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LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

July 27, 2011

TO: Gary Hooser, Director
Office of Environmental Quality Control

FROM: RWK William Aila, Chairperson
Department of Land and Natural Resources

SUBJECT: Request for publication of "Kawailoa Wind Power Draft Habitat Conservation Plan" in the August 8, 2011 Environmental Notice

We respectfully request publication of the "Kawailoa Wind Power Draft Habitat Conservation Plan", as well as the associated draft Environmental Assessment in the August 8, 2011 Environmental Notice.

Please find enclosed a complete OEQC publication form, one hard copy of each document and one electronic copy the document in PDF form on CD.

Please contact Division of Forestry and Wildlife Program Manager Dr. Scott Fretz at Scott.Fretz@hawaii.gov or 808 227 3403 with any questions.

Tuiolosega, Herman

From: Paul.J.Conry@hawaii.gov
Sent: Friday, August 05, 2011 4:58 PM
To: Tuiolosega, Herman
Cc: Scott.Fretz@hawaii.gov; Lauren.E.Goodmiller@hawaii.gov
Subject: RE: Draft EA for the Kawailoa Wind Power project - DLNR anticipates a FONSI for the project

Aloha Herman, this email is to clarify/confirm that the Department/Division anticipates a FONSI for the Draft EA for the Kawailoa Wind Power project. Thank you for your assistance in publishing it in the next OEQC bulletin.

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Paul J. Conry, Administrator
Division of Forestry and Wildlife
Department of Land and Natural Resources
1151 Punchbowl Street, Room 325
Honolulu, Hawaii 96813
Phone: (808) 587-0166
Fax: (808) 587-0160
E Mail: Paul.J.Conry@hawaii.gov
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Publication Form
The Environmental Notice
Office of Environmental Quality Control

Instructions: Please submit one hardcopy of the document along a with determination letter from the agency. On a compact disk, put an electronic copy of this publication form and a PDF of the EA or EIS. Mahalo.

Name of Project: Kawailoa Wind Power
Applicable Law: HRS Chapter 195D and HRS Chapter 343
Type of Document: Habitat Conservation Plan and Environmental Assessment
Island: Oahu
District: Waialua District
TMK: TMKs 6-1-005:001, 6-1-006:001, 6-1-007:001, 6-2-009:001, 6-2-011:001
Permits Required: Incidental Take License
Name of Applicant or Proposing Agency:
First Wind; Kawailoa Wind Power LLC
810 Richards St # 650
Honolulu, HI 96813-4714
808 695-3300
Approving Agency or Accepting Authority:
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street Room 325
Honolulu, Hawaii, 96815
808 587 0166
Consultant
SWCA Environmental Consultants
201 Merchant Street, Suite 2310
Honolulu, HI
808 548-7922

Project Summary: Summary of the direct, indirect, secondary, and cumulative impacts of the proposed action (less than 200 words).

Kawailoa Wind Power LLC (or the "Applicant") proposes to construct and operate a new 70-megawatt (MW), 30-turbine commercial wind energy generation facility at Kawailoa in the northern portion of the Island of Oahu, Hawaii.

Construction and operation of the wind farm has the potential to result in the incidental take of six threatened or endangered species: the Hawaiian stilt or ae'o (*Himantopus mexicanus knudseni*), Hawaiian coot or 'alae ke'oke'o (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or 'alae 'ula (*Gallinula chloropus sandvicensis*), Newell's shearwater or 'a'o (*Puffinus auricularis newelli*), and Hawaiian hoary bat or 'ope'ape'a (*Lasiurus cinereus semotus*). One State listed endangered species, the Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), is also believed to have potential take. The endangered mollusc species (*Achatinella mustelina*) was historically found adjacent to the proposed site for off-site communications, and a population is present approximately 50 meters away.

To address potential take and to comply with Hawaii endangered species law, Hawaii Revised Statutes Chapter 195D, the Applicant has developed a draft Habitat Conservation Plan that outlines measures to avoid, minimize, mitigate, and monitor take of the aforementioned covered threatened and endangered species. In addition, the draft Habitat Conservation Plan outlines measures to ensure a net recovery benefit to the species that are the focus of the plan. Pursuant to Hawaii Revised Statutes Chapter 343 an Environmental Assessment has also been prepared which includes the Habitat Conservation Plan actions.

The public is encouraged to comment on the draft Habitat Conservation Plan. Please send comments to:

Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street Room 325
Honolulu, HI, 96813
Attention: HCP Coordinator Sandee Hufana

Or email comments to: Sandee.K.Hufana@hawaii.gov

Public comments should be received by October 8, 2011.

The Division of Forestry and Wildlife will also hold a public hearing on Oahu to receive public comments on the draft Habitat Conservation Plan. The date and location of the public hearing will be made available to the public via legal notice in the Honolulu Star Advertiser.

ENVIRONMENTAL ASSESSMENT

KAWAILOA WIND POWER FACILITY HABITAT CONSERVATION PLAN

PREPARED FOR

State of Hawai‘i
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813

PREPARED BY

SWCA Environmental Consultants
201 Merchant Street Suite 2310
Honolulu, HI 96813

July 2011

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COVER SHEET

Title for Proposed Action: Issuance of an Incidental Take License for the incidental take of six federally listed threatened and endangered species and one state-listed endangered species during construction and operation of Kawailoa Wind facility, Island of Oʻahu, Hawaiʻi in association with an Endangered Species Act Section 10(a)(1)(B) Incidental Take Permit.

Unit of the U.S. Fish and Wildlife Service Proposing the Action: Regional Director, Region 1, Fish and Wildlife Service, Portland, Oregon.

Legal Mandate for Proposed Action: Hawaii Endangered Species law, Hawaii Revised Statutes Chapter 195-D, and Endangered Species Act of 1973, as amended, Section 10(a)(1)(B), as implemented by 50 CFR 17.22.

Applicant: Kawailoa Wind Power LLC

Permit Number: N/A

Funding Plan: Proposed monitoring and mitigation measures would be provided by Kawailoa Wind in the form of a bond, letter of credit, or similar instrument naming U.S. Fish and Wildlife Service (USFWS) and/or State Department of Land and Natural Resources (DLNR) as beneficiaries.

Duration: 20 years

Document prepared by: SWCA Environmental Consultants, 201 Merchant Street, Suite 2310, Honolulu, HI.

Division of Forestry and Wildlife Contact: Sandee Hufana, 1151 Punchbowl Street, Room 325, Honolulu, HI

SUMMARY

Kawailoa Wind Power LLC (Kawailoa Wind Power or the "Applicant"), a fully owned subsidiary of First Wind, proposes to construct and operate a new 70-megawatt (MW), 30-turbine wind energy generation facility (or wind farm) on Kamehameha Schools' Kawailoa Plantation lands, approximately four miles northeast of Haleʻiwa town on the north shore of the Island of Oʻahu, Hawaiʻi. Like the Kahuku Wind Power facility located to the east, Kawailoa Wind Power would supply wind-generated electricity to the Hawaiian Electric Company, Inc. (HECO).

Construction and operation of the Kawailoa Wind Power project has the potential to result in the incidental take of six federally listed threatened and endangered species: the Hawaiian stilt or āeʻo (*Himantopus mexicanus knudseni*), Hawaiian coot or ʻalae keʻokeʻo (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or ʻalae ʻula (*Gallinula chloropus sandvicensis*), Newell's shearwater or ʻaʻo (*Puffinus auricularis newelli*), and Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*). One state-listed endangered species, the Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), is also believed to have potential to collide with the proposed wind turbine generators (WTGs) or other project infrastructure. These seven Covered Species are known to fly in the vicinity of the project area and could be injured or killed if they collide with WTGs, permanent meteorological (met) towers, overhead lines, and other project components. The listed species could also be struck by vehicles and construction equipment during construction and operation. In accordance with Section 10(a)(1)(B) of the Endangered Species Act (ESA) of 1973, as amended, Kawailoa Wind Power has prepared a Habitat Conservation Plan (HCP) to comply with Incidental Take Permit (ITP) requirements of the U.S. Fish and Wildlife Service (USFWS). Additionally, a state incidental take license (ITL) must also be obtained from the State Department of Land and Natural Resources (DLNR) in accordance with Chapter 195-D of the Hawaii Revised Statutes. Upon issuance of the ITP and ITL, Kawailoa Wind Power would be authorized for the incidental take of the six federally listed threatened and endangered species in connection with the construction and operation of the proposed wind energy generation facility.

Because the decision to issue an ITL is a state action, it is subject to compliance with the State of Hawaiʻi Environmental Impact Statement law, Chapter 343, Hawaii Revised Statutes. As part of the Chapter 343 process, an Environmental Assessment (EA) is required to evaluate the potential environmental and socioeconomic impacts of, and potential alternatives to, issuing an ITL and approving the implementation of the proposed HCP. This Draft EA describes the existing environment in the Kawailoa Wind Power project area; discusses alternatives to the Proposed Action; and evaluates the potential impacts of the alternatives. If no significant impacts are identified during preparation of this EA, USFWS would issue a Finding of No Significant Impact (FONSI). If potentially significant impacts are identified, an Environmental Impact Statement (EIS) would be prepared.

The Proposed Action (Alternative 1) is the issuance of an ITL and approval of an HCP to authorize the potential incidental take of six federally listed threatened and endangered species during the construction and operation of the Kawailoa facility, and to adequately avoid, minimize, and mitigate the anticipated incidental take. Construction of the proposed project would disturb approximately 335.1 acres of the approximately 4,200 acre leased project area. The permanent project footprint would be 21.7 acres. In addition to the wind turbine generators and appurtenant facilities at the proposed wind farm on Kawailoa Plantation lands, the project may also require installation of communications equipment at existing facilities on Mt. Kaʻala, roughly nine miles southwest of the proposed Kawailoa wind farm site. This communication equipment would provide a link between the wind farm and the existing Hawaiian Electric Company substations that would be receiving the power.

This EA also evaluates the potential impacts of issuing an ITL and approving an HCP for the Communications Site Layout (Alternative 2). This alternative requires attaching the proposed antennae to two new communication towers at the Mt. Kaʻala site instead of attaching them to existing towers at the same sites. The wind farm layout is otherwise identical under Alternative 2. Overall, disturbance is the same as Alternative 1 except for an additional 0.006-acre disturbance at the communication sites. In addition, a No Action Alternative (Alternative 3) is evaluated in the EA, which consists of non-issuance of an ITL and HCP by USFWS for Kawailoa Wind Power. This alternative represents a "no build scenario" because Kawailoa Wind Power would not construct the wind energy facility due to the risk of the facility causing unauthorized incidental take of listed species.

Table i. Summary of Comparison of No Action Alternative to Action Alternatives.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
Climate	<u>Construction:</u> Construction of the project would not affect local weather conditions, such as temperature, rainfall, and humidity. <u>Operation:</u> Operation of the project would not affect local weather conditions. Relative to global climate change, operation of the project would have a beneficial effect by providing renewable energy to be used in place of fossil fuel-generated energy, thereby reducing emissions of greenhouse gases. <u>HCP measures</u>: No impacts.	The construction and operation impacts of this alternative would be the same as those associated with the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to climate.
Air Quality	<u>Construction:</u> Construction of the project would generate fugitive dust from earthmoving activities, as well as exhaust emissions from construction equipment and vehicles travelling to and from the project site. To mitigate impacts such that there is not discharge of visible fugitive dust beyond the property lot line, standard best management practices (BMPs) would be implemented. Because emissions would be temporary, relatively small, and would be minimized through implementation of BMPs, impacts to air quality are expected to be minimal. <u>Operation:</u> Once operational, the proposed project would result in minor emissions of air pollutants due to employee vehicle use, periodic use of cranes, and operation of the electrical substation and possible Battery Energy Storage System (BESS). These emissions would be very low and would not result in adverse long-term impacts to air quality. On a broader scale, the project would provide a substantial net benefit by replacing energy generated by burning fossil fuels with renewable energy, thereby reducing emissions of greenhouse gases. <u>HCP measures</u>: Minor impacts from vehicle exhaust associated with seabird, waterbird, and bat mitigation.	Ground disturbance associated with the excavation of the tower footings at the Mt. Kaʻala communication sites would create fugitive dust but, in general, the construction and operation impacts of this alternative would be the same as the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to air quality, including long-term beneficial air quality impacts of fossil fuel alternatives.
Geology, Topography, and Soils	<u>Construction:</u> Construction of the project would result in ground disturbance, particularly as a result of grading for the turbine foundations and new access roads. A total of approximately 335.1 acres would be disturbed, of which approximately 21.7 acres would be within the permanent project footprint. Impacts to major topographic features (including the gullies and streams) would be avoided, and BMPs would be implemented to prevent and minimize erosion associated with ground disturbing activities. No ground disturbance would occur at the Mt. Kaʻala communication sites. <u>Operation:</u> Following construction, BMPs would be implemented to prevent	A very small amount of ground disturbance would occur for excavation of the tower footings at the Mt. Kaʻala communication sites; in general, the construction and operation impacts of this alternative would be the	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to geology, soils, or geologic hazards.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	and minimize erosion. In particular, all temporarily impacted areas would be revegetated to stabilize exposed soils. HCP measures: Minor impacts to topography and soil resources due to trampling during monitoring, removal of invasive vegetation, and fence construction. In the long-term, wetland/forest restoration and and ungulate control would benefit soils.	same as the Proposed Action.	
Hydrology and Water Resources	Construction: Construction of the project components would require minimal subsurface work, all of which would occur well above the water table; therefore, no direct interaction with groundwater is anticipated. Surface water features have been excluded from the project footprint to the greatest extent possible. The only surface water features within the footprint are waterways that intersect with the existing onsite roads; these are generally culverted under the roads and road improvements would be conducted to avoid impacts to these features. One unculverted crossing occurs within the project footprint at Laniākea Stream, where it washes over Cane Haul Road. Work that would be conducted in this area would be limited to repair and maintenance of the road surface; no work would be conducted outside the existing footprint of the road. Increased sediment and other pollutants in stormwater runoff could affect water quality in receiving waters. BMPs would be implemented to prevent and minimize water quality potential impacts. No surface water features are present within the Mt. Kaʻala communication sites. Operation: Following construction, BMPs would be implemented as needed to prevent and minimize erosion that could affect receiving waters. In particular, all temporarily disturbed areas would be revegetated to stabilize exposed soils, and the onsite roadways would be maintained with gravel surfaces and rock-lined swales. HCP measures: Monitoring, fencing, ungulate control, predator control and weed control may affect hydrology and water resources but no significant impacts are expected.	The construction and operation impacts of this alternative would be the same as those associated with the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to water resources.
Biological Resources (Flora)	Construction: No state or federally listed threatened, endangered, or candidate plant species occur within the wind farm site, and no areas have been designated as critical habitat for any listed species. Vegetation in areas that would be disturbed consists of predominantly non-native species that are common throughout Oʻahu and the main Hawaiian Islands. Where native trees do occur, they would be avoided to the extent possible; if native trees are removed; at least an equal number of native trees (of the same species)	A very small amount of ground disturbance would occur for excavation of the tower footings at the Mt. Kaʻala communication sites. Nine plant species	There would be no change in existing conditions and no impacts to botanical resources.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	would be replanted in surrounding areas of the property. Nine plant species have critical habitat designations that encompass the tower sites. The plant species are *Alsinidendron trinerve, Cyanea acuminate, Cyanea longiflora, Diplazium molokaiense, Hedyotis parvula, Labordia cyrtandrae, Phyllostegia hirsute, Tetramolopium lepidotum* ssp. *lepidotum, Viola chamissoniana* ssp. *chamissoniana.* None of the plant species with designated critical habitat that encompass the tower sites are present on-site at the two tower locations. No ground disturbance would occur, but a limited amount of vegetation trimming may be required to provide adequate line-of-sight between the antennae. All vegetation trimming activities would be directly coordinated with State of Hawaiʻi Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) staff to minimize the potential for impacts to native species. In addition, control measures would be implemented to minimize the potential for introduction of invasive species. <u>Operation</u>: Mechanical methods would be used to clear vegetation in designated areas within the wind farm site during operation. Non-native species are expected to establish in these areas; therefore, no significant adverse impacts to botanical resources would be expected. <u>HCP measures</u>: Trampling during monitoring and fencing construction would create minor short-term impacts but in the long-term provide beneficial impacts to native vegetation through invasive species management, wetland/forest restoration, and ungulate control.	have critical habitat designations that encompass the tower sites. None of the plant species with designated critical habitat that encompass the tower sites are present on-site at the two tower locations. Construction and operation impacts of this alternative would be commensurate with those associated with the Proposed Action.	
Biological Resources (Fauna)	<u>Construction</u>: The impact of the proposed wind farm on non-listed wildlife species would be minor. Incidental takes of federally and/or state-listed species could occur as a result of collision with the turbines, equipment, vehicles, and other project components. Seven listed species could be impacted; these include: Newell's shearwater, Hawaiian duck, Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, Hawaiian short-eared owl, and Hawaiian hoary bat. The proposed project includes measures to avoid, minimize, and mitigate take of these species as outlined in Section 3.5.4. The mitigation measures were developed in collaboration with biologists from the U.S. Fish and Wildlife Service (USFWS), DOFAW, and members of the Endangered Species Recovery Committee (ESRC); they are based on anticipated levels of incidental take as determined through on-site surveys, modeling, and the results of post-construction monitoring conducted at other wind projects in Hawaiʻi and elsewhere in the U.S. With implementation of these measures, the project would be expected to result in a net benefit to listed species. The proposed equipment to be installed at the Mt. Kaʻala communication sites	The height of the proposed towers at the communication sites would be no greater than that of the existing structures and, as such, would not be expected to create a significant collision hazard to any of the Covered Species if they should happen to transit these locations. Construction and operation impacts of this alternative would be commensurate with those associated with	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to wildlife.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	is similar in size and type to existing onsite equipment; therefore, it is not expected to create a significant collision hazard to any non-listed or listed avian species, should they happen to transit these locations. A limited amount of tree trimming may be required to provide adequate line-of-sight between the antennas. Because this vegetation could potentially support native mollusk species (including at least one listed species*, Achatinella mustelina*), surveys would be conducted prior to any vegetation trimming. All vegetation trimming activities will be directly coordinated with USFWS and DOFAW staff to minimize the potential for impacts to native vegetation. If the endangered *Achatinella* spp. is detected during the surveys, no vegetation will be trimmed. If no *Achatinella* is detected, then vegetation will be trimmed by hand. Baseline surveys of ant fauna would be conducted prior to and following installation of the antennae. In addition, all materials and vehicles would be inspected for the presence of ants, prior to transport to the site. One invertebrate species, the endangered Hawaiian picture-wing (pomace) fly, *Drosophila substenoptera*, has designated critical habitat that encompasses the off-site microwave tower facilities*.* The endangered O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*) also has critical habitat designated that encompasses the off-site microwave tower facilities. T <u>Operation</u>: Impacts during operation are similar to those described above, except that once operational, the turbines would have greater potential to affect listed species. The proposed project includes measures to avoid, minimize, and mitigate take of these species during operation, as discussed above. Potential impacts and associated mitigation measures for operation of the equipment at the Mt. Ka'ala communication sites are similar to those during construction, as described above. <u>HCP measures</u>: Non-listed species- Avoidance and minimization measures will reduce collision risk with project components for wildlife and avoid impacts to mollusks and new species of ants at the off-site antennae locations. Fencing, ungulate control, and predator control associated with seabird, waterbird, bats, and owl mitigation could adversely impact non-listed non-native fauna. Listed non-covered species- No impacts are expected to *Drosophila substenoptera* or O'ahu 'elepaio. Newell's Shearwater- Avoidance and minimization measures would minimize collision risk of seabirds. Mitigation at Tier 1 (self-resetting cat traps) is expected to yield improvements in protection, reproductive success and survival of the species. Mitigation at Tier 2 (translocation protocol and/or	the Proposed Action. If *Achatinella* species are detected at the location of the proposed towers, the towers will not be erected. One invertebrate species, the endangered Hawaiian picture-wing (pomace) fly, *Drosophila substenoptera*, has designated critical habitat that encompasses the off-site microwave tower facilities*.* The endangered O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*) also has critical habitat designated that encompasses the off-site microwave tower facilities. T	

