessment (DEA) which is proposing to conduct land uses in the Conservation District General, Resource and Protective Subzones.

The Division of Forestry and Wildlife (DOFAW) is proposing to harvest non-native timber and non-timber forest products; to implement roadway improvements and maintenance; to conduct minimal site grading and land management activities and to promote fire suppression and fire management plans on the subject parcels. On *September 11, 1998* DOFAW published the *Forest Management Plan for the Waiākea Timber Management Area* which outlined goals, considerations and best management practices for the WTMA.

According to a Department of Land and Natural Resources (*Department*) policy (*c. 1992*), divisions within the Department, that are proposing to conduct land uses on their own managed lands inside the Conservation District, are not required to apply for a Conservation District Use Permit (CDUP) when a management plan is already in place for the specified land use and the proposed land use is consistent with that specific divisions management objectives for the project area. However, those divisions must adhere to the criteria and guidelines of §183C Hawaii Revised Statutes (HRS) and §13-5 Hawaii Administrative Rules (HAR). Similarly, those divisions proposing land use actions in the conservation district shall ensure compliance with §343 HRS in regards to the specific environmental review requirements.

At this time the Office of Conservation and Coastal Lands has no comments for the pre-consultation. We look forward to reviewing the Draft Environmental Assessment (DEA) when it is completed and reserve the right to comment on any proposals located within the Conservation District.

Should you have any questions, please feel free to contact Alex J. Roy of the Office of Conservation and Coastal Lands at 808-587-0316.

CC: *Chairperson*
HDLO
County of Hawaii Department of Planning

NEIL ABERCROMBIE
GOVERNOR
STATE OF HAWAI'I

JOBIE M. K. MASAGATANI
CHAIRMAN DESIGNATE
HAWAIIAN HOMES COMMISSION

MICHELLE K. KAUHANE
DEPUTY TO THE CHAIRMAN

STATE OF HAWAI'I
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAI'I 96805

May 25, 2012

Ms. Jan Pali
Forestry Watershed Planner
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, HI 96813

Aloha Ms. Pali:

Thank you for your letter dated March 12, 2012 regarding the Pre--consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawaii.

The Department of Hawaiian Home Lands is the State of Hawaii's largest affordable housing developer serving the needs of native Hawaiians pursuant to the Hawaiian Homes Commission Act, 1920, as amended.

The Aina Mauna Legacy Program was adopted by the Hawaiian Homes Commission in 2009. It is comprised of 56,200 acres of land at Humu'ula Pi'ihonua the objective is to insure long term restoration and management of the native forest and other resources in the area. The goal is to develop and reinvest the income to preserve the area in a self-sustainable economic model. DHHL anticipates DLNR's project will not impact DHHL's statewide development program and therefore has no comments to add to the assessment.

Thank you for the opportunity to provide these comments. If you have any questions, please do not hesitate to contact me at (808) 620-9501 or the DHHL Planning Office staff, Bob Freitas at (808) 620-9484.

Me ke aloha,

Jobie M.K. Masagatani
Chairman Designate
Hawaiian Homes Commission

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

LORETTA J. FUDDY, A.C.S.W., M.P.H.
DIRECTOR OF HEALTH

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

In reply, please refer to:
File:12-051

March 14, 2012

Ms. Jan Pali
Forestry Watershed Planner
Division of Forestry and Wildlife
Department of Land and Natural Resources

Dear Ms. Pali;

SUBJECT: Pre-Consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawai'i

The Department of Health (DOH), Environmental Planning Office (EPO), acknowledges receipt of your letter, dated **March 12, 2012.** Thank you for allowing us to review and comment on the subject document. We have no comments at this time, but reserve the right to future comments. We strongly recommend that you review all of the Standard Comments on our website: www.hawaii.gov/health/environmental/env-planning/landuse/landuse.html. Any comments specifically applicable to this application should be adhered to.

Please provide us with a copy of the draft EA when it is complete.