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	restoration fund) is expected to increase the population and range of the species. Hawaiian Duck- Avoidance and minimization measures are likely to minimize collision risk of waterbirds. Removal of feral ducks, mallards, and Hawaiian duck hybrids at ʻUkoʻa Pond will prevent the continued dilution of the Hawaiian duck gene pool. Wetland restoration, fencing, and predator control at the pond is also expected to protect any pure Hawaiian ducks that may utilize the pond in the future. Hawaiian Stilt, Hawaiin Coot, and Hawaiian Moorhen- Avoidance and minimization measures are likely to minimize collision risk of waterbirds. Predator exclusion and eradication, weed control, and monitoring at ʻUkoʻa Pond are expected to increase species productivity. Predator trapping poses some risk of harassment to Hawaiian moorhens but overall increased productivity and beneficial effects. Hawaiian Hoary Bat- Low wind speed curtailment will be implemented at night as an avoidance and minimization measure benefitting bats. Tree clearing timing and a barbless wire fence design will also avoid and minimize impacts. Wetland or forest habitat restoration is expected to increase and improve bat foraging and roosting habitat which will lead to increased survival and productivity of the species.		
Historical, Archaeological, and Cultural Resources	<u>Construction</u>: A total of 17 archaeological sites were identified within the project footprint, all of which date from the historic period and were likely associated with either former military operations or former plantation activities; no pre-Contact sites were identified within the project footprint. Given the extent of previous disturbance within the wind farm site, it is likely that any earlier archaeological features have either been significantly impacted if not completely destroyed. To the extent possible, impacts would be avoided as part of construction of the project. However, in the event that impacts are unavoidable, it is expected that a reasonable and adequate amount of information has been collected to warrant a no further work requirement, and thus a no historic properties affected determination for these sites, subject to SHPD concurrence. No archaeological or historic resources are known to occur within either of the Mt. Kaʻala communication sites. A Cultural Impact Assessment was conducted to identify cultural practices and beliefs associated with the wind farm and Mt. Kaʻala communication sites. A total of nine interviews were conducted with *kamaʻāina* (Native-born) and *kūpuna* (elders). Many of the participants supported the proposed project;	In general, the construction and operation impacts of this alternative would be the same as the Proposed Action. A very small amount of ground disturbance would occur for excavation of the tower footings at the Mt. Kaʻala communication sites. However, no archaeological or historic resources are known to occur. The project would not preclude or limit access to the area by	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to historical, cultural, or archaeological resources.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	while others articulated concerns that the project may impact the area's *mo'olelo*, cultural sites, and beliefs and practices. Although the project cannot be implemented in a way that entirely avoids all potential cultural impacts, particularly those related to cultural beliefs, the goal is to develop and operate the project in a way that is respectful to Hawai'i's unique cultural and natural resources while also contributing to the local community where the project is located, so as to balance any perceived negative effects. The intent of these measures is to balance the beliefs and traditions of the past with the need for clean, renewable energy to sustain future generations. The project would not preclude or limit access to the area by cultural practitioners beyond the existing conditions. <u>Operation</u>: Same as above. <u>HCP measures</u>: Impacts will be avoided.	cultural practitioners beyond the existing conditions.	
Visual Resources	<u>Construction</u>: During construction, visible components of the project would include construction equipment, and transport and assembly of project components, including the turbines. In general, these activities would be minor and temporary in nature. <u>Operation</u>: Once operational, the most visible component of the project would be the turbines, as they are taller and bulkier than the other structures (e.g., electrical substation, BESS, overhead collector lines). Project planning and siting efforts that were conducted in a manner so as to best integrate the project components with the natural characteristics of the site and minimize visual impacts to the extent possible. The approach taken is consistent with design guidelines and best practices that have been developed and implemented for other wind development projects worldwide; it is also consistent with the guidelines set forth in the North Shore Sustainable Communities Plan (City and County of Honolulu 2011). Through these measures, the potential visual impacts of the proposed project would be partially avoided, minimized and/or mitigated. There are no additional measures that could reasonably be implemented to further reduce the potential visual impacts; given the large scale of wind turbines, a certain degree of impacts is unavoidable. In general, the greatest number of wind turbines would be potentially visible. In many cases, views of the wind turbines would be blocked by vegetation, existing structures, and topographical features. Installation of the equipment at the Mt. Ka'ala communication sites would not be readily visible from any public vantage points, given the distance of the site and the small size of the structures. They would be visible from the Mt.	In general, the construction and operation impacts of this alternative would be the same as the Proposed Action. Given the distance of the site and the small size of the equipment, the towers at the Mt. Ka'ala site would not be readily visible from any public vantage points. They would be visible from the Mt. Ka'ala summit access road and the nearby hiking trails; however, the equipment is visually consistent with the existing communication facilities.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to visual resources.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	Ka‘ala summit access road and the nearby hiking trails; however, the equipment is visually consistent with the existing communication facilities potentially visible from viewpoints located farther away from the wind farm site. For viewpoints located closer to the wind farm, the turbines would be more visually prominent, but a fewer number of turbines would be potentially visible. In many cases, views of the wind turbines would be blocked by vegetation, existing structures, and topographical features. Installation of the equipment at the Mt. Ka‘ala communication sites would not be readily visible from any public vantage points, given the distance of the site and the small size of the structures. They would be visible from the Mt. Ka‘ala summit access road and the nearby hiking trails; however, the equipment is visually consistent with the existing communication facilities. <u>HCP measures</u>: The marking of guy wires to reduce bird collisions may make these structures more visible, but these structures are not adjacent to populated areas and the visual impact of these structures is likely to be insignificant. Only the construction of fences and fence corridors for waterbird and possibly bat mitigation have the potential to have visual impacts. However, a portion of ‘Uko‘a Pond, the mitigation site for waterbirds and possibly bats, is along Kamehameha highway, and the fenceline could be visible from the highway. However, an existing fence is already present and the construction of the new fence (while removing the old one) will not add to the existing visual landscape.		
Noise	<u>Construction</u>: Construction of the proposed project would produce short-term noise within the project area as a result of the operation of graders, excavators, trucks, and other heavy equipment. A noise permit would be obtained from HDOH; this permit would restrict the time of day when construction activities may emit noise. Other BMPs (for example, use of noise barriers, mufflers on diesel and gasoline engines, and proper maintenance of machines) would be implemented to mitigate construction noise, as needed. The proposed communication equipment near Mt. Ka‘ala would be installed on existing Hawaiian Telcom structures; no excavation or ground disturbing activities would be required. Installation would involve trucks and a helicopter to transport the components and necessary tools to the site. Noise generated by these activities and would be intermittent and very short in duration. <u>Operations</u>: Following construction, the only project components expected to generate sound on a regular basis would be the wind turbines. Turbine noise would not be expected to exceed the HDOH maximum permissible noise limits in areas that are zoned for agriculture. Noise levels would likely exceed the limits where the project site borders preservation land, and may require a	Construction and operation impacts of this alternative would be the same as the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no noise impacts.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	variance. Turbine noise is expected to increase the ambient sound levels by less than 3 decibels (dB) at Waimea Valley, which is the nearest sensitive receptor. During daytime hours, modeling results indicate that turbine sounds would be completely masked by ambient noise sources; at night, turbine sounds are expected to be just barely perceptible at Waimea Valley. Noise from the wind turbines is expected to be less than the ambient levels measured in the communities surrounding the project site and would not likely be audible at these locations. Operation of the equipment at the Mt. Kaʻala communication sites would not be expected to generate any significant noise. HCP measures: Noise associated with monitoring and mitigation will be of short duration and low intensity and is not anticipated to significantly increase noise levels at the site. The transportation of antennae to the off-site microwave tower by helicopter will temporarily increase noise levels along the flight path. The flights will be few in number and will occur during normal work hours and is not expected to substantially change the sound levels in the affected areas.		
Land Use	Construction: The project has been sited to avoid areas that are currently in agricultural production and, as such, no impacts to current agricultural operations are anticipated. Approximately 21.7 acres are within the permanent project footprint, and would no longer be available for agricultural purposes; however, given the amount of land available for cultivation in this area, this is not expected to significantly affect future agricultural production. Implementation of the proposed project would allow Kamehameha Schools to maintain the existing agricultural uses of the Kawailoa property, consistent with their North Shore Master Plan and Strategic Agricultural Plan. Lease revenues generated by the project can be used by Kamehameha Schools to improve the irrigation system and other infrastructure that directly benefits local farmers on the *makai* sections of the property. The unused areas surrounding the wind farm components are currently being fenced for pasture by Kamehameha Schools, and will be actively grazed. As such, the proposed project is not expected to have more than a minimal adverse impact on agricultural production and, in fact, would allow for productive, sustainable use of the land. The current and anticipated future uses of the Mt. Kaʻala sites are for communication facilities and as such the proposed project would not have a land use impact. Operations: Same as above. HCP measures: For mitigation occurring at ʻUkoʻa Pond, former ranching that	Construction and operation impacts of this alternative would be the same as the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to land use.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	occurred in the area will no longer be allowed if restoration and fencing of the wetland occurs. Ranching will no longer be allowed at the entire 150 acres of wetland and possibly up to 80 acres of forest in the periphery of the pond may also be fenced off and restored.		
Transportation and Traffic	Construction: The major components of the wind farm, such as the blades, towers, and nacelles, would be transported by sea and offloaded at Kalaeloa Harbor. The equipment would be handled as general containerized cargo and is not expected to place an unusual demand on the harbor facilities. Delivery of the turbine components and other project equipment would require the use of existing state and county roadways by oversized vehicles. The proposed routes have been evaluated and the existing infrastructure is expected to be of sufficient capacity and dimension to accommodate the oversized loads. Potential impacts include traffic delays and delays in emergency services caused by periods where traffic flow must be stopped to allow oversized trailers to navigate turns. To mitigate these impacts, police escorts would be used and hours of transport would be restricted to those hours when traffic is typically light. Other project-related traffic would be associated with delivery of other project-related equipment and employee trips. These activities would increase traffic levels during project construction, but in general, the impacts would be short-term and localized in nature. Operations: Most of the vehicular traffic associated with operation of the proposed wind farm would be employees reporting to or leaving the facility and service trips by HECO maintenance personnel. The amount of vehicular traffic during operation would be minimal and the proposed project is not anticipated to noticeably increase traffic volumes on Kamehameha Highway or roadways in the area over the long-term. HCP measures: The vehicles and vehicular trips required for monitoring and implementation of mitigation measures will involve too few vehicle trips (weekly to monthly trips) to significantly affect transportation and traffic.	Construction and operation impacts of this alternative would be commensurate with those associated with the Proposed Action.	There would be no change in existing conditions and no impacts relative to transportation and traffic.
Military Operations	Construction: The eastern portion of the wind farm site overlaps with a Tactical Flight Training Area (TFTA), which is used for aviation and ground training by several services of the Department of Defense (DoD). To address concerns of the wind farm's impacts on military training, the DoD services formed a working group composed of the affected DoD services, First Wind, and the site's landowner, Kamehameha Schools, referred to as the Regional Mission Compatibility Review Team (RMCRT). Construction-related impacts to military operations and training identified by the RMCRT include a safety risk	Construction and operation impacts of this alternative would be the same as the Proposed Action. Construction and operation impacts of this alternative would be the same as the Proposed	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to military operations. If the proposed project were

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	from the construction crane to helicopters operating in the low-level training area. To mitigate for this potential impact, the affected DoD services would be notified of the anticipated plans for crane position and transit across the site. Operations: Potential impacts associated with operation of the project have been identified by the local RMCRT, and include those related to: (1) the alert area A-311, (2) night vision device (NVD) entry control point, (3) landing zones, (4) non-directional beacon (Copter NDB 152), (5) turbine markings, and (6) overhead electrical lines. As described in Section 3.11, mitigation for each of these potential impacts has been identified by the RMCRT, such that the impacts would be reduced to a less-than-significant level. The RMCRT will continue to serve as a communication mechanism between Kawailoa Wind Power and DoD stakeholders, and will be used to continue to develop mitigation measures for impacts, as needed. Access to, as well as radar and communications activities within the Mt. Kaʻala area are managed by the multi-agency Kaʻala Joint Use Coordination Committee (JUCC), which includes representatives from the U.S. Armed Services. Similar to that conducted for the Kahuku wind farm project for microwave equipment at the Hawaiian Telcom site, siting approval would be obtained from the Kaʻala JUCC for the microwave antennas for the Kawailoa Wind Power project. Construction and Operation: Ignition sources for accidental fires include errant sparks from a variety of vehicles, equipment and tools, and discarded matches and cigarette butts. These are of limited intensity, and under most conditions are unlikely to spark a grass or other fire. To address fire risk, the site would be supported by an external fire hydrant, supplied from two water tanks, and fire-fighting equipment would be maintained in work vehicles. No significant impacts are expected. The wind farm (including communication towers) is more than one mile from the nearest residence and is not publicly accessible. As such, the unlikely event of a tower collapse, blade throw, shadow flicker, stray voltage, or lightning impacting public safety is minimal. HCP measures: No impacts.	Action.	not constructed and operated, there would be no change in existing conditions and no impacts to public safety.
Hazardous Substances and Materials	Construction: No hazardous material or hazardous wastes are known to be present within the proposed wind farm project site. Construction would involve the use, transportation, or storage of small amounts of several hazardous materials that require special handling and storage. These would be identified, along with measures for containment and spill prevention, in a Spill Prevention, Countermeasure, and Control (SPCC) Plan. Potentially adverse impacts would be minimized by requiring the contractor to follow BMPs. An underground storage tank (UST) release was previously reported at the existing Hawaiian Telcom facility; however the new antennae would be	Construction and operation impacts of this alternative would be the same as the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts from hazardous substances and materials.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	mounted on existing structure, no ground disturbance would occur under the Proposed Action. Therefore, no hazardous materials that could be associated with the UST release are expected to be encountered during construction. Operations: Operation of the facility would require onsite use and storage of several materials that require special handling including common lubricants, petroleum products, or other chemical cleaning products. Implementation of the SPCC Plan, including BMPs, would minimize the risk of potential adverse impacts. HCP measures: Fuel will be used to operate vehicles to transport staff and equipment to the mitigation sites and fuel may be used to run equipment to carry out mitigation measures. Herbicides may be used as part of vegetation control. Proper precautions will be taken when driving and operating equipment and the herbicide will only be applied according the labeled instructions. Therefore, monitoring and implementation of mitigation measures will not result in any significant impacts due to hazardous materials.		
Socioeconomic Characteristics	Construction: Potentially beneficial effects of the proposed project include increased employment, business activity, and lease and tax revenue. During the construction phase, Kawailoa Wind Power may employ an average of 75 people per day, with an anticipated maximum level of 129 employees. No adverse impacts are anticipated. Operations: The project is not expected to result in new residents moving to the area due to increased energy availability and would therefore not be considered growth inducing. Operation would result in employing a regular staff of approximately eight people and generating ongoing expenditures for materials and outside services. No disproportionate adverse health or environmental impacts would occur to any low-income or minority population. HCP measures: The implementation of mitigation measures will likely result in the hiring of local contractors or subcontractors. These may be long-term or short-term employments. Overall, mitigation measures may have a small positive effect on the socioeconomics of O‘ahu. No effect (positive or negative) is expected for minorities or low-income persons.	Construction and operation impacts of this alternative would be the same as the Proposed Action.	If the proposed project were not constructed and operated, there would be no change in existing conditions and no impacts to socioeconomic conditions including beneficial impacts of employment.
Natural Hazards	Construction: Neither construction nor operation of the proposed project is expected to affect the incidence rate of a natural hazard, with the exception of an increased potential for wildfires associated with use of vehicles and electrical equipment in the project area. To address the risk of wildfire, the site would be supported by an external fire hydrant, supplied by onsite water tanks. Construction and operation of the project could be adversely affected	Construction and operation impacts of this alternative would be commensurate with those associated with the Proposed Action.	There would be no change in existing conditions and no impacts relative to natural hazards.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	by a natural hazard, such as a hurricane or earthquake, should one occur; however, the occurrence rate is expected to be very low. Operations: Same as above. HCP measures: No impact.		
Public Safety	Construction:During construction, ignition sources for accidental fires include errant sparks from a variety of vehicles, equipment and tools, and discarded matches and cigarette butts. These are of limited intensity, and under most conditions are unlikely to spark a grass or other fire. To address fire risk, the site would be supported by an external fire hydrant, supplied by onsite water tanks, and fire-fighting equipment would be maintained in work vehicles. Operations: The wind farm facilities are greater than one mile away from the nearest residence, and are not publicly accessible. As such, the unlikely event of a tower collapse, blade throw or stray voltage significantly impacting public safety is minimal. The results of a shadow flicker analysis for the project indicated that areas of potential shadow flicker effect extend 4,577 feet from each turbine. Because the project is located in an agricultural area, no residences are located within the areas within which detectable shadow flicker would be created. The Mt. Kaʻala communication sites are isolated from any populated areas, and would not be expected to present any risk to public safety. HCP measures: The implementation of mitigation measures will not have any negative effects on public safety in the area. In fact, mitigation measures such as fencing, eradication/control of ungulates and introduced mammals are likely to improve the safety of the mitigation site when accessed by people.	Construction and operation impacts of this alternative would be commensurate with those associated with the Proposed Action.	There would be no change in existing conditions and no impacts relative to public safety.
Public Infrastructure and Services	Construction: The project has little potential to adversely affect utilities and public services during construction. Operations: The proposed project would place no additional burden on public services. It would consume only small amounts of electrical power, while potentially generating 70 MW of power. All of the water needed for the facility would be obtained from onsite water tanks, and an onsite septic tank system would be constructed to handle wastewater. Given the low voltage (46 kV) and the elevation near sea level, the power lines for the proposed project are not expected to result in a significant amount of electromagnetic interference with telecommunication services.	Construction and operation impacts of this alternative would be commensurate with those associated with the Proposed Action.	There would be no change in existing conditions and no impacts relative to public infrastructure and services.

Resource	Proposed Action (Alternative 1)	Communications Site Layout (Alternative 2)	No Action (Alternative 3)
	HCP measures: No impact.		
Cumulative Impacts	Construction: The cumulative contribution of impacts of the Proposed Action varies from beneficial to adverse and negligible, depending on the resource. As discussed in Section 4.18.1, the Proposed Action would beneficially impact these resources: Climate, Socioeconomics, and Public Infrastructure and Services. Adverse or negligible impacts would occur to these resources: Air Quality, Geology, Topography, and Soils, Hydrology and Water Resources, Biological Resources, Historical, Archaeological, and Cultural Resources, Visual Resources, Noise, Land Use, Transportation and Traffic, Military Operations, Hazardous Substances and Materials, Natural Hazards, Public Safety. Operations: Same as above. HCP measures: Cumulative adverse impacts may occur, though the proposed mitigation is expected to more than offset the anticipated take and provide a net benefit to Covered Species.	Cumulative impacts of this alternative would be commensurate with those associated with the Proposed Action.	There would be no cumulative impacts.

ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
AG	Attorney General
ALISH	Agricultural Lands of Importance to the State of Hawaii
APE	area of potential effects
AWEA	American Wind Energy Association
BA	biological assessment
BCR	Bird Conservation Region
BESS	Battery Energy Storage System
BLNR	Board of Land and Natural Resources
BMPs	Best Management Practices
BO	biological opinion
CAA	Clean Air Act
CDP	Census Designated Place
CDUP	Conservation District Use Permit
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CUP-M	Conditional Use Permit-Minor
CWA	Clean Water Act
CZM	Coastal Zone Management
DBEDT	Department of Business, Economic Development, and Tourism
DEIS	Draft Environmental Impact Statement
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
DOD	Department of Defense
DOE	Department of Energy
DOFAW	Department of Forestry and Wildlife
DOH	Department of Health
DOT	Department of Transportation
DPP	Department of Planning and Permitting
EA	Environmental Assessment
EF	emission factors
EHSD	Environmental Health Service Division
EIS	Environmental Impact Statement
EISPN	Environmental Impact Statement Preparation Notice
EPA	Environmental Protection Agency
EPO	Environmental Planning Office
ESA	Endangered Species Act
ESRC	Endangered Species Recovery Committee
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FONSI	Finding of No Significant Impact
GHG	greenhouse gas
HAR	Hawaii Administrative Rules
HC	hydrocarbons
HCEI	Hawaii Clean Energy Initiative
HCP	Habitat Conservation Plan
HECO	Hawaiian Electric Company, Inc.
Hg	mercury
HIOSH	Hawaii Occupational Safety and Health
HRS	Hawaii Revised Statutes
IPCC	Intergovernmental Panel on Climate Change

IRS	Interconnection Requirement Study
ITL	Incidental Take License
JUCC	Joint Use Coordination Committee
kV	kilovolt
KWP	Kaheawa Wind Power
MBTA	Migratory Bird Treaty Act
mg/l Cl^-	milligrams per liter chloride
MOU	Memorandum of Understanding
mph	miles per hour
MW	megawatt
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_X	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NSSCP	North Shore Sustainable Communities Plan
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
O&M	operations and maintenance
O_3	ozone
OCCL	Office of Conservation and Coastal Lands
OISC	Oahu Invasive Species Committee
OHA	Office of Hawaiian Affairs
OSHA	Occupational Safety and Health Administration
PCE	Primary Constituent Element
Phase I ESA	Phase I Environmental Site Assessment
PM_{10}	particulate matter smaller than 10 microns
$PM_{2.5}$	particulate matter smaller than 2.5 microns
POI	Point of interconnection
PPA	Power Purchasing Agreement
RCRA	Resource Conservation and Recovery Act
rpm	revolutions per minute
RSZ	Rotor Swept Zone
SARA	Superfund Amendment Reauthorization Act
SCADA	Supervisory Command and Data Acquisition
SCP	Sustainable Communities Plan
SHA	Safe Harbor Agreement
SHPD	State Historic Preservation Division
SHPO	State Historic Preservation Officer
SMA	Special Management Areas
SO_2	sulfur dioxide
SO_X	sulfur oxides
SPCC	Spill Prevention, Countermeasure, and Control
TMK	Tax Map Key
TSCA	Toxic Substances Control Act
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
WEOP	wildlife education and observation program
WTG	wind turbine generator

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CHAPTER 1: INTRODUCTION

1.1 Proposed Development and Location

Kawailoa Wind Power LLC (Kawailoa Wind Power or the "Applicant") is proposing to develop a new 70-megawatt (MW) wind energy generation facility within the Kawailoa Plantation in the northern portion of the Island of O'ahu, Hawai'i (Figure 1-1). The proposed project is situated east of Hale'iwa Town and south of Waimea Valley in the District of Waialua. It is bounded on all sides by agricultural lands. The western portion abuts residences makai (seaward) of Kamehameha Highway and military training land is present east of the property. All parcels are owned by Kamehameha Schools and designated as an Agricultural District. The primary access road is Kawailoa Road off Kamehameha Highway (Hwy 83). Temporary construction disturbance would occur on 335.1 acres within the approximately 4,200 acre project area with 21.7 acres of permanent disturbance. The project may also include installation, operation, and maintenance of communication equipment at two existing Hawaiian Telcom facilities near the summit of Mt. Ka'ala.

The proposed project consists of construction of 30 Siemens 2.3-MW wind turbine generators (WTGs), electrical collector lines, an electrical substation, a possible Battery Energy Storage System (BESS)[1], two interconnection facilities, two communication towers, an operations and maintenance (O&M) building and laydown areas, meteorological (met) monitoring equipment, onsite access roads and the implementation of the HCP. The project may also include installation, operation, and maintenance of up to four microwave dish antennae on two existing Hawaiian Telcom facilities near the summit of Mt. Ka'ala. The communication equipment would provide a link between the wind farm and the existing Hawaiian Electric Company (HECO) substations that would be receiving the power.[2] The site layout for the proposed project is shown in Figure 1-1 and 1-2.

1.2 Purpose and Need for Action

Kawailoa Wind Power is voluntarily applying for an Incidental Take License from the Department of Land and Natural Resources, Division of Forestry and Wildlife, under Chapter 195-D of the Hawaii Revised Statutes and an an Incidental Take Permit (ITP) under Section 10(a)(1)(B) of the Endangered Species Act (ESA). This permit is being sought to authorize the incidental take of six federally listed species that are known to occur in the project area and that are believed to have the potential to collide with the proposed WTGs or other project infrastructure. These species include the Hawaiian stilt or āe'o (*Himantopus mexicanus knudseni*), Hawaiian coot or 'alae ke'oke'o (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or 'alae 'ula (*Gallinula chloropus sandvicensis*), Newell's shearwater or 'a'o (*Puffinus auricularis newelli*), and Hawaiian hoary bat or 'ōpe'ape'a (*Lasiurus cinereus semotus*). Hereafter, these six federally listed species and the one state-listed species, the short-eared owl (*Asio flammeus sandwichensis*), are collectively referred to as the "Covered Species." If granted, an ITP would authorize the incidental take of the six federally listed species identified above during construction and operation of the Kawailoa facility. Kawailoa Wind Power is also seeking an Incidental Take License (ITL) in accordance with Chapter 195-D of the Hawaii Revised Statutes (HRS) to authorize potential impacts to these same six federally listed species, as well as one state-listed endangered species, the Hawaiian short-eared owl or pueo. The ITL is issued by the State Department of Land and Natural Resources (DLNR).

1.2.1 Purpose of the Proposed Action for DLNR-DOFAW

For DLNR-DOFAW, the purpose of the Proposed Action includes the following:

[1] Based on an analysis of their system requirements, HECO has recently indicated that a BESS may or may not be required for integration of wind-generated power into the existing electrical grid. The specific requirements will be determined through ongoing coordination between Kawailoa Wind and HECO, but a BESS has been included as part of the Proposed Action in this EIS to allow for analysis of the maximum extent of potential impacts.

[2] HECO has also indicated that the communication equipment may or may not be required for integration into the existing electrical grid. Similar to the BESS, the communication equipment has been included as part of the Proposed Action in this EIS to allow for analysis of the maximum extent of potential impacts.

Figure 1-1. Kawailoa Wind Power Location and Site Layout.

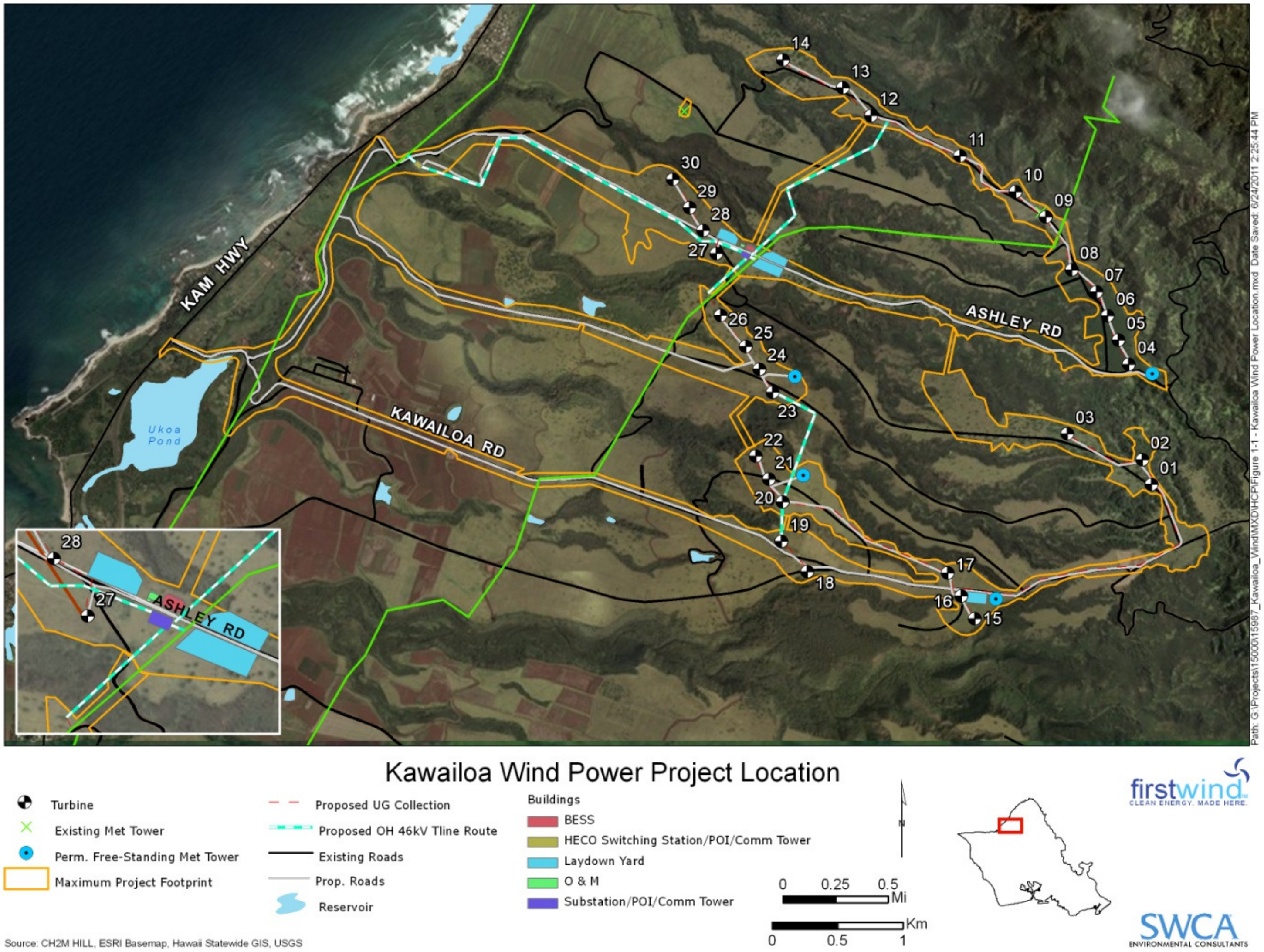
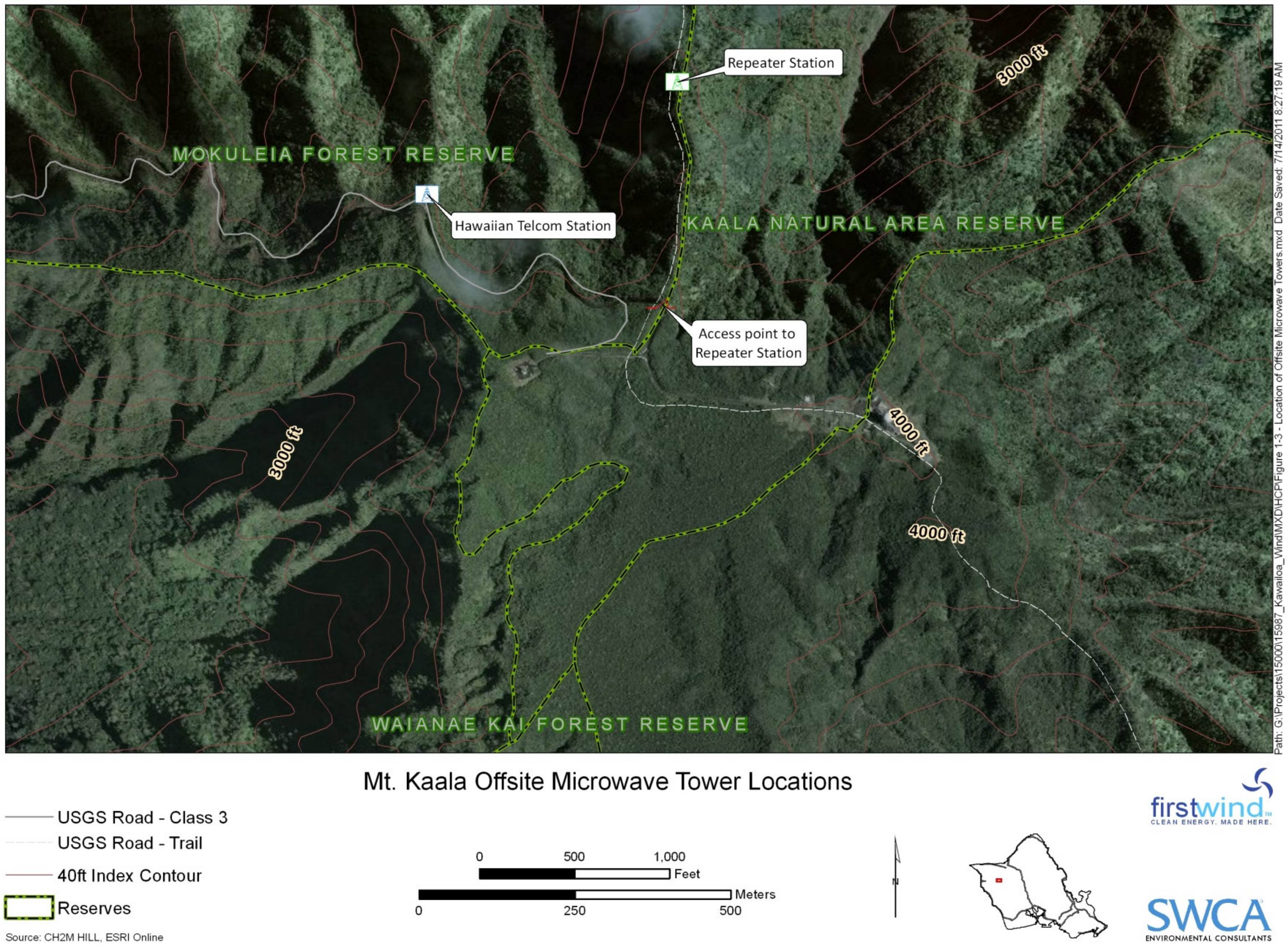


Figure 1-2. Location of Offsite Communication Towers.



- Respond to Kawailoa Wind Power's application for an ITL for the Covered Species related to activities that have the potential to result in take, pursuant to Chapter 195-D and ESA Section 10(a)(1)(B) and its implementing regulations and policies;

- Protect, conserve, and enhance the Covered Species and their habitat for the continuing benefit of the people of the United States (per Section 2(a)(4) of the ESA); and

- Ensure species needs are met through minimizing and mitigating to the maximum extent practicable.

1.2.2 Need for the Proposed Action for DLNR-DOFAW

For DLNR-DOFAW, the need for the Proposed Action includes the following:

- Provide a means and take steps to conserve the ecosystems depended on by the Covered Species;

- Ensure the long-term survival of the Covered Species through protection and management of the species and their habitat; and

- Ensure compliance with Chapter 195-D, Chapter 343, ESA, National Environmental Policy Act (NEPA), and other applicable state and federal laws and regulations.

The proposed issuance of an ITL by DLNR-DOFAW is a state action that triggers the preparation of an EA by Chapter 343 of the Hawaii Revised Statutes. The issuance of an ITP by the USFWS is a federal action that may affect the human environment and, therefore, is subject to review under NEPA. DLNR-DOFAW has prepared this EA to evaluate the impacts of Kawailoa Wind Power's Proposed Action (Alternative 1), the Alternative Communications Site Layout (Alternative 2), and a No Action Alternative (Alternative 3) on the natural and human environment. The scope of the analysis in this EA covers the direct, indirect, and cumulative environmental impacts of approving the HCP and issuing an ITL and ITP, and the anticipated future impacts of implementing the HCP. The following documents will also be included in the record for this proceeding and will supplement the analyses contained in this EA: (1) an ESA Section 7 Biological Opinion concerning Permit issuance; (2) ESA Section 10 Statement of Findings; and (3) a NEPA analysis decision document.

1.2.3 Permit Issuance Criteria for the USFWS

Under provisions of the ESA, the Secretary of the Interior (through the USFWS) may issue a permit for the incidental taking of a listed species if the application conforms to the issuance criteria identified in Section 10(a)(2)(B) of the ESA. In order to issue a permit, the ESA requires:

- The taking will be incidental;

- The Applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;

- The Applicant will ensure that adequate funding for the conservation plan and procedures to deal with unforeseen circumstances will be provided;

- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild; and,

- That measures required under Section 10(a)(2)(A)(iv), if any, are met and such other assurances that may be required that the HCP will be implemented.

As a condition of receiving an ITP, an applicant must prepare and submit to the USFWS for approval an HCP containing the mandatory elements of Section 10(a)(2)(A). An HCP must specify the following:

- The impact that will likely result from the taking;
- What steps the Applicant will take to minimize and mitigate such impacts, the funding available to implement such steps, and the procedures to be used to deal with unforeseen circumstances;
- What alternative actions to such taking the Applicant considered, and the reasons why such alternatives are not proposed to be utilized; and,
- Such other measures that the Secretaries may require as being necessary or appropriate for the purposes of the plan.

The ESA Section 10 assessment would be documented in the respective Section 10 findings document produced by the USFWS at the end of the process. If the USFWS makes the above findings, the USFWS would issue the ITP. In such case, the USFWS would decide whether to issue a permit conditioned on implementation of the proposed HCP as submitted or to issue a permit conditioned on implementation of the proposed HCP as submitted together with other measures specified by the agency. If the USFWS finds that the above criteria are not satisfied, the permit request shall be denied.

1.3 Relationship to Laws, Regulations, Plans, and Policies

The primary laws, regulations, plans, and policies that affect development and implementation of an HCP, ITL, ITP, and the covered activities are summarized below to assist the reviewer by adding additional context for the Kawailoa Wind Power HCP. Section 4.10.1.2 discusses how the proposed project is compliant with these laws, plans, and policies.

1.3.1 Federal Regulatory Context

1.3.1.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 (42 USC 4321 et seq.) requires that federal agency decision-makers, in carrying out their duties, use all practicable means to create and maintain conditions under which people and nature can exist in productive harmony and fulfill the social, economic, and other needs of present and future generations of Americans. NEPA provides a mandate and a framework for federal agencies to consider all reasonably foreseeable environmental effects of their proposed actions and to involve and inform the public in the decision-making process. This Act also established the Council on Environmental Quality (CEQ) in the Executive Office of the President to formulate and recommend national policies which ensure that the programs of the federal government promote improvement of the quality of the environment. The CEQ set forth regulations (40 CFR Parts 1500-1508) to assist federal agencies in implementing NEPA during the planning phases of any federal action. These regulations, together with specific federal agency NEPA implementation procedures, help to ensure that the environmental impacts of any proposed decisions are fully considered and that appropriate steps are taken to mitigate potential environmental impacts.