Sincerely,

Laura McIntyre AICP
Environmental Planning Office Manager

NEIL ABERCROMBIE
GOVERNOR

GLENN M. OKIMOTO
DIRECTOR

Deputy Directors
JADE T. BUTAY
FORD N. FUCHIGAMI
RANDY GRUNE
JADINE URASAKI

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

IN REPLY REFER TO:
DIR 0314
STP 8.0802

April 16, 2012

TO: THE HONORABLE WILLIAM J. AILA, JR., CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
DEPARTMENT OF LAND AND NATURAL RESOURCES

ATTN: JAN PALI, FORESTRY WATERSHED PLANNER
DIVISION OF FORESTRY AND WILDLIFE

FROM: GLENN M. OKIMOTO, PH.D.
DIRECTOR OF TRANSPORTATION

SUBJECT: PRE-CONSULTATION ON ENVIRONMENT ASSESSMENT - WAIAKEA TIMBER MANAGEMENT AREA (WTMA), COMMERCIAL HARVESTING OF FOREST PRODUCTS AND REFORESTATION, ISLAND OF HAWAII

Thank you for requesting the State Department of Transportation's (DOT) review of the subject project. DOT understands the Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) is proposing to harvest non-native timber and non-timber forest products from the WTMA, and to reforest the harvested areas.

While the magnitude and timing of the project is not known at this time, given the location and nature of the project, State harbors and highways facitilities will be affected:

1. The need to transport products through our harbor facilities will require DOFAW to coordinate with our Harbors Division for any special requirements.
2. The need to transport oversized and/or overweight materials and equipment on State highway facilities will require DOFAW to obtain a permit from DOT Highways Division, Hawaii District Office.

DOT appreciates the opportunity to provide comments. If there are any questions, including the need to meet with DOT Highways or Harbors Division staffs, please contact Mr. Garrett Smith of the Statewide Transportation Planning Office at 831-7976.

William P. Kenoi
Mayor

BJ Leithead Todd
Director

Margaret K. Masunaga
Deputy

West Hawai'i Office
74-5044 Ane Keohokalole Hwy
Kailua-Kona, Hawai'i 96740
Phone (808) 323-4770
Fax (808) 327-3563

County of Hawai'i
PLANNING DEPARTMENT

East Hawai'i Office
101 Pauahi Street, Suite 3
Hilo, Hawai'i 96720
Phone (808) 961-8288
Fax (808) 961-8742

April 17, 2012

Ms. Jan Pali
DLNR, Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu HI 96813

Dear Ms. Pali:

SUBJECT: Pre-Consultation on Environmental Assessment
Applicant: DLNR, Division of Forestry and Wildlife
Land Owner: State of Hawai'i
Project: Commercial Harvesting of Forest Products and Reforestation of Waiākea Timber Management Area
TMK: 1-8-12:Portions of 1 and 3, 'Ōla'a Forest Reserve, Puna, Hawai'i
TMK: 2-4-8:Portions of 1, 6, 10, 19 and 22, Waiākea Forest Reserve, Hilo, Hawai'i

This is in response to your March 12, 2012 letter regarding the Division of Forestry and Wildlife's proposal for the commercial harvesting of forest products and reforestation of Waiākea Timber Management Area (WTMA) on the island of Hawai'i.

The WTMA was established to create a resource base for a forest products industry. Non-native timber and non-timber forest products would be harvested. Subsequently, the harvested area would be reforested with commercial valuable tree species.

We have the following to offer for each parcel:

TMK	Acreage	State Land Use	Zoning	General Plan
1-8-12:Por. of 1	5,292.76	Conservation	None	Conservation
1-8-12:Por. of 3	6,871	Conservation	None	Conservation
2-4-8:Por. of 1	62,855.855	Conservation	None	Conservation
2-4-8:Por. of 6	150	Conservation	None	Conservation
2-4-8:Por. of 10	259.679	Conservation	Por. Agricultural	Extensive Agriculture & Important. Agricultural

			(A-3a)/None	Land
2-4-8:Por. of 19	1,652	Conservation	None	Conservation
2-4-8:Por. of 22	1,159.881	Conservation	None	Conservation

1. Although Forestry is permitted within the A-3a (Agricultural – 3 acres) zoned area, within the State Land Use Conservation district, there is no County zoning per se. The Department of Land and Natural Resources has jurisdiction over the Conservation area.
2. The General Plan designation is primarily Conservation with only TMK: 2-4-8:10 designated Extensive Agriculture and Important Agricultural Land.
3. The parcels are not located within the County's Special Management Area.

In addition, we have the following comments on the proposed project:

1. A definition as to what constitutes "non-timber forest products" should be provided.
2. Impacts of the previous plantings and the impact of additional non-native tree species through reforestation on the native species should be discussed.
3. Clarify whether the logging operations will include clear-cutting of areas that include significant, albeit less than 50%, of native forest cover.
5. The Puna Community Development Plan stresses the importance of maintaining a continuous native forest canopy between Volcano National Park and the nearby State Forest Reserves and natural area reserves in order to maintain critical native habitats. Therefore, the Puna Community Development Plan Action Committee may have similar concerns regarding this project and should be consulted. They can be contacted, care of our Planning Department.

Please send us a copy of the draft EA when completed.

Should you have questions, please feel contact Esther Imamura of our office at 961-8139.

Sincerely,

BJ LEITHEAD TODD
Planning Director

ETI:mad
P:\Wpwin60\ETI\Eadraftpre-Consul\Pali DLNR Forestry & Wildlife 81-8-12 & 2-4-8.Rtf

xc: Mr. Larry Brown, Puna CDP Project Manager

William P. Kenoi
Mayor

Randall M. Kurohara
Director

Laverne R. Omori
Deputy Director

County of Hawaii

DEPARTMENT OF RESEARCH AND DEVELOPMENT

25 Aupuni Street, Room 1301 • Hilo, Hawaii 96720-4252
(808) 961-8366 • Fax (808) 935-1205
E-mail: chresdev@co.hawaii.hi.us

10 April 2012

Division of Forestry and Wildlife
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, HI 96813
ATTN: Jan Pali

RE: Pre-Consultation on EA for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawai`i

Dear Ms. Pali:

Thank you for sharing the information about the proposed project. We strongly suggest that you also address the impact of transporting the timber on the existing traffic, the capacity of the existing road to withstand the planned frequency of heavy loads, the disposition of materials that cannot be commercially utilized and access to the timber for our local wood workers.

We would greatly appreciate receiving a copy of the draft EA when completed.

Sincerely,

RANDALL M. KUROHARA
Director

xc: Margarita Hopkins, Agriculture Specialist, County of Hawai`i

William P. Kenoi
Mayor

Darren J. Rosario
Fire Chief

Renwick J. Victorino
Deputy Fire Chief

County of Hawai'i
HAWAI'I FIRE DEPARTMENT
25 Aupuni Street • Room 2501 • Hilo, Hawai'i 96720
(808) 932-2900 • Fax (808) 932-2928

March 27, 2012

Ms. Jan Pali
State of Hawai'i
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, Hawai'i 96813

Dear Ms. Pali,

RE: Pre-Consultation of Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawai'i

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The Hawai'i Fire Department does not have any comments to offer at this time regarding the above-referenced early consultation on Environmental Assessment.

Thank you for the opportunity to comment. A copy of the draft Environmental Assessment is not needed when completed.

Sincerely,

DARREN J. ROSARIO
Fire Chief

RP:lc

Mauna Kea
Recreational Users Group
Public Land for Public Use
447 Kalanianaole Avenue, Hilo, Hawaii 96720
contact@maunakearug.com

April 13, 2012

Jan Pali
Forestry Watershed Planner
Division of Forestry and Wildlife
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, HI 96813

Re: Pre-Consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawai'i.

Dear Jan,

Thank you for the opportunity to comment on proposed harvesting at Waiakea Timber Management Area. The Mauna Kea Recreational Users Group (MKRUG) maintains cooperation and communication with people of the various recreational users of this area. We are very interested in the State's management of the Waiakea Timber Management Area.

We asked our committee chairs of our user groups to solicit comments from users relating to their use of the area. We received comments back from the hunters, bicyclists and off-highway vehicle users. A copy of written comments from the bicycle and OHV groups are attached for your information.

There seems to be consensus on the following:

- Users support the State's need to harvest the tree plantation to derive economic benefit to the department to support future management efforts, and to the local community to enjoy the benefits of a local sustainable resource.
- Users support the replanting and wish to see the area continue to operate as a timber management area and as an important recreational resource.
- The existing grid road alignments should be restored after harvesting.
- Believe that public access should be maintained and roads remain open thru the harvesting and re-planting process. Closures for safety reasons during active operations is understandable. All areas should be open on weekends while there are no active operations.
- A system of advance notice to potential users of active operations and necessary

closures should be instituted.
- Since its creation the WTMA has been very important recreational resource with ongoing usage by many people with many different interests.