Although the requirements of the ESA and NEPA overlap considerably, the scope of NEPA exceeds the ESA by considering impacts of a federal action on other natural and human resources besides endangered and threatened species and their habitats. Depending on the scope and impact of the HCP, NEPA requirements can be satisfied by one of the three following documents or actions:

- Categorical exclusion (CATEX)
- Environmental Assessment (EA)
- Environmental Impact Statement (EIS)

Activities that do not individually or cumulatively have a significant effect on the environment can be categorically excluded from NEPA. An EA is prepared when it is unclear whether a more comprehensive EIS is needed or when the project does not require an EIS but is not eligible for a CATEX. An EA culminates in either a decision to prepare an EIS or a Finding of No Significant Impact (FONSI). An EIS is required when the project or activity that would occur under the HCP is a major federal action significantly affecting the quality of the environment, though an agency may produce an EIS at its discretion even in cases where significant effects are not likely to occur.

1.3.1.2 Federal Endangered Species Act

The ESA provides broad protection for plants, fish, and wildlife that have been listed as threatened or endangered in the U.S. or elsewhere and conserves ecosystem in which the species depend (16 U.S.C. 1531-1544). Section 9 of the ESA prohibits the unauthorized "take" of any endangered or threatened species of fish or wildlife listed under the ESA. "Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect species listed as endangered or threatened, or to attempt to engage in any such conduct (50 CFR 17.3). "Harm" has been defined by USFWS to mean an act which actually kills or injures wildlife, and may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). "Harass" has been defined to mean an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 CFR 17.3). Section 10 of the ESA contains exceptions and exemptions to Section 9, if such taking is incidental to the carrying out of an otherwise lawful activity, and outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species.

1.3.1.3 Federal Migratory Bird Treaty Act

All native migratory birds of the United States are protected under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 U.S.C. 703-712 *et. seq.*). The five bird species covered in the HCP, and several other non-listed bird species in the project vicinity, are protected under the MBTA. This act states that it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product. "Take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." No process for authorizing incidental take of MBTA-protected birds or providing permits is described in the MBTA (USFWS and NMFS 1996). In this case, if the HCP is approved and USFWS issues an ITP to Kawailoa Wind Power, the terms and conditions of that ITP would also constitute a Special Purpose Permit under 50 CFR 21.27 and any take of the listed bird species would not be in violation of the MBTA.

1.3.1.4 Federal National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA) is the primary federal law protecting cultural, historic, Native American, and Native Hawaiian resources. Section 106 of the NHPA (36 CFR 800) requires federal agencies to assess and determine the potential effects of their proposed undertakings on prehistoric and historic resources (e.g., sites, buildings, structures, and objects) and to develop measures to avoid or mitigate any adverse effects. Detailed requirements for complying with Section 106 of the NHPA are addressed in regulations promulgated by the Advisory Council on Historic Preservation (ACHP) under 36 CFR 800.

USFWS issuance of an ITP under ESA Section 10(a)(1)(B) is considered an "undertaking" covered by the ACHP and must comply with Section 106 of NHPA. Accordingly, USFWS must consult with the ACHP, the State Historic Preservation Officer (SHPO), affected Tribes, the Applicant, and other interested parties, and make a good-faith effort to consider and incorporate their comments into project planning.

Section 800.16(d) of the ACHP regulations requires agencies to determine the area of potential effects (APE), defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist." The USFWS generally interprets the APE as the specific location where incidental take may occur and where ground-disturbing activities may affect historic properties.

1.3.1.5 Executive Order 12898 - Environmental Justice

President Clinton issued Executive Order 12898 on federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations on February 11, 1994. Executive Order 12898 requires federal agencies to take appropriate steps to identify and avoid disproportionately high and adverse effects of federal actions on the health and surrounding environment of minority and low-income persons and populations. All federal programs, policies, and activities that substantially affect human health or the environment shall be conducted to ensure that the action does not exclude persons or populations from participation in, deny persons or populations the benefits of, or subject persons or populations to discrimination under such actions because of their race, color, income level, or national origin. The Executive Order was also intended to provide minority and low-income communities with access to public information and public participation in matters relating to human health and the environment.

The U.S. Environmental Protection Agency (USEPA), working with the Enforcement Subcommittee of the National Environmental Justice Advisory Council, has developed technical guidance to ensure that environmental justice concerns are effectively identified and addressed throughout the NEPA process. The State of Hawaiʽi has also developed its own legislation and guidance related to environmental justice. Act 294 was signed by Governor Lingle in July 2006 to define environmental justice in the unique context of Hawaii and to develop and adopt environmental justice guidance document that addresses environmental justice in all phases of the environmental review process (Kahihikolo 2008).

1.3.2State and Local Regulatory Context

1.3.2.1 Hawaiʽi State Plan

The *Hawaiʽi State Plan* is a policy document intended to guide the long-range development of the State of Hawaiʽi by: identifying goals, objectives, and policies for the State of Hawaiʽi and its residents; establishing a basis for determining priorities and allocating resources; and providing a unifying vision to enable coordination between the various counties' plans, programs, policies, projects and regulatory activities to assist them in developing their county plans, programs, and projects and the state's long-range development objectives. The *Hawaiʽi State Plan* is dependent upon implementing laws and regulations to achieve its goals.

1.3.2.2 Hawaii Revised Statutes, Chapter 195D

The purpose of Chapter 195D of Hawaii Revised Statutes (HRS) (Conservation of Aquatic Life, Wildlife, and Land Plants), is "to insure the continued perpetuation of indigenous aquatic life, wildlife, and land plants, and their habitats for human enjoyment, for scientific purposes, and as members of ecosystems … " (§195D-1). Section 195D-4 states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by state statute. Like the ESA, the unauthorized "take" of such endangered or threatened species is prohibited [§195D-4(e)]. Under Section 195D-4(g), the Board of Land and Natural Resources (BLNR), after consultation with the state's Endangered Species Recovery Committee (ESRC), may issue a temporary license (subsequently referred to as an "ITL") to allow a take otherwise prohibited if the take is incidental to the carrying out of an otherwise lawful activity. Kawailoa Wind Power is currently seeking an ITL.

1.3.2.3 Hawaii Revised Statutes, Chapter 343

HRS Chapter 343 (Environmental Impact Statements) was developed "to establish a system of environmental review which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations" (§343-1). This chapter requires the development of an EIS, which is an informational document that discloses the effects of a proposed action on the environment, economic welfare, social welfare, and cultural practices, as well as mitigation measures and alternatives to the action.

Because the project is being permitted pursuant to the state's HRS Chapter 201N Energy Facility Siting Process, an EIS has been prepared for the project with the Department of Business, Economic Development and Tourism (DBEDT) as the accepting authority. An EIS Preparation Notice (EISPN) was released for public comment on September 23, 2010. Following the end of the 30-day public review period for the EISPN, Kawailoa Wind Power addressed comments on the EISPN, and prepared a DEIS which discussed the likely direct, indirect, and cumulative impacts of the proposed project, as well as mitigation measures. The DEIS was released on February 23, 2010 and the public comment period lasted for 45-days as provided by law. The Final EIS (FEIS) incorporated and responded to all the comments on the DEIS and was submitted to DBEDT for review and accepted on June 27, 2011. The accepted EIS is incorporated by reference into this document.

1.3.2.4 Hawaii Revised Statutes, Chapter 205

Under The State Land Use Law (Act 187), HRS Chapter 205, all lands and waters in the state are classified into one of four districts: Agriculture, Rural, Conservation, or Urban. Conservation Districts, under the jurisdiction of DLNR, are further divided into five subzones: Protective, Limited, Resource, General, and Special. The use of Conservation District lands is regulated by HRS Chapter 183C and Hawaii Administration Rules (HAR) Chapter 13-5.

Most of the Kawailoa Wind Power project area is designated as an Agricultural District; however, portions of some of the parcels are designated as General and Limited subzones of the State Conservation District. The mauka (inland) portion of the project area is also designated as Conservation. Both of the proposed offsite communication towers are located on Conservation District land. Lands within a Conservation District are typically utilized for protecting watershed areas, preserving scenic and historic resources, and providing forest, park, and/or beach reserves (subsection 205-2[e] HRS). Kawailoa Wind Power is required to obtain a Conservation District Use Permit (CDUP) from the Office of Conservation and Coastal Lands (OCCL) to operate in a Conservation District.

1.3.2.5 Hawaii's Coastal Zone Management Program

Hawaii's Coastal Zone Management (CZM) Program (HRS 205A-2) is designed to protect valuable and vulnerable coastal resources by reducing coastal hazards and improving the review process for activities proposed within the coastal zone. The CZM Program focuses on ten objectives and policies related to the following: recreational resources; historic resources; scenic and open space resources; coastal ecosystems; economic uses; coastal hazards; managing development; public participation; beach protection; and marine resources. The CZM program also includes a permit system to control development within Special Management Areas (SMAs), which include lands within 300 feet from the shoreline. The proposed project area is not located within a SMA, although SMAs do occur along portions of the project boundaries. The project may require a SMA permit (CH2M Hill 2011).

1.3.2.6 City and County of Honolulu General Plan

The General Plan for the City and County of Honolulu, revised in 1992, is a comprehensive document with long-range social, economic, environmental, and design objectives, as well as broad policies to facilitate the attainment of those objectives. The General Plan is divided into 11 subject areas including population, economic activity, the natural environment, housing, transportation and utilities, energy, physical development and urban design, public safety, health and education, culture and recreation, and government operations and fiscal management (DPP 2006). The General Plan designated the North Shore as a rural area and specifies that agricultural lands along in the area be maintained for diversified agriculture.

1.3.2.7 Community Plans

The county is divided into eight regional areas that are guided by Development Plans or Sustainable Communities Plans (SCP). Kawailoa is located in the North Shore Sustainable Communities Plan (NSSCP) area. The area is bounded on the west by Ka'ena Point, on the east by Waiale'e Gulch near Kawela Bay in the east, and the north by O'ahu's shoreline, and on the south by Helemano and the slopes of the Wai'anae and Ko'olau Mountain Ranges. The plan area includes the country towns of

Haleʽiwa and Waiʽalua and the rural residential communities of Mokulēʽia, Kawailoa, and Sunset/ Pūpūkea. In cooperation of the General Plan, the NSSCP is designed to guide public policy, investment, and decision-making over a 20-year period. The Plan states that the role of the NSSCP area is "to maintain the rural character, agricultural lands, open space, natural environment, recreational resources and scenic beauty of Oʽahu's northern coast, in contrast to more urbanized areas of Oʽahu … " (Helber Hastert & Fee Planners 2009). Land use maps within the NSSCP area depict the project area as Agriculture (Helber Hastert & Fee Planners 2009).

1.3.2.8 County Zoning

Land use on Oʽahu is also dictated by the Land Use Ordinance from the City and County. The City and County of Honolulu zoning ordinance defines the project area as AG-1 Restrict Agricultural District. Adjoining land is also zoned AG-1 Restricted or AG-2 General. The AG-1 designation is intended to preserve "important agricultural lands" for agricultural functions, such as the production of food, feed, forage, fiber crops and horticultural plants (City and County of Honolulu, Land Use Ordinance, Chapter 21). A wind energy project is permitted in this zoning area with acquisition of a Conditional Use Permit (City and County of Honolulu, Land Use Ordinance, Chapter 21, Section 5.700). Because turbine foundations physically occupy only a small fraction of the project area's land area, development of wind energy is generally considered compatible with some agricultural uses, such as grazing (Global Energy Concepts LLC 2006). The offsite communication towers site is zoned as P-1 Preservation District by the City and County of Honolulu. Further information on land use policies and plans is provided in the accepted EIS (CH2M Hill 2011).

Four temporary 197 feet guy wire-supported met towers were installed in the project area between August and December 2009 to collect wind resource data. In order to construct these structures, the project was granted a Temporary Use Approval by the City and County of Honolulu's Department of Planning and Permitting (DPP) in August 10, 2008, September 18, 2009, and April 21, 2010.

1.3.2.9 Hawaiʽi Agricultural Land Use Map (ALUM)

Agricultural land use designations have been developed for Hawaiʽi. The State of Hawaiʽi Agricultural Land Use Map (ALUM) depicts the majority of the project area as sugarcane. Smaller areas are classified as Dairy and Grazing land. The remainder of the project area is not classified within the ALUM. Neither of the communication tower sites is classified by ALUM.

1.3.2.10 University of Hawaiʽi's Land Study Bureau Detailed Land Classification

The University of Hawaiʽi's Land Study Bureau developed a Detailed Land Classification that divides the island into a five-class agricultural productivity rating using the letters "A" through "E." "A" represents the class of highest productivity and "E" the lowest. The project would be located in soils classified as Categories B, C, D, and E. Turbine and tower facilities would be distributed as follows: 15 of the turbines and one meteorological tower would be located in B soils, eight turbines and one meteorological tower would be located in C soils, and seven turbines and two meteorological would be located in D soils. Other facilities associated with the project may be located in soils classified as Categories B, C, D, or E. Although Class B rated soils exist in the project area, wind energy facilities are permitted uses on agricultural areas, per HRS Chapter 205-4.5. The offsite communication tower sites are classified as E rated soils.

1.3.2.11 Agricultural Lands of Importance to the State of Hawaiʽi's

The State Department of Agriculture's Agricultural Lands of Importance to the State of Hawaiʽi (ALISH) system also ranks areas based on soil agricultural suitability. Designed to inventory prime farmlands, the system divides agricultural lands into three classes (Unique, Prime, and Other). Prime agricultural land is defined as land with soil temperature, soil pH, moisture supply, and growing season needed to produce high yields of crops when treated and managed according to modern farming methods. The Other designation refers to land that is important to agriculture, but lacks properties to be Prime or Unique; this land usually has slopes less than 35% and has been used or could be used for grazing. A large portion of the project area is located on land classified under the ALISH system as prime agricultural land. Neither of the communication tower sites is classified by ALISH.

1.4 Public Involvement and Agency Coordination

Under the USFWS's NEPA implementing procedures, public scoping is not required to prepare an EA. However, public scoping for the project has occurred through the State of Hawai'i's HCP, EIS, and CDUP processes (see Sections 1.3.2.2- 1.3.2.4, respectively).

Public involvement through the state's regulatory process began with the public review of the state EISPN which was released on September 23, 2010. The 30-day comment period was held from September 23 to October 23, 2010. Subsequently, a DEIS was released to the public on February 23, 2011 for a 45-day comment period (CH2M Hill 2011). Feedback and comments on the proposed project were incorporated into the FEIS, which was submitted to DBEDT for review and accepted on June 27, 2011 (CH2M Hill 2011b).

The state HCP process also provides the opportunity for public involvement. The Draft HCP will be made available from the State Office of Environmental Quality Control (OEQC) during the fall of 2011. The final state HCP will be reviewed by ESRC and, if approved, issuance of ITL is expected concurrently with the Federal ITP.

Furthermore, Kawailoa Wind Power also conducted community outreach to discuss wind power at Kawailoa through meetings and site visits with members of the public, including representatives of the community. These meetings provided Kawailoa Wind Power with the opportunity to incorporate feedback into the project design and mitigation measures. Details of these outreach efforts are available in the accepted EIS (CH2M Hill 2011).

Kawailoa Wind Power has also met with local, state, and federal agencies and non-governmental field biologists during development of the proposed project. This includes coordination and consultation with the USFWS, DOFAW, ESRC, OCCL, and State Historic Preservation Division (SHPD). The ESRC met to discuss the proposed project on: September 16, 2010 and December 6, 2011. ESRC visited the site on December 7, 2010. Consultations with USFWS and DOFAW occurred on October 4, 2010, January 20, 2011, March 4, 2011, April 20, 2011, June 7, 2011, June 13, 2011, to discuss and address comments on the proposed take levels, avoidance and minimization, mitigation measures and monitoring protocols. A draft was submitted for review on November 6, 2010 and DOFAW and USFWS comments on the draft HCP were received on January 18, 2011. These comments were addressed in subsequent drafts presented on March 8, 2011 and March 23, 2011. Additional meetings with USFWS only were held on June 27, 2011.

CHAPTER 2: ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter identifies and describes the Proposed Action and alternatives to the Proposed Action, as required by Section 102(2)(E) of NEPA. Alternatives to the Proposed Action include the No Action Alternative, Alternate Project Locations, Alternate Siting Areas at Kawailoa, Greater or Fewer Number of WTGs, and Alternative WTG Size or Design. Only impacts anticipated as a result of the Proposed Action (Alternative 1), Communications Site Layout Alternative (Alternative 2), and the No Action Alternative (Alternative 3) are evaluated in this EA. Reasons the other alternatives were rejected without further impact analysis are discussed in Section 2.4.

2.1 Alternative 1 (Proposed Action)

2.1.1 Construction and Operation of Kawailoa Wind Power Facility

The Proposed Action is the issuance of an ITL/ITP and approval of an HCP for the Kawailoa Wind Power facility to authorize the potential incidental take of six federally listed threatened and endangered species and one state-listed endangered species during the development, construction, and operation of Kawailoa Wind Power, and to adequately avoid, minimize, and mitigate the anticipated incidental take.

If the required land use approvals and environmental permits are granted, Kawailoa Wind Power would:

- Land Use Agreement: Obtain a lease from the Kamehameha Schools for approximately 4,200 acre of land within the former Kawailoa Plantation. Kawailoa Wind Power is also applying for a license agreement with Hawaiian Telcom and will coordinate with the State of Hawai‘i Division of Land and Natural Resources Land Division for use of lands at the proposed Mt. Ka‘ala communication sites.

- Road Network: Upgrade existing cane haul roads and create new internal service roads, as needed, to connect to the WTGs, other project components, and to Kawailoa Road (which would serve as the primary access road). The proposed new roads would be approximately 40 feet wide, of which only 16 to 20 feet would be graveled; the remainder of the road would be earthen. Approximately 4.3 miles of existing access roads would be widened and 6.8 miles of access roads would be constructed.

- WTG Sites: Install30 Siemens SWT-2.3-101 turbines. The turbines would be arranged in several arrays along the northeastern and southeastern boundaries of the project area (Figure 1-2). Each turbine site would consist of a turbine pad, pad-mounted transformer, power distribution panel, turbine tower and rotor, and gravel access drive and buffer area. An area roughly 135 feet in radius surrounding each turbine site would be temporarily disturbed during construction of the turbine components. A gravel perimeter would be provided around each foundation at the completion of construction to facilitate access and maintenance. Disturbed areas outside the gravel perimeter would be revegetated to stabilize the soil. In addition, a 429,285 square-foot area (9.9 acres based on 75% of 493 foot tower height) around each turbine would be maintained in a mowed condition for the life of the project in order to facilitate detection of downed wildlife. The poured concrete foundation for each tower is approximately 46 square feet.

  The towers proposed for the project are approximately 328 feet in height. The proposed rotor has a diameter of 332 feet, and when the blade is at the top of its arc, the maximum height of the structure is 493 feet from ground elevation.

- Meteorological Monitoring Towers: Before construction, up to six new 328-foot meteorological towers would be installed for the calibration of the wind farm equipment. Four of these towers would be temporarily installed within the work areas for the wind turbines, and would be removed after an initial calibration period of approximately three to four months. The other two towers would be installed in a subset of the four potential locations, and would be used for ongoing data collection and certification of the wind turbines over the operational life of the project. Each would be an unguyed lattice tower, approximately 328 feet in height, with a 35-foot by 35-foot concrete foundation.

Table 2-1. Characteristics of Siemens SWT-2.3-101 Turbine.

Description	Measurement
Power Generation	2,300 kilowatts (2.3 MW)
Tower Height	328 feet (100 meters)
Rotor Diameter	332 feet (101 meters)
Total Height (Tower + ½ Rotor)	493 feet (150.5 meters)
Rotor Swept Area	8,000 square meters
Rotor Speed	6 – 16 rotations per minute
Minimum Operational Wind Speed	4 m/s (8 mph)
Maximum Operational Wind Speed	25 m/s (55 mph)

NOTES: kW = kilowatt, m/s = meters per second, mph = miles per hour

Electrical Collection System: Electrical power generated by the turbines would be transmitted to a transformer located at the base of each tower, where the voltage would be increase from 690 V to 23 kV. The 23 kV power would be carried from each turbine to an onsite substation via an electrical collector system, comprised of a network of underground and overhead collection circuits. In general, most of the collector lines would be located underground along the access roads; in general, only those lines that cross gulches would be located overhead.[3] The overhead lines would be installed on 45-foot-high wooden poles, typically spaced at 200- to 300-foot intervals. The underground lines would be direct-buried in trenches, each approximately 3 feet wide and 4 feet deep; once backfilled, these areas would be hydromulched to stabilize the soil and facilitate revegetation. The collector system lines would also accommodate fiber optic cable to facilitate communication between the individual turbines and other project components. The electrical collector cables would be routinely monitored, inspected, and maintained by qualified personnel and maintenance technicians over the lifetime of the project. These activities would be accomplished with small trucks; heavy construction or excavation equipment would only be required if an underground cable needed replacement.

Electrical Substations: An electrical substation would transform the voltage of electricity to allow integration into the existing 46 kV HECO sub-transmission system. Two HECO sub-transmission lines currently cross the site: the Waialua-Kuilima and Waialua-Kahuku 46 kV sub-transmission lines. These lines each have an available transmission capacity of 50 MW and 20 MW, respectively. It is anticipated that the substation would be located along Ashley Road, near the Waialua-Kuilima sub-transmission line. One set of overhead 46 kV connector lines would be constructed from the substation to the interconnection facility and POI (point of interconnection) for the Waialua-Kuilima line, which would be located just east of the substation. A second set of overhead 46 kV connector lines would run from the substation, west along Ashley Road to the interconnection facility and POI for the Waialua-Kahuku line sub-transmission line. These higher-voltage connector lines would be installed on approximately 60-foot-high poles, as specified by HECO, and would be spaced at an average interval of approximately 250 to 350 feet. Both lines may also accommodate fiber optic cable to facilitate communications, as well as a low-voltage secondary line to provide power to the control house at each switching station. The substation would be an open switchrack design, with free-standing steel structures up to a maximum height of approximately 50 feet. It would have a gravel base and a fully fenced perimeter, with a maximum footprint of approximately 200 feet by 300 feet, for a total area of 1.4 acres (60,000

[3]The 46 kV sub-transmission lines that would deliver the wind-generated energy from the substation to the POIs would also be located overhead.

square feet). The substation would provide for the termination of the 23 kV collection lines, two 23-46 kV step-up power transformers, and connection for the 46 kV lines that would deliver the energy to the respective interconnection facilities.

BESS: Because of the technical requirements of interconnecting to the HECO system, the project may include a BESS to stabilize energy output during extreme wind fluctuations.[4] The BESS provides short-term storage (essentially charging during periods of sustained wind and discharging into the grid when the wind falls off suddenly), thereby mitigating variations in output. The BESS, if required, would be sized according to the Interconnection Requirement Study (IRS) currently being conducted by the utility, and may have a capacity of approximately 20 MW with 14 megawatt hours (MWh) of energy storage capability.

The BESS would be installed immediately adjacent to the substation and would be enclosed in a four-wall structure with an angled pitched roof, up to 25 feet in height and totaling approximately 25,000 square feet (0.6 acre) in area. The BESS enclosure would house the power cell components and electrical equipment, including control and switching panels, direct current/alternating current (DC/AC) inverters, and external pad-mounted transformers to connect to the substation.

Interconnection Facilities: Near each of the two POIs, the required interconnection facilities would be constructed to connect the 46 kV connector lines to the existing 46 kV HECO sub-transmission lines. A fenced yard would contain steel switchrack structures, ring bus, utility poles and both overhead and underground electrical lines; the construction methods would be similar to those described for the electrical substation. The yard would be a maximum of approximately 200 feet by 200 feet and surfaced with gravel. Inside the yard, a pre-fabricated control room (approximately 10 feet by 20 feet) would house equipment for controls, metering and communication, all of which are required for interconnection of the wind farm. In addition, each yard would accommodate a communication tower with up to two microwave dish antennae, as further discussed below.

O&M building: The O&M building would be a prefabricated metal building, approximately 7,000 square feet (0.16 acre) and up to 25 feet in height. It would house the wind farm management system, which monitors the performance of the overall system and the operational status and performance of individual turbines and wind monitoring equipment; an emergency back-up propane generator would be located at the facility to provide operating power for the management system in the event of a power outage. The facility would also provide for an indoor shop and a storage area for spare parts, as well as an office for the site manager and operations and environmental staff. Outdoor parking would be provided for five to eight vehicles.

Open space in the vicinity of the O&M building would be used as a lay-down area for storage of large equipment (such as spare turbine blades and gear boxes). In addition, two other areas would be temporarily used for construction laydown. Following construction, temporary laydown areas would be revegetated using a hydroseed mixture to stabilize the soil and prevent erosion. A portion of the laydown area adjacent to the O&M building would be used over the lifetime of the project for parking at the O&M building, water tank storage, and a septic system.

The project facilities have very low onsite water requirements. As a result, it is not anticipated that a direct connection to the municipal water supply system would be required. However, several water tanks would be installed in the vicinity of the O&M building; these would be periodically filled with non-potable water trucked onto the site (or obtained from the onsite irrigation ditches). One tank would supply water for plumbing for the restrooms in the O&M building; a septic tank would be used to collect the wastewater, which would be collected and transported to an appropriate wastewater treatment facility or other approved location for disposal. The other tanks would have a total capacity of approximately 60,000 gallons and would be used primarily to supply an exterior fire hydrant, as needed to meet the requirements of the City and County of Honolulu Fire Department.

[4] As previously noted, HECO has recently indicated that a BESS may not be required for integration into the existing electrical grid. However, a BESS has been included as part of the Proposed Action in this EA to allow for analysis of the maximum extent of potential impacts.

Communication equipment: Communication equipment may be installed as part of the project to provide a secure high-speed communication link between the wind farm and the HECO substations that would be receiving the power.[5] The communication equipment would include up to eight microwave dish antennas installed in four different locations. Two new towers would be installed at the Kawailoa wind farm site, one at each of the interconnection facilities. The tower at the makai interconnection facility would be approximately 50 feet tall, and the tower at the mauka interconnection facility would be approximately 60 feet tall, each with a concrete foundation approximately 144 square feet in area. Up to two antennae, approximately 11 feet in diameter, would be mounted horizontally on each tower.

The remaining antennae would be installed on existing structures at two different Hawaiian Telcom communication sites, both located on the north slope of Mt. Kaʻala, approximately five miles southwest of Waialua town. One of the sites would enable transmission to and from the existing HECO substation in Waialua; the other would enable transmission to and from the existing HECO substation in Wahiawa.

The two Hawaiian Telcom communication sites each include structures that have been in place for several decades. The first site has a small building and is adjacent to the paved access road at an elevation of approximately 3,600 feet. The building supports a metal scaffold tower and several antennae. The second site is located on an adjacent mountain ridge at an elevation of approximately 3,200 feet, and is accessed from the paved road via an existing concrete stairway and trail (approximately 0.25 mile from the paved road). This site has two metal scaffold towers, each approximately 15 feet tall, one of which supports two dish antennae. Up to two new antennae (one for receiving and one for transmitting signals) would be installed on the existing structures at each of these sites. Similar to those currently in place, each antenna would be approximately 11 feet in diameter; the antennae at the Hawaiian Telcom building would be connected via waveguide cable to existing radio equipment inside the building. The antennae to be installed at the Hawaiian Telcom building would be transported via the existing paved access road, then carried on foot; the antennae to be installed at the repeater site would be transported via helicopter to minimize vegetation trimming along the access trail. In both cases, the antennae would be mounted to the existing structures; no ground disturbance is expected at either site.

Access for radar and communications activities within the Mt. Kaʻala area are managed by the multi-agency Kaʻala Joint Use Coordination Committee (JUCC), which includes representatives from the U.S. Armed Services. A Conservation District Use Permit will also be required for the mounting of the antennae.

Onsite Access Roads: A network of roads currently exists on the Kawailoa property, most of which were designed to accommodate large cane haul trucks. These include Kawailoa Road, Cane Haul Road, Ashley Road, Mid-Line Road, and Bull's Boulevard. The site layout has been designed to focus access within the site along these roadways to the maximum extent possible. Other unnamed roads occur along or between the main onsite roads; use of these roads would generally be limited to periodic access by small construction and maintenance vehicles (for example, 4-wheel-drive pickup trucks). No improvements are planned along the unnamed roadways.

The primary access to the proposed facility would be via either Ashley Road or Kawailoa Road, both of which intersect with Kamehameha Highway. Other existing onsite roadways that would be used during construction and operation of the project are Cane Haul Road, Mid-Line Road, and Bull's Boulevard. In general, these existing roadways leading up to the turbine strings (a total of approximately 8.5 miles of roadway) are wide enough to accommodate the vehicles transporting the turbine equipment, but would require resurfacing and localized improvements to the grade and/or turning radius (for example, along the inner horseshoe turn on Kawailoa Road and segments of Cane Haul Road).

The existing roads between the turbine strings, which include Ashley Road, Mid-Line Road, and Bull's Boulevard, would require widening to approximately 40 feet. Of this width, approximately 16 to 20

[5] As previously noted, HECO has recently indicated that communication equipment may not be required for integration into the existing electrical grid. However, this equipment has been included as part of the Proposed Action in this EIS to allow for analysis of the maximum extent of potential impacts.

feet would be a gravel surface, with 10- to 12-foot earthen shoulders on either side. This width is needed to accommodate the crawler crane used to erect the turbines; the crane would straddle the graveled portion of the road as it tracks to each turbine site. These existing roadways may also need improvements, including regrading and installation of drainage features. Widening and other improvements would be implemented along approximately 4.3 miles of existing onsite roadways.

In addition, several segments of new onsite roadway would be constructed, as needed, to connect the turbines to the existing onsite access roads. Approximately 6.8 miles of new roads would be constructed; these would also have a cleared and graded width of approximately 40 feet to accommodate the crawler crane. The road layout has been designed to avoid known cultural resources and the need for new crossings of gulches or ditches.

The roads would be cleared and graded using bulldozers and scrapers, followed by placement of gravel. Water trucks would be used as needed to apply water to minimize dust during construction. Stormwater runoff would be appropriately addressed through design features that incorporate best management practices (BMPs)[6] that minimize the quantity and water quality impacts of the runoff. Following construction, the road shoulders would be hydromulched to stabilize the soils, and a permanent road width of approximately 16 feet would be maintained. The onsite roadways would be periodically inspected over the lifetime of the project, with repair and maintenance efforts conducted as needed. It is likely that periodic maintenance consisting of surface dragging, blading, or grading would be required to remove vehicle ruts that may develop because of maintenance traffic or after periods of heavy rainfall.

[6] A best management practice (BMP) is an engineered structure, management activity, or a combination, that eliminates or reduces an adverse environmental effect of a pollutant (City and County of Honolulu 2006).

Table 2-2. Approximate Areas of Disturbance Associated With Each Project Component.

Project Component	Quantity	Description of Area to be Disturbed (ft = feet, ft^2 = square feet)	Total Extent of Disturbance	Long-Term Vegetation Management	Permanent Footprint of Facilities
WIND FARM SITE					
Wind turbine generators	30 turbines	Wildlife search areas = 9.9 acres per turbine (370 foot radius) [a] Temporary work area = 2.9 acres per turbine (200 foot radius) Permanent foundation = 2,800 ft^2 per turbine (30 foot radius)	251.0 acres [a]	249.1 acres	1.9 acres
Electrical collector lines [b]	4.0 miles of overhead lines [c](approximately 78 poles)	Corridor width = 50 feet Footprint = 5 ft x 5 ft (25 ft^2) per pole	12.6 acres	5.5 acres	0.04 acre
	7.2 miles of underground lines [d]	Corridor width = 3 feet [d]	3.2 acres	--	--
Electrical substation	1	200 ft x 300 ft = 60,000 ft^2 (1.38 acre)	1.4 acre	--	1.4 acre
Battery energy storage system	1	100 ft x 250 ft = 25,000 ft^2 (0.57 acre)	0.6 acre	--	0.6 acre
Interconnection facilities (each includes a control house and communication tower)	2	200 ft x 200 ft = 40,000 ft^2 (0.9 acre)	1.8 acres	--	1.8 acres
O&M building	1	70 ft x 100 ft = 7,000 ft^2 (0.2 acre)	0.2 acre	--	0.2 acre
Laydown area	3	350 ft x 375 ft = 131,250 ft^2 (3.0 acres) 350 ft x 375 ft = 131,250 ft^2 (3.0 acres) 420 ft x 725 ft = 304,500 ft^2 (7.0 acres)	13.0 acres	--	0.5 acre [e]
Meteorological monitoring equipment	2 towers [f]	Wildlife search areas = 1.96 acre per tower (165 foot radius) Foundation = 35 ft x 35 ft (1,225 ft^2)	3.9 acre	3.8 acre	0.1 acre

Project Component	Quantity	Description of Area to be Disturbed (ft = feet, ft^2 = square feet)	Total Extent of Disturbance	Long-Term Vegetation Management	Permanent Footprint of Facilities
Onsite access roads	4.3 miles of existing access roads to be widened [g]	Width of straight sections = 40 ft Width around turns ≤ 85 ft Permanent width = 16 ft	14.5 acres	--	2.1 acres
	6.8 miles of new access roads		32.9 acres	--	13.2 acres
Subtotal			**335.1 acres**	**258.5 acres**	**21.7 acres**
MT. KA'ALA SITE					
Communication equipment at existing Hawaiian Telcom building	Up to 2 microwave antenna dishes	Dish mounted on existing tower (no ground disturbance, tree trimming if needed)	--	--	--
Communication equipment at existing Hawaiian Telcom repeater station	Up to 2 microwave antenna dishes	Dish mounted on existing tower (no ground disturbance, tree trimming if needed)	--	--	--
Subtotal			**0 acre**	**0 acre**	**0 acre**
ENTIRE PROJECT					
Total			**335.1 acres**	**258.5 acres**	**21.7 acres**

NOTES:

[a]Based on a radius of 370 feet for the search plot around each turbine, the total area of disturbance associated with the turbines would be approximately 296.2 acres. However, approximately 45.2 acres is considered to be unsearchable because of steep topography; therefore, total area within search plots is anticipated to be approximately 251.0 acres.

[b]The 46kV connector lines running from the substation to the points of interconnection (POIs) are quantified as part of this category.

[c]Of the 4.0 miles of overhead lines, approximately 1.9 miles associated with the 46kV connector lines would be located along access roads and presumably would fall within the footprint of those features. The calculation of total area disturbed by the overhead lines is based only on the remaining 2.1 miles of lines that are not located along access roads. It is possible that some of these overhead spans would instead be routed underground along access roads; the extent of disturbance associated with placing these lines underground would be equal to or less than those presented in this table.

[d]Of the 7.2 miles of underground lines, approximately 7.1 miles are along access roads, so no additional disturbance is anticipated beyond the 3-foot-wide trench. For the 0.1 mile of line that is not located along an access road, temporary disturbance is expected to occur within a 50-foot-wide corridor.

[e]The permanent footprint of the laydown areas would include the parking area for the O&M building, water tank storage, and septic system.

[f]A total of four potential meteorological monitoring tower locations have been identified; up to two permanent towers would be installed in a subset of these locations. In addition, four temporary towers would also be installed, but would be located within the work areas for the wind turbines, so there would be no additional disturbance area.

[g]The calculation of total area disturbed by the onsite access roads assumes the primary access roads leading up to the turbines (approximately 8.2 miles) would be improved, but not widened, and therefore would not have any additional area of disturbance. The existing access roads between the turbine strings would be temporarily widened up to 40 feet to allow for movement of the construction crane; these roads are assumed to have an average existing width of 12 feet. Therefore, the total area to be temporarily disturbed would be equal to the road length (4.3 miles) multiplied by an average increase in width of 28 feet (40 feet minus 12 feet). The permanent footprint would be equal to the road length (4.3 miles) multiplied by an average increase in the footprint of 4 feet (16 feet minus 12 feet).

2.1.2 ITL/ITP Avoidance, Minimization, Mitigation, and Management Measures

A summary of authorized take for Covered Species under a Federal ITL/ITP is provided in Table 2-3. Following the table is the associated avoidance, minimization, and management measures associated with the proposed take authorizations.

Table 2-3. Amount of Authorized Take Requested at Tier 1 and Above.

Covered Species	Level of Take	Requested Authorization 20-Yr Limit
Newell's Shearwater	Tier 1	3 adults/ immatures and 2 chicks/eggs
	Tier 2	6 adults/ immatures and 3 chicks/eggs
Hawaiian Duck	Tier 1	4 adults/ immatures and 4 ducklings
	Tier 2	6 adults/ immatures and 6 ducklings
Hawaiian Stilt	Tier 1	8 adults/ immatures and 4 fledglings
	Tier 2	12 adults/ immatures and 6 fledglings
Hawaiian Coot	Tier 1	8 adults/ immatures and 4 fledglings
	Tier 2	12 adults/ immatures and 6 fledglings
Hawaiian Moorhen	Tier 1 Take for Harassment from Trapping	8 adults/ immatures and 4 fledglings 50 individuals
	Tier 2 Take for Harassment from Trapping	12 adults/ immatures and 6 fledglings 50 individuals
Hawaiian Short-Eared Owl (state-listed)	Tier 1	4 adults/ immatures and 4 fledglings
	Tier 2	6 adults/ immatures and 6 owlets
Hawaiian Hoary Bat	Tier 1	16 adults/ immatures and 8 juveniles
	Tier 2	32 adults/ immatures and 16 juveniles
	Tier 3	48 adults/ immatures and 24 juveniles

2.1.2.1 Avoidance and Minimization Measures

- Using "monopole" steel tubular turbine towers rather than lattice towers. Tubular towers are considerably more visible than lattice towers and should reduce collision risk.
- The use of unguyed instead of guyed permanent met towers for the project site.
- Marking guy wires on temporary met towers with high visibility bird diverters made of spiraled PVC and twin 12-inch white poly vinyl marking tape to improve the visibility of the wires.
- Utilizing a rotor with a significantly slower rotational speed (range of 6 – 16 rpm) compared to older designs (28.5 – 34 rpm). This increases the visibility of turbine blades during operation

and decreases collision risk.

- Placement of all new power collection lines underground as far as practicable to minimize the risk of collision with new wires; overhead collection lines will be fitted with marker balls to increase visibility where appropriate. All overhead collection lines will be spaced according to Avian Power Line Interaction Committee (APLIC) guidelines to prevent possible electrocution of native species. Species most at risk are those likely to perch on power poles or lines (APLIC 2006). Only one species is identified to be at risk at Kawailoa Wind Power, the Hawaiian short-eared owl. Using the barn owl as a surrogate species, the horizontal spacing will be more than 20 inches to accommodate the wrist-to-wrist distance of the owl. If a vertical arrangement is chosen, a vertical spacing of more than 15 inches (head-to-foot length) will be used (APLIC 2006). Any jumper wires will be insulated.
- Overhead collection lines will be parallel to treelines whenever possible. Overhead lines spanning the gulches will be fitted with marker balls to increase their visibility to Covered Species and minimize risk of collisions.
- Improving drainage in areas as needed to eliminate the accumulation of standing water after periods of heavy rain to minimize potential of attracting waterbirds to the site.
- Where feasible, minimizing night-time construction activities to avoid the use of lighting that could attract seabirds and possibly bats.
- Use of minimal on-site lighting at buildings and using shielded fixtures that will be utilized only on infrequent occasions when workers are at the site at night. Onsite lighting will be fitted with motion-sensors, automatic shut-off timers or similar devices to limit lighting to periods when personnel are actively working.
- Refraining from clearing trees above 15 feet in height for construction between June 1 and September 15, which is the period when non-volant Hawaiian hoary bat juveniles may occur in the project area.
- Implementing low wind speed curtailment to reduce the risk of bat take: Recent studies on the mainland indicate that most bat fatalities occur at relatively low wind speeds, and consequently the risk of fatalities may be significantly reduced by curtailing operations on nights when winds are light and variable. Research suggests this may best be accomplished by increasing the cut-in speed of wind turbines from their normal levels (usually 3.5 or 4 m/s, depending on the model) to 5 m/s. Two years of research conducted by Arnett et al. (2009, 2010) found that bat fatalities were reduced by an average of 82% (95% CI: 52–93%) in 2008 and by 72% (95% CI: 44–86%) in 2009 when cut-in speed was increased to 5 m/s. No significant additional improvement over this level was detected when the cut-in speed was increased to 6.5 m/s.