While the whole area is used by hunters, OHV and gatherers, mountain biking and horseback riding also occur there. Mountain biking occurs primarily in the area below Quarry road in the former sugar plantation lands. Equestrian use is common along the Puna boundary of the forest reserve. The Upper Waiakea ATV Dirt Bike Park managed by Na Ala Hele is located in WTMA between Flume and Tree Planting roads. A similar mountain bike park is in planning stages for the Quarry road area.

It should be noted that the annual Mauna Kea 200 motorcycle event held almost every year since 1976 relies heavily on the area for course mileage. The event is held on Memorial Day weekend near the end of May. The course grooming work by the volunteers is most intensive in the six months prior to the event date. The Rock Island Riders, the group implementing the MK200, have been helpful to the State and other users of the area in keeping much of the grid roads relatively open and identifiable when most would otherwise be lost to the wild overgrowth.

We have noticed several very invasive species of plants in the WTMA. A large miconia tree is located in one of the grids below Quarry road. A few sighting of Australian Tree fern have been noticed. Tibouchina is common in the lower elevations. Particularly disturbing to the users is the Himalayan blackberry which is getting established in areas above and below Flume road. While tibouchina may not be able to be controlled perhaps a plan to control or eliminate some other species may be possible.

Sincerely,

Wayne Blyth
Chair
Mauna Kea Recreational Users Group
447 Kalanianaole Avenue
Hilo, Hawaii 96720
wayne@maunakearug.com
808-936-7521

Big Island Mountain Bike Association
318 East Kawili Street Hilo Hawai'i 96720
808-961-4452

April 5, 2012

To: Jan Pali
Division of Forestry and Wildlife
1151 Punchbowl Street Room 325
Honolulu Hawai'i, 96813

Re:Timber Management Plan for Waiākea Forest Reserve, Hilo Hawai'i

Aloha,

As the representative for the Big Island Mountain Bike Association (BIMBA), I would like to thank you for the pre-consultation on environmental assessment for commercial harvesting within the Waiākea Timber Management Area (WTMA). The bicycling club known as BIMBA has been using parts of the WTMA since 1987. Our club has sponsored, promoted and managed off-road bicycling events in this forest area for over 25 years.

As weekly users of this forest, our group has seen the growth of these replanted timber areas as well as a growth in user-ship. At this time, within TMK (3) 2-4-008: portion 022, there are presently 11 miles of single-track trail and over 15 miles of double-track roads. This area is ideal for off-road bicycle use much more than any area within 20 miles of Hilo town, due to its gentle slope and widely spaced eucalyptus trees. Furthermore, because it was once part of the Puna Sugar Corp, the ground has been graded which happens to be the appropriate grade allowing for proper drainage and discouraging mud production, which is a detriment to off-road bicycling.

We, BIMBA, would like to request that when harvesting commences, that the harvesters selectively harvest when possible rather than clear-cut the area. By clearing at spaced-out increments, the off-road bicycling community could assist with replanting efforts and also help prevent the displacement of this recreational group.

As users of the WTMA, it is and has been understood that this area will eventually be harvested for commercial use. Due to its close proximity to Hilo, area TMK (8) 2-4-008: portion 022, creates an ideal recreational area used by responsible residents. I can personally say that our club, BIMBA, has been fostering this area and would like to continue this for many years to come. Please include us in your future plans to prevent to the greatest extent possible any negative impact to historical, cultural and recreational resources in this area.

Me ka mahalo nui loa,
Chris Seymour

Dennis C. Vierra
MKRUG OHV Chairperson
212 Alaloa Road
Hilo, Hawaii 96720
Ph.: 990-9322

April 7, 2012

Ms. Jan Pali
Forestry Watershed Planner
Division of Forestry and Wildlife
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, Hawaii 96813

Re: Pre-Consultation on Environmental Assessment for Commercial Harvesting of Forest Products and Reforestation of Waiakea Timber Management Area on the Island of Hawaii

Dear Ms. Pali

Thank you for allowing us this opportunity to comment on the proposed harvesting plan for the Waiakea Timber Management Area.