  Therefore, based on best available science, low wind speed curtailment will be implemented at night by raising the cut-in speed of the project’s wind turbines to 5m/s.

  Based on data collected to date, the curtailment will initially occur during months of March to November, which is when bat activity has been relatively higher. Curtailment will be for the duration of the night (from sunset to sunrise). Curtailment will also be extended if fatalities are found outside the initial proposed curtailment period with concurrence from USFWS and DLNR. Curtailment may also be reduced or shifted with the concurrence of DOFAW and USFWS if site-specific data demonstrate a lack of bat activity during certain periods, or if experimental trials are conducted that demonstrate that curtailment is not reducing collision risk at the project during the entire curtailment period.
- A speed limit of 15 mph will be observed while driving on site, to minimize collision with species listed in the HCP, in the event they are found to be utilizing habitat on site or injured.
- Vegetation clearing will be suspended within 300 feet of any area where distraction displays, vocalizations, or other indications of nesting by adult Hawaiian short-eared owls are seen or heard, and resumed when it is apparent that the young have fledged or other confirmation that nesting is no longer occurring.
- Measures will also be implemented to avoid impacts to native mollusks at the off-site

antennae locations. The antennae will be mounted on existing towers. A limited amount of tree trimming may be required during installation and ongoing maintenance, to provide adequate line-of-sight between the antennas. A helicopter will be used to transport the antennae to the repeater station to minimize the need for vegetation trimming along the access trail. In addition, all vegetation trimming activities will be directly coordinated with USFWS and DOFAW staff to minimize the potential for impacts to native vegetation. Because native vegetation at the site could potentially support native mollusk species (including at least one federally and state-listed species), additional mollusk surveys will be conducted before any vegetation trimming at either site, also in coordination with USFWS and DOFAW staff. If *Achatinella* spp. are detected during the surveys, no vegetation will be trimmed. If no *Achatinella* are detected, then vegetation will be trimmed by hand. A post-construction report will be submitted to USFWS and DOFAW within a month of the installation of the antennae at the off-site communications towers.

- To minimize the potential for introduction of non-native invasive ant species at either of the Hawaiian Telcom sites, baseline surveys of ant fauna will be conducted before and following installation of the antennas, in coordination with DOFAW staff. In addition, all materials and vehicles will be inspected for the presence of ants before transport to the site. With implementation of these measures, impacts to native invertebrate species would be insignificant.

- All ungulate fences built to implement mitigation measures for the Covered Species will have a barbless top-strand of wire to prevent entanglements of the Hawaiian hoary bat on barbed wire.

2.1.2.2 Proposed Mitigation and Management Measures

Mitigation measures proposed by Kawailoa Wind Power to compensate for the expected impacts of the project on the Covered Species were selected in collaboration with biologists from USFWS, DLNR-DOFAW, First Wind, and SWCA, and with members of the ESRC. The mitigation proposed to compensate for impacts to the Covered Species is based on anticipated levels of incidental take as determined through onsite surveys, modeling, and the results of post-construction monitoring conducted at other wind projects in Hawaiʻi and elsewhere in the U.S. All required state and federal permits will be obtained before the implementation of any mitigation measure.

Several levels of take for each Covered Species are used to identify possible levels of take that may occur over the life of the project. Take for each Covered Species will be classified as "Baseline" or Tier 1 and "Higher" or Tier 2. For bats, an additional higher tier, Tier 3, was added to account for the uncertainty surrounding the susceptibility of non-migrating Hawaiian hoary bats colliding with turbines. Table 2-4 lists the mitigation measures proposed for Kawailoa Wind Power, based on the level at which take is determined to be occurring.

Table 2-4. Summary of Mitigation Measures Proposed for Kawailoa Wind Power

Species	Take Level	
	Tier 1	Tier 2 and Above
Seabirds	Development and testing of self-resetting cat trap, efficacy testing and implementation at a Newell's shearwater colony on Kauaʻi.	Development of translocation protocols and implementation for the Newell's shearwater or contribute to a restoration fund for predator control, social attraction and translocation of Newell's shearwaters to Kahoʻolawe.

Table 2-4. Summary of Mitigation Measures Proposed for Kawailoa Wind Power

Species	Take Level	
	Tier 1	Tier 2 and Above
Waterbirds	Predator control, fencing, and vegetation maintenance at ʻUkoʻa Pond or other site for five years. Subsequent mitigation efforts to meet Tier 1 requested take as required.	Additional mitigation efforts at ʻUkoʻa Pond or at additional wetlands.
Hawaiian short-eared owl	Upfront contribution of $12,500 for research and rehabilitation and up to a maximum of $25,000 to implement management strategies if/as they become available.	Additional funding of $6,250 for research and rehabilitation and up to a maximum of $12,500 to implement management strategies.
Hawaiian hoary bat	Restoration of wetland or forest habitat to increase foraging capacity and provide additional roost trees. Research to evaluate the efficacy of wetland or forest mitigation.	Tier 2 and Tier 3: Additional restoration of wetland or forest habitat to increase foraging capacity and provide additional roost trees.

Mitigation will be adjusted to account for rates of take found to differ from Tier 1 so mitigation for the Tier 2 take level (or Tier 3 for bats). According to USFWS policy (see 65 Fed. Reg. 35242 [June 1, 2000]), adaptive management is defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an on-going feedback loop for continuous improvement. In the case of Kawailoa, some uncertainty exists in the Proposed Action, from estimated rates of take to the success of the proposed mitigation measures.

The proposed tiered approach to mitigation was designed with adaptive management in mind because of the uncertainty and assumptions associated with models used to estimate impacts to Covered Species, and the ability of take monitoring to detect the rare collision events involving the Covered Species. The HCP acknowledges that actual rates of take may not match those projected through the seabird modeling and results of mortality monitoring performed to date at the Kawailoa facility. Therefore, the HCP proposes to increase mitigation efforts, if monitoring demonstrates that incidental take is, or may be, occurring above Tier 1, but within the Tier 2 levels identified in the Kawailoa Wind Power HCP. Any changes in the mitigation measures would be made only with the concurrence of USFWS and DLNR. Similarly, an adaptive approach is also proposed for the specific type of mitigation to be implemented for each of the Covered Species.

The overall expenditure at the Tier 1 (excluding contingency funds) is not expected to exceed a total of $5.226 million[7], but the budgeted amounts are estimates and are not necessarily fixed. Kawailoa Wind Power will provide the required conservation measures in full, even if the actual costs are greater than anticipated.

Kawailoa Wind Power also recognizes the cost of implementing habitat conservation measures in any one year may exceed that year's total budget allocation, even if the overall expenditure for the conservation program stays within the total amount budgeted over the life of the project.

[7]As of July 11, 2011

Accomplishing these measures may, therefore, require funds from future years to be expended or likewise unspent funds from previous years to be carried forward for later use.

For practical and commercial reasons, such reallocation of funds among years may require up to 18 months lead time in order to meet revenue and budgeting forecast requirements. Similarly, contingency funds earmarked for habitat conservation could be directed toward implementing adaptive management strategies. However, if reallocation between species or budget years and the contingency funds are not sufficient to provide the necessary conservation, Kawailoa Wind Power will nonetheless be responsible for ensuring that the necessary conservation is provided.

Seabird Mitigation Measures

For Tier 1, mitigation measures will support the development of improved traps for predators and in subsequent utilization at a Newell's shearwater colony on Kaua'i or Maui. Kaua'i is where the largest portion of the species' population is found, and where action is most likely to result in benefits to the species. DOFAW and USFWS have been working since 2002 to identify breeding colonies of Newell's shearwaters and Hawaiian petrels on Kaua'i.

Development of a Self-Resetting Cat Trap and its Implementation at a Newell's Shearwater Colony

The development of a more efficient cat trap is consistent with the one of the recovery milestones identified by in the *Recovery Plan for the Hawaiian Petrel and Newell's Shearwater* (USFWS 1983 and the 5-Year Work Plan for Newell's Shearwater (NESH Working Group 2005). The recovery plan states that one of the primary management objectives for the two species are: *"Developing efficient predator control methods and techniques for use in and around isolated nesting sites."* The Newell's Shearwater (NESH) Working Group developed a 5-Year Work Plan for Newell's Shearwater (NESH Working Group 2005) which outlines specific recovery objectives for the Newell's Shearwater that can be met within five years. The first recovery objective is also to "Minimize adult/breeder mortality and maximize fledgling production by developing and implementing effective predator control methods in colonies."

Goodnature Limited (http://www.goodnature.co.nz/), a New Zealand based company, is currently seeking funding to develop a self-resetting cat trap. The funding is anticipated to result in a trap that specifically targets cats while excluding sensitive species. The trap will dispatch the cats humanely and then will self-reset multiple times so that the traps are active again without human intervention. The prototype will be commercially available 12 months after the funding is received. These traps will be tested in a location where cats are common in Hawai'i, to demonstrate the effectiveness and efficiency of the trap. Concurrently, a Newell's seabird colony will be identified and a pilot study will be designed where these traps are deployed to provide localized control of cats over an area where birds are known to be breeding. The study will be designed by Goodnature Limited and Kawailoa Wind Power will be responsible for the implementation of the study by the first Newell's shearwater breeding season after the trap is commercially available. The cat trap will be deployed for one breeding season and based on modeling of a reduction from medium to mild predation (HT Harvey and Associates 2011), the cat trap deployment is expected to result in a 10% increased breeding probability, 7.5% increased breeding success and 1.5 - 2.5% increase in survival of adults and sub-adults that are protected within the trapped area from cats. Modeling shows that within one year, for 20 active burrows protected, the reduction of cat predation could potentially result in the additional survival of 0.5 adults, 4.1 juveniles and 2 fledglings. For 30 burrows, the accrual after one season is expected to be 0.8 adults, 6.1 juveniles and 2.9 fledglings (HT Harvey and Associates 2011). The seabird colony may be on Maui, Kaua'i or other islands. Seabirds colonies currently under consideration include, but are not limited to, Wainiha Valley, Limahuli Valley and Hono O Nā Pali on Kaua'i, or Makamaka'ole and a potential seabird colony at Upper Kahakuloa Valley on Maui.

Mitigation will be deemed successful if the self-resetting cat trap is successfully developed and is demonstrated to successfully function in the field at a Newell's shearwater colony for one breeding season, is efficient and effective in dispatching cats, with no adverse impact to the seabirds. With the low requested take at Tier 1, the proposed mitigation measures of the development of a self-resetting cat trap and its implementation at a seabird colony as part of a pilot study, are expected to produce a net benefit in the form of an increase in the species' population by increasing productivity and survival rates of the Covered Species. The pilot study will result in immediate increase in adult and sub-adult survival as well as increased reproductive output, above the unmanaged state. While the area managed is anticipated to be small, trap development is expected to more than compensate for the requested take at Tier 1. A more effective cat trap for Newell's shearwater predator management will help to meet a milestone identified as necessary for the recovery of the species, and the eventual implementation at additional colonies will increase survival and reproduction. The new trap is anticipated to have far reaching benefits beyond the mitigation measures implemented by the Applicant. The development of the trap will enable managers to conduct predator control at sites that are currently not suitable for trapping because of their remoteness and the intensive labor required to maintain a trapping grid. It is anticipated that the cat trap will be less labor intensive to operate and more effective than the cat traps currently available (current cat traps, once sprung, are inactive and need to be manually reset by a person) and will be utilized extensively by most parties involved in the management of Newell's shearwater colonies once developed. This is expected to yield improvements in protection, reproductive success and survival over current management methods, for many currently unmanaged colonies, with benefits extending years into the future.

Tier 2 mitigation will consist of providing funds for the development and implementation of Newell's shearwater translocation protocols or contributing to a restoration fund for predator control, social attraction and translocation of Newell's shearwaters.

Alternative 1 (Preferred Alternative) Development of a Translocation Protocol for Newell's Shearwater and Implementation at a Managed Site

Kawailoa Wind Power will provide the two years of funding ($100,000 per year) for the development and implementation of translocation protocols for the Newell's shearwater. In Year 1, the translocation protocols will be developed. The protocols developed may involve the translocation of eggs or chicks from other Newell's shearwater colonies and collecting data on emergence, ageing and feeding for a successful translocation (David Priddel pers comm., Principal research Scientist, Office of Environment and Heritage, New Zealand). In Year 2, translocation following the protocols will be implemented at a managed site. Currently the preferred site for the initial implementation of the translocation protocol is Kilauea Point National Wildlife Refuge. Current management programs at the refuge include protecting six species of breeding seabirds and their habitats. The Refuge cooperates with the State of Hawaiʽi in increasing and monitoring the nēnē (*Branta sandvicensis,* Hawaiian goose) population and a newly discovered Newell's shearwater population. Predator control is conducted at the Refuge and there are plans to erect a predator fenceline around the perimeter of the Refuge to protect breeding seabirds and nēnē. During 1978 to 1980, a total of 65 Newell's shearwater eggs were translocated from a number of source colonies to Kīlauea point on Kauaʽi, where they were placed inside wedge-tailed shearwater burrows (Byrd 1984). On average 83% of these eggs produced a fledgling (Byrd 1984). Unfortunately, there are no data to confirm if these fledged birds returned to nest at Kīlauea Point, but information collected by Refuge biologists suggest that it is highly likely that the few birds currently nesting at Kilauea Point are progeny of those that were part of the translocation project (Brenda Zaun, USFWS, pers. comm.). The presence of a suitable host species (wedge-tailed shearwater) and protected habitat seaward of additional anthropogenic threats, such as power lines and lights, makes translocation to protected coastal sites or offshore islets a good conservation measure for Newell's shearwaters. Source population for translocation could be small colonies that are not considered likely to persist. On Kauaʽi this includes Wailua, and Makaleha (DOFAW unpubished data).

Alternative 2 Contributing to a Restoration Fund for Predator Control and Translocation or Social Attraction of Newell's Shearwater

If at the time when Tier 2 rates of take are determined, the translocation protocols have already been developed, Kawailoa will contribute to a restoration fund for predator control, social attraction and translocation of Newell's shearwaters. Kahoʽolawe has been identified as a potential site where Kawailoa Wind Power would contribute $200,000 to the restoration fund. Kahoʽolawe and its surrounding waters were under control of the U.S. Navy from 1941 to 1994. Over 50 years of use as a live-fire training area have significantly impacted the landscape, although there were efforts to remove unexploded ordinance. Kahoʽolawe and its surrounding waters were conveyed back to the State of Hawaiʽi in 1994, and since then, Kahoʽolawe and the waters within two nautical miles of its shores have been designated as a reserve, and the State of Hawaiʽi has established the Kahoʽolawe Island Reserve Commission (KIRC). The commission is committed to environmental and cultural restoration of Kaho'olawe, and with funding and partnership with various groups. With respect to the restoration of seabird colonies, KIRC identifies two main efforts in its 2010 report: the eradication of invasive mammals and the removal of marine debris. Feral cats are rampant on Kaho'olawe, and have ravaged the island's seabird population. In partnership with the U.S. Fish and Wildlife Service (USFWS) and Island Conservation, the development of an operational and management plan is underway, and a feasibility study to remove invasive mammals has been completed. The contributions by Kawailoa Wind Power to predator control at the site and the eventual translocation of Newell's shearwater to a managed area within Kaho'olawe are expected to aid in establishing a new Newell's shearwater seabird colony within Maui Nui.

Waterbird Mitigation Measures

Mitigation for the Tier 1 level of take of the four waterbirds at 'Uko'a Pond will consist of a five year plan that will contribute to fencing and managing a smaller unit of wetland (40 acre) within 'Uko'a Pond. This 40-acre unit is currently overgrown by invasive species particularly water hyacinth (*Eichhornia crassipes*) and bulrush (*Schoenoplectus* varieties) but is still connected to a small body of open water (Kamehameha Schools 2005).There is a source of flowing water nearby due to a previously capped well and the area is close to an access point where equipment and materials to manage the site can be staged. The removal of the invasive vegetation will increase the amount of open water available and should be attractive to waterbirds. The overall goals of the restoration and management of the 40 acre unit would be to attract waterbirds to the managed site and provide immediate protection from predators through fencing and predator control to encourage breeding and increase productivity. Partnerships between Kawailoa Wind Power, Kamehameha Schools and a third party contractor will be developed for the management of the site. The details of the management plan are still being discussed with the third party contractor. The third party contractor will submit a work plan that will be approved by DOFAW and USFWS before the commencement of the work. Components of the plan that Kawailoa Wind Power proposes to fund include:

- A one-time contribution of $77,000 towards the construction of a fence around the 40 acre unit (Year 1);
- Up to $30,000 for costs associated with permitting for fence construction (Year 1);
- Up to $30,000 for four years of fence maintenance (Year 2 to 5);
- Up to $100,000 for four years of predator trapping by a qualified contractor or personnel approved by USFWS and DLNR (Year 2 to 5);
- Up to $80,000 for five years for monitoring of the management effort (Year 1 to 5);
- Up to $80,000 for four years of weed control (Year 2 to 5) and
- Up to $24,000 for the biological oversight of third-party contractor work

The total funding allocated to the management efforts amounts to $421,000. Following permit issuance for predator control, vegetation maintenance, and monitoring of waterbird populations and reproductive activity, the following will be conducted:

a. Completion of a perimeter fence to keep out ungulates, dogs and pigs by Year 1;
b. Predator trapping and baiting will begin during the first breeding season after fence construction and vegetation removal and will be funded for four years. The trapping design will be approved by USFWS and DOFAW. Predator trapping will be conducted year round using traps, leg holds, and/or snares. Traps would be placed along the perimeter of the fences. Leg holds and snares would be placed deeper within the fenced area, depending on visual observations of predators. Traps will be checked every 48 hrs and snares and leg holds every 24 hrs in accordance with USFWS guidelines. Bait stations will be deployed year-round following protocols set forth by the Department of Agriculture;
c. Vegetation maintenance (Year 2 to Year 5) will be conducted to further remove and prevent invasive species from encroaching on waterbird nesting habitat and to enhance available nesting habitat where possible; and,
d. Monitoring of reproductive activity and waterbird populations will establish a baseline and quantify the effectiveness of the predator and vegetation control methods (Year 1 to Year 5).Monitoring of reproductive activity and bird resightings will be conducted weekly from May through September for stilt and year round for the other Covered Species of waterbirds as

nests as discovered. Total bird counts including specification of life stages, and the tracking of productivity of individual nests or broods to fledging will be conducted the maximum extent practicable. Banding of chicks or juvenile birds annually may be used to facilitate this, and will be incorporated if qualified personnel with the appropriate banding and endangered species permits are available.