This area has been a vital recreational resource for the OHV (Off-Highway Vehicles) as well as many other activities such as hunting, bicycling, hiking, gathering, etc. In fact it is possibly the last of a few remaining areas where our activity is allowed by the Department of Forestry and Wildlife. The annual Mauna Kea 200 a two-day motorcycle enduro is conducted primarily in this area every year over the past 30 years. We would like to see this area used by **all recreationalist** for many years too come.

At the present time, a large portion of the Upper Waiakea Forest Reserve is designated as a Motorcycle and ATV Park and currently managed by the State Wide Na Ala Hele Program. I am currently working with DLNR to set aside a portion of the Lower Waiakea Forest Reserve for a Bicycle Park.

We support the harvesting of The Timber Management Area as stated in your letter of March 12, 2012, providing our access to un-harvested portions of the present Timber Management Areas are not denied. We also support replanting of timber in the harvested areas.

We would like to receive a copy of the draft EA when completed.

Sincerely,

Dennis C. Vierra
MKRUG OHV Chairperson

cc: Mr. Roger Imoto

Re: Timber Management Plan for Waiākea Forest Reserve , Hilo Hawai'i TMK (3)2-4-008:portion 022

Chris Seymour to: Jan.N.Pali 04/20/2012 11:05 AM

Aloha, Thank you for replying to our comments pertaining to the future harvesting of WTMA area close to Hilo. Please send us a copy of the Draft EA when it has been completed.
Mahalo nui loa,
Chris Seymour
Big Island Mountain Bike Association
808-961-4452
318 East Kawili Street
Hilo Hi. 96720

On Wed, Apr 18, 2012 at 4:22 PM, <Jan.N.Pali@hawaii.gov> wrote:

Dear Mr. Seymour and the Big Island Mountain Bike Association,

Thank you for taking the time to provide comments for the Division of Forestry and Wildlife's pre-consultation for the proposed timber harvesting and reforestation of the Waiakea Timber Management Area (WTMA). We appreciate the information that you have provided characterizing the off-road bicycling recreation that occurs in the WTMA. There are a variety of outdoor recreational activities that public enjoys in the WTMA in addition to off-road bicycling such as hunting, hiking, gathering of materials for personal, cultural and traditional uses and sightseeing. These recreational activities will continue, but the proposed action will result in restricted public access in areas where harvesting and reforestation activities are being conducted. These restrictions will be temporary and will only include areas where safety and efficiency of the forestry operations are an issue.

The Division is aware of the presence of Threatened and Endangered (T&E) species within the WTMA and it will be addressed in the Environmental Assessment (EA). Mitigation measures will be put in place to ensure that the proposed activity will not significantly impact any T&E species or any other aspect of the environment. We appreciate the input provided by your organization and will include a copy of you letter in the Draft EA for the project. Thank you again for your interest in this project and please let me know if you would like a copy of the Draft EA once it is complete.

Jan Pali
Forestry Watershed Planner
Division of Forestry and Wildlife, DLNR
1151 Punchbowl St., Rm. 325
Honolulu, HI 96813
Ph (808) 587-4166 Fx (808) 587-0160

-----Chris Seymour <hilobikehub@gmail.com> wrote: -----
To: Jan.N.Pali@hawaii.gov
From: Chris Seymour <hilobikehub@gmail.com>
Date: 04/10/2012 02:16PM
Subject: Re:Timber Management Plan for Waiākea Forest Reserve, Hilo Hawai‘i TMK (3)2-4-008:portion 022

Big Island Mountain Bike Association

318 East Kawili Street Hilo Hawai‘i 96720

808-961-4452

To: Jan Pali

Division of Forestry and Wildlife

1151 Punchbowl Street Room 325

Honolulu Hawai‘i, 96813

Re:Timber Management Plan for Waiākea Forest Reserve, Hilo Hawai‘i TMK (3)2-4-008:portion 022

April 10, 2012

Aloha,

As the representative for the Big Island Mountain Bike Association (BIMBA), I would like to thank you for the pre-consultation on environmental assessment for commercial harvesting within the Waiākea Timber Management Area (WTMA). The bicycling club known as BIMBA has been using parts of the WTMA since 1987. Our

club has sponsored, promoted and managed off-road bicycling events in this forest area for over 25 years.

As weekly users of this forest, our group has seen the growth of these replanted timber areas as well as a growth in user-ship. At this time, within TMK (3) 2-4-008: portion 022, there are presently 11 miles of single-track trail and over 15 miles of double-track roads. This area is ideal for off-road bicycle use much more than any area within 20 miles of Hilo town, due to its gentle slope and widely spaced eucalyptus trees. Furthermore, because it was once part of the Puna Sugar Corp, the ground has been graded which happens to be the appropriate grade allowing for proper drainage and discouraging mud production, which is a detriment to off-road bicycling.

In the last 10 or so years, we have been fortunate to observe a group of five ʻōpeʻapeʻa, otherwise known as Hawaiian hoary bats, living in the forest at TMK (3) 2-4-008: portion 022. Not only is the endangered bat an endemic species to Hawaiʻi as its only native land mammal, but ʻōpeʻapeʻa holds special value to Hawaiians as an ʻaumakua, or spirit.

We, BIMBA, would like to request that when harvesting commences, that the harvesters selectively cut when possible rather than clear-cut the area. Selective cutting may safeguard against the loss of natural, cultural and recreational resources by maintaining forest structure for wildlife habitat. By clearing at spaced-out increments, the off-road bicycling community could assist with replanting efforts and also help prevent the displacement of this recreational group.

As users of the WTMA, it is and has been understood that this area will eventually be harvested for commercial use. Due to its close proximity to Hilo, area TMK (8) 2-4-008: portion 022, creates an ideal recreational area used by responsible residents. I can personally say that our club, BIMBA, has been fostering this area and would like to continue this for many years to come. Please include us in your future plans to prevent to the greatest extent possible to any negative impact to natural, historical, cultural and recreational resources in this area.

Me ka mahalo nui loa,

Chris Seymour

{In Archive} Re: Waiakea Timber Management Area (WTMA)

Jan N Pali to: ikaika ikaika 04/10/2012 08:08 AM

Bcc: Sheri S Mann, Melissa I Sprecher

Archive: This message is being viewed in an archive.

Mr. John Ikaika Crabbe,

Thank you for your interest regarding the Waiakea Timber Management Area. The Division of Forestry and Wildlife is just beginning the planning process for this project and is engaging neighboring landowners and interest groups to collect more information on the area. The environmental assessment (EA) is still being drafted, but when finished we will be publishing the EA in Office of Environmental Quality Control's Environmental Notice, as is required by law. The Division is willing to provide a digital or hardcopy of the EA to those individuals that request one and will have a copy of the document posted on our website as well. Once the EA is published in the Environmental Notice, the formal comment period will begin and last for 30 days. As background, an environmental assessment for this area and project was completed in 1999. We would like to make sure that we have updated information to account for any changes to the environmental conditions in the project area over the past 13 years.

The letter that you receive is a pre-consultation letter aimed at collecting information to be included in the EA. I have attached a digital copy of the WTMA map in color; it would be helpful for us to know what additional information you would like to see included in the map and legend. Additionally, if you have information regarding WTMA that would be helpful in the planning process for this area we would be grateful to have it. Thank you again for your interest in this project. Also, are you interested in receiving a digital or hardcopy of the draft EA once it is complete?

Sincerely,

Jan Pali
Forestry Watershed Planner
Division of Forestry and Wildlife, DLNR
1151 Punchbowl St., Rm. 325
Honolulu, HI 96813
Ph (808) 587-4166 Fx (808) 587-0160

WTMA_map.pdf

ikaika ikaika Aloha Jan, I am a resident of 764 Kulaloa Road i... 04/04/2012 08:27:01 PM

From: ikaika ikaika <braddahcrab@gmail.com>
To: jan.n.pali@hawaii.gov
Cc: asugata@daylum.com
Date: 04/04/2012 08:27 PM
Subject: Waiakea Timber Management Area (WTMA)

Aloha Jan,

I am a resident of 764 Kulaloa Road in Hilo, Hawaii. I have received your letter regarding the Environmental Assessment (EA) for the Waiakea Timber Management Area. The map that was enclosed with the letter is completely unacceptable. The black and white copy displays different shades that cannot be deciphered. A more detailed legend should be provided where all particulars of the map appear. This letter must be resent to all residents with a COLOR MAP and detailed legend. In addition, what are the plans for informing the general

public via public notice for the EA? I have not seen any notice in any of the local newspapers or media. The clock for the EA must be reset until all residents and the community receive adequate maps and notification to understand the significance of the project and provide feedback.

Sincerely,

John Ikaika Crabbe