The predator control, vegetation maintenance and monitoring will be performed by a qualified contractor or personnel approved by DLNR and USFWS. After five years of management, the number of fledglings or adults accrued for the Covered waterbird species will be reviewed, and if they are at least one more than required to compensate for the Tier 1 requested take, the required mitigation will be considered fulfilled. Productivity and survival rates will be calculated annually, based on the results from the weekly monitoring and resighting data. This standard applies to the Hawaiian coot, Hawaiian stilt and Hawaiian moorhen. Currently, as few pure Hawaiian ducks are believed to exist on Oʻahu due to hybridization, mitigation for Hawaiian ducks may also consist of removal of feral ducks, mallards and Hawaiian duck hybrids at ʻUkoʻa Pond. Removals will be coordinated with DOFAW and USFWS.

Currently only Hawaiian stilts and Hawaiian moorhen are occasionally observed at ʻUkoʻa Pond, and none of the four waterbird species have in recent years been observed nesting at the site. Therefore baseline population and productivity is zero. In the absence of a baseline population it is difficult to predict the number of birds that will become established at ʻUkoʻa Pond within the project life, but birds are expected to respond rapidly to the newly available nesting and foraging habitat. Hāmākua Marsh, located on the windward side of Oʻahu, and similar to ʻUkoʻa Pond, characterized as seasonal floodplain and influenced by high tidal events, is used as a basis for the estimate of expected bird densities and fledgling production at ʻUkoʻa Pond. Between 2005 and 2009 the 22 acre Hāmākua Marsh produced an average of 2.2 coot fledglings, 36.6 moorhen fledglings, and 11 stilt fledglings annually (SWCA 2010d). Considering the fact that the total habitat area at ʻUkoʻa Pond will be approximately double that of Hāmākua Marsh, it is expected that the total number of fledglings produced over the project life will meet the mitigation requirements of Tier 1. Annual fledgling production rates at ʻUkoʻa Pond after habitat restoration and implementation of predator control measures is expected to be double that at Hāmākua Marsh and be approximately 4.4 coot, 65 moorhen, and 22 stilt fledglings, assuming the species composition at both sites are similar. Over four years the total accrual is expected to result in 17 coot, 260 moorhen and 88 stilt fledglings. The number of fledglings accrued, particularly for Hawaiian moorhen and Hawaiian stilt, are expected to far exceed the required number of fledglings required for Tier 1. Hāmākua Marsh has an unusually large number of moorhen at the site that are thought to displace the Hawaiian coot from nesting (Misaki pers comm., DOFAW 2010), therefore, if the species composition at ʻUkoʻa Pond is more balanced, the Hawaiian coot fledglings accrued are expected to compensate for the Tier 1 requested take as well. Consequently, as the fledglings accrued for each species may be uneven due to differences in pair abundance or reproductive success, more effort may be concentrated on enhancing the productivity of one species more than another in order to achieve the required number of fledglings to meet the Tier 1 requested level of take. In addition, mitigation will be continued till the required mitigation is achieved for the Hawaiian stilt, Hawaiian coot and Hawaiian moorhen.

If Tier 1 requirements have not been met through the management of 40 acres at ʻUkoʻa Pond, additional funding (estimated up to $250,000 for five years, i.e., equivalent to Year 1 to 5 funding less the fence construction, permitting and biological oversight costs) will be provided by the Applicant for additional mitigation measures to offset Tier 1 requested take for the Hawaiian coot, Hawaiian stilt and Hawaiian moorhen. This may also result in an extension of management past the 20-year term of the ITP/ITL. As the fledglings accrued for each species may be uneven due to differences in pair abundance or reproductive success, more effort may be concentrated on enhancing the productivity of a specific Covered waterbird species in order to meet the Tier 1 requested take, provided the measures do not negatively affect the productivity of other Covered Species at the mitigation site. The design and scope of each year's effort will be determined with USFWS and DLNR in coordination with Kawailoa Wind Power and Kamehameha Schools. Coordination is necessary to ensure that the proposed management actions funded by Kawailoa Wind Power satisfy the mitigation criteria required of Kawailoa Wind Power by both DLNR and USFWS.

If monitoring indicates that factors other than predator control are a higher priority for the recovery of the endangered waterbird species covered in the HCP, Kawailoa Wind Power in concurrence with

USFWS and DLNR will direct the specified funds toward whatever management action is deemed most appropriate at the time. Should another waterbird nesting site be identified as a more suitable location for mitigation measures, management actions may be conducted in an alternate site as appropriate. Other important management techniques for wetland habitat improvement in Hawai‘i could include water level control, disease prevention and monitoring of environmental contaminants (USFWS 2005a).

It is possible that bat mitigation (as described below) may also include wetland restoration at ‘Uko‘a Pond. If this occurs, the area proposed for wetland restoration will increase by another 40 acres and is likely exceed that required for Tier 1 mitigation for waterbirds. If the wetland restoration area is increased to accommodate bat mitigation, it is anticipated that the additional restored areas would also attract waterbirds. Therefore, the management measures outlined above (fencing, trapping, vegetation maintenance and monitoring) would correspondingly be increased to ensure that the entire restored area is also managed for waterbirds. Monitoring of waterbird productivity would document any mitigation accrued above the Tier 1 level.

If Tier 2 take occurs for any of the waterbird species, the number of fledglings or adults accrued for that Covered Species will be examined to determine if the fledglings or adults accrued are enough to cover the number required to be commensurate with the requested take at Tier 2 levels and achieve a net conservation benefit for the species. If this is determined to be so, then no additional mitigation will be provided. If it is determined that this is not the case, mitigation actions will first be increased at ‘Uko‘a Pond. Activities will include intensifying the trapping effort or implementing additional vegetation management. If increased efforts at ‘Uko‘a Pond are not sufficient to increase adult survival or produce enough fledglings required to be commensurate with the requested take at the Tier 2 level, and achieve a net conservation benefit for the species at the measured take levels, Kawailoa Wind Power will provide funding for a similar set of waterbird management measures at one or more additional sites. Selection of additional sites and identification of appropriate levels of effort will be determined in consultation with DLNR and USFWS.

Predator trapping poses some risk of harassment due to capture, and could result in injury or mortality to the Covered waterbird species. Moorhen are attracted to traps (DesRochers et al. 2006) and moorhen on O‘ahu have been documented entering live traps (DesRochers et al. 2006; Nadig/USFWS, pers. comm.). USFWS recommends additional take of not more than ten Hawaiian moorhen annually in the form of harassment due to capture. The trapping at ‘Uko‘a Pond is anticipated to last five years and a total of take of 50 individuals in the form of harassment is also requested. No risk of injury or mortality is anticipated from this harassment and the conservation strategy to implement wetland management including a predator control program will result in an overall increase in the baseline number of individuals of the endangered Hawaiian moorhen. Therefore, the implementation of live trapping will have beneficial effects through the control of nonnative predators and increased productivity of Hawaiian moorhen. As a beneficial effect no further mitigation would be required for the potential capture of Hawaiian moorhen.

However, if the implementation of mitigation measures causes a waterbird capture that does result in mortality or injury, the take will be assessed as part of the Kawailoa Wind Power project.

<u>Hawaiian Short-eared Owl Mitigation Measures</u>

Mitigation for possible take of the Hawaiian short-eared owl by Kawailoa Wind Power will consist of two parts: funding research or rehabilitation of injured owls; and subsequently implementing management actions on O‘ahu as they are identified and as needed to bring mitigation ahead of take and provide a net benefit.

Prior to the start of operations, Kawailoa Wind Power will contribute a total of $12,500 to appropriate programs or facilities for research or rehabilitation of owls at Tier 1 rates of take. Three alternatives for rehabilitation or research are identified below.

Alternative 1 Owl Rehabilitation on O'ahu

The Aloha Animal Hospital regularly receives injured Hawaiian short-eared owls on O'ahu. A need identified by the veterinarian, Dr. Fujitani of Aloha Animal Hospital, to facilitate the rehabilitation of Hawaiian short-eared owls was the construction of a flight cage to house the owls prior to release. Flight cages allow for birds to exercise their flight muscles prior to release (Greene et al. 2004). The selection of this alternative is contingent upon finding a suitable site to construct the flight cage, as Aloha Animal Hospital currently does not have the space required. The facility that houses the flight cage will need to have qualified rehabilitators to provide the required husbandry and ensure that the owls continue to receive regular veterinary care.

Alternative 2 Owl Rehabilitation on the Island of Hawai'i

The Hawai'i Wildlife Center, located on the Island of Hawai'i, is a facility that will be dedicated to the rescue and recovery of native wildlife in the State of Hawai'i (http://www.hawaiiwildlifecenter.org/mission-statement.htm). A key component of this facility is a wildlife response and care unit that will provide medical and husbandry care for sick, injured and orphaned native wildlife, including those affected by natural and man-made disasters. Individuals that are successfully treated will be returned back to the wild. This center is currently under construction and is still fundraising to complete the facility. Needs identified by Linda Elliot (founder, president and center director) for the rehabilitation of raptors were funding to complete the outdoor aviaries in the recovery yard (each outdoor aviary is estimated to cost $2,500 to build) and funding for facilities such as the intake/exam room, laboratory, holding room or food preparation areas. This facility when completed will have the capacity to rehabilitate native raptors from the entire Hawaiian Archipelago. The Hawaiian short-eared owl is one of two native raptors in the state, the other being the Hawaiian hawk, or 'io (*Buteo solitarius*).

Alternative 3 – Funding for Basic Research

If funding is allocated to research, funding may be used for (but not limited to) the purchase of radio transmitters, receivers, or provide support for personnel to conduct research such as a population census. Research may be conducted on the Island of O'ahu, or other islands based on feasibility.

When practicable management actions that will aid in the recovery of Hawaiian short-eared owl populations are identified on O'ahu, Kawailoa Wind Power will provide additional funding of $12,500 up to a maximum of $25,000 to implement a chosen management measure as agreed upon by USFWS and DLNR. The level of funding provided for management will be decided with the concurrence of DLNR and USFWS and will be deemed appropriate to compensate for the Tier 1 requested take (adjusted for take already mitigated for in the rehabilitation program) and also provide a net benefit to the species.

If monitoring indicates a Tier 2 take, Kawailoa Wind Power will provide additional funding of $6,250 for increased owl research and rehabilitation. Examples of possible research include studies of where Hawaiian short-eared owls are likely to breed, quantification of productivity, or developing and testing the effectiveness of management techniques. Additional support for owl rehabilitation on O'ahu or other islands may be provided if identified. However, should research indicate that other areas of study are more important or pressing in aiding the recovery of the species, in concurrence with USFWS and DLNR, these funds will be used for whatever management or research activity is deemed most appropriate at the time.

This funding will be followed by an additional $6,500 up to a maximum of $12,500 for implementing chosen management actions as they become available, with the concurrence of USFWS and DLNR. The level of funding provided for management will be decided upon with concurrence of DLNR and USFWS and will be deemed appropriate to compensate for the requested take at a Tier 2 level and also provide a net benefit to the species.

Bat Mitigation Measures

Mitigation for the Hawaiian hoary bat at Tier 1 levels was developed through discussions with USFWS, DLNR, and bat experts, and involved identifying the most immediate needs required for the recovery of the species. Based on the feedback received, the Applicant proposes a combination of measures consisting of:

1. On-site surveys to add to the knowledge base of the species' status on O'ahu;
2. On-site research into bat interactions with the wind facility;
3. Implementation of bat habitat improvement measures (either wetland or forest restoration) to benefit bats as determined in consultation with DLNR, USFWS and ESRC;
4. Monitoring to verify increased use of restored and managed habitats; and,
5. Research to verify increased health, survivorship and/or productivity of local bats as a result of using the restored and managed habitats.

Research on Bat Habitat Utilization and Bat Interactions at Kawailoa Wind Power

A critical component identified as essential to Hawaiian hoary bat recovery is the need to develop a standardized survey protocol for the Hawaiian hoary bat monitoring program to enable results collected by different parties to be directly comparable. The Applicant will join the Hawaii Bat Research Cooperative (HBRC) and as a contribution to the on-going research efforts in the state, will conduct its own surveys and monitoring at Kawailoa Wind Power and the vicinity. Survey protocols will be developed prior to start of project operations, in consultation with HBRC, with approval by USFWS and DLNR. Up to 12 anabat detectors will be deployed at Kawailoa Wind Power and the vicinity.

The Applicant will continue to survey for and monitor Hawaiian hoary bats within and in the vicinity of the Kawailoa Wind Power site. The goal of this research will be to document bat occurrence, habitat use and habitat preferences on site, as well as identify any seasonal and temporal changes in Hawaiian hoary bat abundance. These on-site surveys are also expected to advance avoidance and minimization strategies that wind facilities in Hawai'i and elsewhere can employ in the future to reduce bat fatalities. Surveys will be conducted during years when systematic fatality monitoring is conducted, (i.e., during the first three years and at five year intervals thereafter, or as otherwise determined under the Adaptive Management provisions), to:

1. Correlate observed activity levels with any take that is observed. Thermal imaging or night vision technology may be used to assist acoustic monitoring as trends are detected. The use of additional techniques and technologies will also be considered;
2. Determine seasonal and nightly peak bat activity periods on-site; and,
3. Determine if bats are being attracted to the wind facility by comparing post-construction data with pre-construction activity levels.

Incidental bat observations will also be recorded under the wildlife education and observation program (WEOP).

Wetland Restoration Alternative

Kawailoa Wind Power's preferred mitigation is to provide wetland restoration at 'Uko'a Pond. USFWS and DOFAW have recently required that upland forest restoration be provided as compensation for bat take by at the rate of 40 acres per pair of bats (one male and one female). The Tier 1 requested take of 16 adult bats and 8 juveniles equates to approximately 19 adults (with an estimated 30% survival rate of juveniles to adulthood) or roughly 10 pairs of bats (10 males and 10 females).

Based on existing data from other sites and in the vicinity of 'Uko'a Pond (the proposed wetland restoration site), it is expected that the foraging activity rates at a restored wetland will increase by seven to 10-fold above that occurring at forests in the area (Brooks and Ford 2005; Grindal et al. 1999). Hence, it is proposed that wetland restoration which will create high quality foraging habitat, will be five times more beneficial to foraging bats than forest restoration and that as a rough metric, one acre of wetland is equivalent to five acres of forest.

This wetland restoration proposal has received considerable support from Dr. Michael J. O'Farrell (O'Farrell Biological Consulting LLC), the bat expert Kawailoa Wind Power has consulted with and who estimates that this project will have a high probability of success based on his long-term observations in the field of *Lasiurus* species on the mainland and work on numerous published and technical reports (O'Farrell 2006a, 2006b, 2007, 2009; O'Farrell et al. 2000, 2004; Bradley et al. 2005; Williams et al. 2006; Gannon et al. 2004).

Therefore, for wetland restoration, one acre of wetland is assumed to have the foraging potential of five acres of forest, thus the wetland area for restoration is calculated to be 80 acres (40 acres x 10 pairs / 5 acres). In addition to the restoration of 80 acre of ‘Uko‘aPond, 40 acres of adjacent forest will be restored to provide day and night roosts as part of Tier 1 mitigation.

‘Uko‘awetland is surrounded by a thick canopy layer averaging 20-30 feet in height. The canopy is dominated by Chinese banyan (*Ficus microcarpa*), date palm (*Phoenix dactylifera*), kiawe (*Prosopis pallida*), Manila tamarind (*Pithecellobium dulce*), paperbark, Christmas berry, and Java plum (*Syzygium cumini*).The interior of the wetland is dominated by California bulrush (*Schoenoplectus californicus*), California grass (*Urochloa mutica*), neke fern (*Cyclosorus interruptus*), saltmarsh bulrush (*Bolboschoenus maritimus paludosus*), ‘ahu ‘awa haole (*Cyperus involucratus*), and juncus (*Juncus polyanthemos*). Throughout the interior, there are also pockets of small shrubs and trees, dominated by paperbark and sourbush. The ground layer is dominated by aeae (*Bacopa monnieri*) and giant duckweed (*Spirodela polyrhiza*). Along the Kawailoa Road boundary of the wetland, the composition is almost completely water hyacinth. A small body of open water exists in the middle of the pond.

The wetland restoration to improve bat foraging habitat will consist of five components:

1) Removal of invasive vegetation to re-create bodies of open water;
2) Control and removal of alien vegetation in the wetland interior to allow for the natural recruitment of native species that are already present. Suitable areas will replanted with native vegetation if necessary;
3) Managing 40 acres of trees around the periphery of the pond by the selective removal of alien trees and replanting to provide night roosts and potentially day roosts. Alien trees that have been frequently documented as suitable roost trees will be retained in consultation with bat experts in Hawai‘i. Tree replanting will consist of native or non-invasive species that will grow well in the soil type and moisture regime of the area, and are also species that are documented as suitable roost trees for the Hawaiian hoary bat;
4) Fencing of the restored wetland and forested area; and,
5) Removal of the ungulates within the restored and forested area.

The removal of invasive vegetation and allowing the establishment of native emergent vegetation around the periphery of open water is expected to create edge habitat rich in foraging potential. The restoration of edge habitat should provide a sufficient foraging base to increase the carrying capacity of the local area (O'Farrell 2011, pers. comm.). The availability of nearby roost trees should also enhance the quality of the habitat, by providing roost trees in close proximity to a high quality foraging habitat. Hence, the restoration of ‘Uko‘a Pond is considered to have a high potential to increase the quality of foraging habitat for the local bat population in the area. By increasing forage biomass and providing additional roost opportunities use of the area by Hawaiian hoary bats is expected to increase and also improve reproductive success through improved foraging opportunities. This hypothesis will be evaluated through a research project outlined below.

Research Accompanying Wetland Restoration

In addition to the implementation of habitat restoration measures, research will be conducted to investigate whether increasing and improving foraging habitat for the Hawaiian hoary bat in wetland areas results in increased reproductive successor increased survival of adults or juveniles. The study will be designed by Kawailoa Wind Power, together with bat experts, and will be approved by DLNR and USFWS before implementation. The study will be conducted by a primary investigator and a minimum of two technicians.

Bat detectors will also be placed within the portion of the pond identified for restoration one year prior to restoration to document baseline levels of bat activity rates. Concurrently, mist-netting and visual surveys will be conducted to census and capture bats to determine the age, sex and breeding status of bats utilizing the unrestored area.

Bat activity, mist-netting and visual surveys will continue for three years post-restoration, and at subsequent five-year intervals. Research will quantify the success of the mitigation and components of the research could consist of documenting increasing bat activity from pre- to post-restoration, to support that wetland restoration improves foraging habitat for bats and results in greater survival and increased productivity. Documenting increased numbers of bats caught in mist-nets or seen during visual surveys will demonstrate that the restoration at ‘Uko‘a Pond has increased the number of individuals utilizing ‘Uko‘a Pond. If the pregnant bats or juveniles caught increase over time, this will also demonstrate that increased reproductive success is occurring at the restored wetland, as compared to baseline (pre-restoration) levels.

If after 5 years of wetland restoration, the monitoring data and results from the research show that the mitigation measures are insufficient to mitigate for take occurring at Tier 1, additional mitigation measures will be implemented to compensate for the deficit. Mitigation measures will consist of additional forest or wetland restoration. However, if other methods for improving bat habitat are available at that point in time, these alternative management strategies will also be considered. The most appropriate mitigation measure to be implemented will be determined in consultation with DLNR, USFWS and bat experts using the best available science and expertise. Mitigation measures may be extended beyond the term of the ITL/ITP if necessary to compensate for the requested take.

Reforestation Alternative

Alternatively, Kawailoa Wind Power is also proposing to restore forest habitat to increase habitat available to bats. 400 acres of native forest will restored, and restoration measures may include fencing, ungulate control, removal of invasive species, and replanting of native species.

Possible locations for native forest restoration and management on O‘ahu include forests currently managed by Kamehameha Schools or at Waimea valley, managed by Hi‘ipaka LLC, a Native Hawaiian non-profit organization. On Maui, possible locations include native habitat plant restoration and management at Kahikinui Forest Reserve, managed by DOFAW or on private land owned by ‘Ulupalakua Ranch on Maui. Other areas for forest restoration on O‘ahu, Maui or other islands will be considered as necessary and the final location for forest restoration and management will be will be determined in consultation with DLNR, USFWS and bat experts. Mitigation can be conducted on Maui only if the bats on Maui and O‘ahu are determined to be genetically similar and not distinct sub-populations.

It is anticipated that the measures outlined above or any others that are developed in the future will be conducted in partnership with other conservation groups or entities and that these activities will complement other restoration, reforestation or conservations goals occurring in that area at the time. Other sites may be chosen if they are determined to be more appropriate for the implementation of the mitigation measures, or if the originally identified mitigation measure does not come to fruition within three years from the start of project operations, with approval from USFWS and DOFAW. Funds will be directed toward whatever management or research activity is deemed most appropriate at the time with the concurrence of USFWS and DOFAW.

Research and Monitoring Accompanying Forest Restoration

In addition to the implementation of restoration measures, research will be conducted to investigate whether increasing and improving roosting and foraging habitat for the Hawaiian hoary bat in forested areas results in an increased productivity or increased survival of adults or juveniles. The study will be designed by Kawailoa Wind Power, together with bat experts, and will be approved by DLNR and USFWS before implementation. The study will be conducted by a primary investigator and a minimum of two technicians.

Bat detectors will also be placed within the area identified for restoration one year prior to restoration to document baseline levels of bat activity rates. Concurrently, mist-netting and visual surveys will be conducted to census and capture bats to determine the age, sex and breeding status of bats utilizing the unrestored area.

Bat activity, mist-netting and visual surveys will continue for three years post-restoration, and at subsequent five-year intervals. Documenting increasing bat activity from pre- to post-restoration, in conjunction with the research component outlined above, will support the idea that forest restoration improves roosting foraging habitat for bats and results in greater survival and increased productivity. Documenting increased numbers of bats caught in mist-nets or seen during visual surveys will demonstrate that the forest restoration has increased the number of individuals utilizing the restored forest. If the pregnant bats or juveniles caught increase over time, this will also demonstrate that increased reproductive success is occurring at the restored forest.

If a Tier 2 or Tier 3 level of take occurs, additional research to investigate the reasons for the increased rate of take will be conducted, and additional measures to reduce the take will be implemented if possible. Additional mitigation measures will also be implemented to mitigate for the increased take.

Additional Research at Kawailoa Wind Power

In the event that take exceeds the threshold for Tier 1, Kawailoa Wind Power will review the fatality records in an effort to determine whether measures in addition to LWSC can be implemented that will reduce or minimize take. If causes cannot be readily identified Kawailoa Wind Power will conduct supplemental investigations that may include but not be limited to:

1. Additional analysis of fatality and operational data;
2. Deployment of acoustic bat detectors to identify areas of higher bat activity during periods when fatalities are occurring;
3. Using thermal imaging or night vision equipment to document bat behavior; and,
4. Determining whether certain turbines are causing most of the fatalities or if fatality rates are related to specific conditions (e.g., wind speed, other weather conditions, season).

Other measures to reduce bat fatalities will be implemented as identified and feasible and may include changes in project operations such as modifying structures and lighting. These data may also be used to refine low-wind speed curtailment criteria, such as revising the times of year when curtailment is implemented, or if curtailment can be confined to a subset of “problem” turbines. These additional measures will be implemented by Kawailoa Wind Power with the concurrence of USFWS and DLNR.

Additional Bat Habitat Management Measures for Tier 2 or Tier 3

Wetland restoration or forest restoration using the acreages described above will be conducted to mitigate for take requested at each higher tier (Tier 2 and Tier 3 level). Since the Tier 2 and Tier 3 requested take are multiples of the Tier 1 requested take (Tier 2 requested take is twice that of Tier 1 and Tier 3 requested take is three times), the mitigation effort for Tier 2 and Tier 3 will consist of implementing additional mitigation measures equivalent to the Tier 1 effort upon entering each higher tier.

Wetland restoration Alternative

If wetland restoration is chosen as the mitigation measure, for each subsequent level, an additional 80 acres of wetland restoration and 40 acres of forest restoration as described in Tier 1 will be added to the on-going mitigation activities. The restoration may be modified depending on the outcome of the research that was conducted in Tier 1. Wetlands that may be restored include completing of the restoration of the 150 acre ‘Uko‘a Pond or conducting the wetland restoration at other locations such as Kawainui Marsh or other wetlands on O‘ahu.

Forest restoration Alternative

If forest restoration is chosen as the mitigation measure, for each subsequent level, an additional 400 acre of forest restoration as described in Tier 1 will be added to the on-going mitigation activities. The actual acreage to be restored may be modified with the approval of DOFAW and USFWS if future research indicates that 400 acres is likely to be either insufficient or excessive.

Possible locations for native forest restoration and management on O'ahu include forests currently managed by Kamehameha Schools or at Waimea Valley, managed by Hi'ipaka LLC, a Native Hawaiian non-profit organization. On Maui, possible locations include native habitat plant restoration and management at Kahikinui Forest Reserve, managed by DOFAW or on private land owned by 'Ulupalakua Ranch on Maui. Other areas for forest restoration on O'ahu, Maui or other islands will be considered as necessary and the final location for forest restoration and management will be will be determined in consultation with DLNR, USFWS and bat experts. Mitigation can be conducted on Maui only if the bats on Maui and O'ahu are determined to be genetically similar and not distinct sub-populations.

Other Alternatives

If at the time of determination of Tier 2 or Tier 3 rates of take, more scientific information is available that indicates that the implementation of measures other than habitat restoration are more important or pressing in aiding the recovery of the Hawaiian hoary bat, Kawailoa Wind Power, in concurrence with USFWS and DLNR, will direct the specified funds toward whatever management action is deemed most appropriate at the time. No changes to Tier 1 mitigation measures are anticipated in the event that Lower Levels of rate of take is determined.

2.2 Alternative 2 – Communications Site Layout Alternative

As described in Section 2.1, the project includes installation of up to eight microwave dish antennae in four different locations to provide a dedicated communication link between the wind farm and the HECO substations in Waialua and Wahiawā. Up to four antennae would be installed on two new communication towers at the Kawailoa wind farm site. The remaining antennae would be installed on existing structures at two different Hawaiian Telcom communication tower sites, both located on the north slope of Mt. Kaʽala.

In the event agreements cannot be made to use the existing structures, a new tower would be installed in an area adjacent to the existing structure at each site. The tower constructed adjacent to the Hawaiian Telcom building would be a 30-foot lattice steel tower supporting up to two antennae, which would be connected via waveguide cable to radio equipment inside the building. At the repeater site, a 20-foot lattice tower with up to two antennae would be constructed. Similar to the tower on the wind farm site, these would both have concrete foundations approximately 144 square feet in area (12 feet by 12 feet). The antennae, approximately 11 feet in diameter, would be mounted horizontally on the towers. This EA evaluates the impacts associated with the alternative of constructing a new tower at either one or both of the Mt. Kaʽala communication sites.

Compared to the Proposed Action (Alternative 1), construction of the proposed project in the Communications Site Layout Alternative (Alternative 2) would require slightly more disturbance area at the Mt. Kaʽala Site (0.006 acres). Wind farm site activities and disturbance would be the same as Alternative 1. Under Alternative 2, Covered Species are expected to be at the same risk of collision with WTGs and the additional met towers. Avoidance, minimization, mitigation, and management measures associated with the ITL/ITP are the same as Alternative 1.

In addition to Alternative 1 avoidance, minimization, mitigation, and management measures, in order to minimize direct impacts of the vegetation clearing on native mollusk species, additional mollusk surveys will be conducted, in coordination with USFWS and DOFAW staff, before any vegetation clearing or trimming at either site. No trimming of vegetation along the trails is anticipated. No vegetation will be cleared if the endangered *Achatinella* species are detected. If *Achatinella* species are detected at the location of the proposed towers, the towers will not be erected. Leaf litter will be collected before the area is graded and distributed to the surrounding area to allow any native snails in the leaf litter to move on to undisturbed ground. If a helicopter is used to deliver construction materials, it will remain 100 ft agl to avoid the impact of rotor wash on any *Achatinella* species that may be present in the vicinity. A post-construction report will be submitted to USFWS and DOFAW within a month of the installation of the off-site communications towers and will include survey methodology, results, and descriptions of minimization and avoidance measures implemented. No direct impacts to avian or mammalian species are expected to occur.

More details on the potential impacts of Alternative 2 compared to Alternative 1 are provided in Chapter 4.

2.3 Alternative 3 – No Action Alternative

Under the No Action Alternative, the DLNR/USFWS would not issue an ITL/ITP, as Kawailoa Wind Power would not construct the wind energy facility due to the risk of the facility causing unauthorized incidental take of listed species. Thus, the No Action Alternative represents a "no build scenario." The no build scenario would not cause take of the Covered Species or any change in the status of the Covered Species, their recovery efforts and existing habitats, or the project area. None of the Covered Species mitigation measures contained in the HCP would be implemented.

The no build scenario does not support the state's desire to develop viable renewable energy sources and reduce dependence on imported oil or support HECO's obligation to meet these milestones. This scenario is also contrary to Kawailoa Wind Power's fundamental purpose and objective as a business entity. Under the no build scenario, the project area may potentially be available for other uses.

2.4 Alternatives Considered But Not Analyzed

2.4.1 Different Turbine Locations on Kamehameha School Property

Wind monitoring has been conducted to assess the strength and distribution of wind resources across Kamehameha Schools' property. In combination with these data, several site constraints have been identified that affect project development. Cumulatively, these conditions were evaluated and used to determine which areas are suitable for project siting, resulting in the delineation of a series of corridors which defined the maximum project envelope. As such, the areas owned by Kamehameha Schools but not within the maximum project envelope were not considered to be feasible locations for project development, and were therefore eliminated from consideration.

As part of this effort, Kawailoa Wind Power specifically evaluated placement of wind turbines along the *mauka* (mountain-ward) portion of ‘Ōpae‘ula Ridge, located immediately south of the current Kawailoa project site, below Anahulu Gulch. Accessible via ‘Ōpae‘ula Road, the land is currently owned by Kamehameha Schools and, like Kawailoa, was also formerly used primarily for agriculture. However, assessment of the existing wind resources on ‘Ōpae‘ula Ridge indicated an inadequate wind regime to support development on a wind farm. Therefore, the ‘Ōpae‘ula lands were excluded from the maximum project envelope and have been eliminated from consideration.

2.4.2 Different Turbine Models and Sizes

Utility-scale wind energy production is now employed by many countries around the world, and the most common wind turbine design, by far, is the upwind, horizontal-axis wind turbine generator with a three-blade rotor. This design is the current industry standard, and is used at all the commercial wind farms operating in Hawai‘i. Proposals to provide equipment were received from several manufacturers, and these were reviewed and evaluated over several months to determine the most effective make and model for the project.

First, prospective turbines were analyzed for their suitability to the onsite wind resources, based on wind data collected over several months. Responses were narrowed to four turbine models that could generate the most energy in the constructible area available at the site. Second, these four models were screened for their electrical compatibility with the HECO grid, as part of their interconnection study. Only two models appeared capable of providing the various control features that would facilitate interconnection with the least negative impact to the transmission system. The third criterion was the consideration of turbine size and impacts. Of the two final turbine models, the General Electric (GE) 1.6 MW and the Siemens 2.3 MW machines, the smaller GE model would have required 43 turbines to be installed to generate the equivalent amount of energy output as 30 of the Siemens turbines. Installing fewer turbines is generally preferable, as it typically results in less site disturbance and fewer impacts in terms of visual, biological, and soil resources. Consequently, the Siemens 2.3 MW turbine was selected as the best suited for the Kawailoa Wind Power project.

2.4.3 Decreased Generating Capacity

Reducing the generating capacity for the project would decrease the project's contribution to O‘ahu's renewable energy portfolio and consequently reduce the benefits to the state. Furthermore, although requiring fewer turbines, a reduced capacity would not result in a proportionate reduction in permitting, construction and operation costs. The cost per megawatt increases as economies of scale are lost to fixed costs of transportation, logistics, mobilization, and other factors. Therefore, development of the project with a reduced generating capacity runs counter to the basic project objectives.

2.4.4 Increased Generating Capacity

The two existing HECO 46 kV sub-transmission lines that traverse the project site, the Waialua-Kahuku line and the Waialua-Kuilima line, have a combined available transmission capacity of 70 MW. Generating capacity exceeding 70 MW would require an additional POI to be established, possibly several miles away from the project site, requiring significantly more offsite infrastructure and improvements to the existing HECO system. Therefore, increasing the generating capacity of the Kawailoa wind farm to more than 70 MW has been eliminated from further consideration.

2.4.5 Wind Farm Development Elsewhere on O‘ahu

As described in Section 2.1, HECO issued an RFP for renewable energy projects for the island of O‘ahu in June 2008. A proposal was submitted to HECO that detailed the development of a 70 MW wind farm on the Kawailoa parcel of Kamehameha Schools' property; the proposal was subsequently selected by HECO to be one of several projects in its final award portfolio of renewable energy projects. Following the selection by HECO, Kawailoa Wind Power negotiated a Site Lease Development Agreement with Kamehameha Schools, allowing them exclusive rights to development of a wind farm at the site. As such, this is the only property on O‘ahu that Kawailoa Wind Power has rights to, and HECO has selected for development. Furthermore, in terms of wind resource availability and constructability, the Kawailoa property is believed to be one of the last few remaining parcels on O‘ahu that is suitable for development of a wind energy project. For these reasons, alternative sites on O‘ahu, to the extent they exist and may be available, are not being considered for development of a wind farm project at this time.

2.4.6 Delayed Implementation of Project

As part of its June 2008 RFP, HECO required that all selected renewable energy projects for the island of O‘ahu commence commercial operation between 2010 and 2014, with preference for those that achieve commercial operation before 2013. Kawailoa Wind Power's current agreement with HECO establishes a commercial operation date no later than December 2013. The parties are now engaged in power purchase negotiations and expect to submit the PPA to the State Public Utilities Commission in 2011. Consequently, Kawailoa Wind Power is not considering a delayed development schedule for the project.

2.4.7 Alternate Energy Storage Technologies

A variety of wind storage technologies can be used for wind farm projects; the effectiveness of each technology is typically dependent on site development and operation factors specific to the wind energy facility. A BESS was selected as the preferred technology for use at the Kawailoa wind farm. This technology offers both environmental and electrical advantages. These include the use of non-toxic materials and a small footprint, as well as an instantaneous response time and a reasonably long cell life (thus allowing thousands of charge and discharge events).

Other energy storage technologies that were considered include pumped water storage, superconducting magnetic energy storage, compressed air storage, thermal energy storage and flywheel storage. A brief description of each technology is provided below, along with the rationale for why it is not being pursued as part of the project.

- Pumped Water Storage: Pumped water storage (often called "pumped hydro") is probably the best known large-scale energy storage technology. It consists of pumping water to a high storage reservoir using available power that is not immediately needed. The stored water is then released through turbo-generators to produce electricity when it is most needed (in this case when the wind is not blowing). Pumped water storage recovers 80% to 90% of the energy consumed by the pumps (that is, the electrical generator that is driven by the water released from the reservoir produces 80% to 90% as much electricity as is consumed by pumping water into the storage reservoir). The chief challenge with pumped water storage is that it typically requires an adequate water supply, and two reservoirs of sufficient size at considerably different elevations; there are few locations on O‘ahu that are well-suited for water storage at this scale. Moreover, it often requires considerable capital expenditure and energy to pump the water, thus increasing the cost of the electricity that is produced. The lack of an available fresh water source combined with the lack of existing infrastructure precludes the use of pumped storage for this project.

- Superconducting Magnetic Energy Storage: Superconducting magnetic energy storage (SMES) systems store energy in a magnetic field created by the flow of direct current in a superconducting coil that has been cooled to a temperature below the point at which it becomes a superconductor. A typical SMES system includes three parts: (1) a superconducting coil, (2) a power-conditioning system, and (3) a cryogenically cooled refrigerator. Once the superconducting coil is charged, the current does not decay and the magnetic energy can be stored indefinitely. The stored energy can be released back to the network by discharging the coil. An SMES system loses less electricity in the energy storage process than other methods of storing energy (less than 5%). The advantage of having low losses is offset by the high energy requirements for refrigeration and of the superconducting wire. Because of this, SMES is typically used for short duration energy storage, such as that needed to improve power quality. An SMES system is not suitable for the Kawailoa wind farm project because of the very high costs, the energy requirements for refrigeration, and the limits in the total amount of energy that can be stored.

- Compressed Air Storage: A compressed air energy storage (CAES) plant stores electrical energy in the form of air pressure, then recovers this energy as an input for future power generation.[8]When applied to wind energy, this technology uses electricity from the wind turbines to compress air, which is then stored in airtight underground caverns. While it is a promising technology for some locations in the continental U.S., this technology is not suitable for O'ahu because of a lack of suitable underground storage conditions.

- Thermal Storage: Several technologies are available that can store energy in a thermal reservoir for later reuse. The thermal reservoir may be maintained at a temperature above (hotter) or below (colder) than that of the ambient environment. The principal application today is the production of ice or chilled water at night which is then used to cool environments during the day. Thermal energy storage technologies are most useful for storing energy that originates as heat in an insulated repository for later use for space heating or for domestic or process hot water heating. They are generally not well suited for storing electrical energy and consequently are not considered to be viable energy storage options for the Kawailoa wind farm.

- Flywheel Storage: This form of storage uses electricity from the wind turbines to power an electric motor that accelerates a heavy rotating disc, which, in turn, acts as a generator on reversal, slowing down the disc and producing electricity. Mechanical inertia is the basis of this storage method, with electricity stored as the kinetic energy of the rotating disc. However, the range of power and energy storage technically and economically achievable with this technology are quite limited, making flywheel storage unsuitable for power system applications such as the Kawailoa wind farm.

None of the storage technologies listed above provides an effective and viable means of storing the large amount of wind-generated energy that would be produced by the Kawailoa wind farm and, therefore, was given further consideration, as described in the accepted EIS (CH2M Hill 2011).

2.4.8 Different Sources of Renewable Energy

The expertise of Kawailoa Wind Power is specific to wind energy generation. It has an extensive experience of implementing wind development projects in a cost-effective and environmentally friendly manner. The Kawailoa wind farm would not exclude or replace other renewable energy resources, but instead, would contribute to the growth and diversification of O'ahu's renewable energy

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[8] Essentially, the CAES cycle is a variation of a standard gas turbine generation cycle. In the typical simple cycle gas fired generation cycle, the turbine is physically connected to an air compressor. Therefore, when gas is combusted in the turbine, approximately two-thirds of the turbine's energy goes back into air compression. With a CAES plant, the compression cycle is separated from the combustion and generation cycle. When the CAES plant regenerates the power, the compressed air is released from the cavern and heated through a recuperator before being mixed with fuel and expanded through a turbine to generate electricity. Because the turbine's output no longer needs to be used to drive an air compressor, the turbine can generate almost three times as much electricity as the same size turbine in a simple cycle configuration, using far less fuel per MWh produced. The stored compressed air takes the place of gas that would otherwise have been burned in the generation cycle and used for compression power.

portfolio. Under the competitive bidding framework ordered by the State Public Utilities Commission, HECO must issue a Request for Proposals for any alternative energy projects larger than 5 MW in capacity on O‘ahu. Other than the expansion of the Honolulu Project of Waste Energy Recovery (H-Power) facility, no other renewable energy projects larger than 10 MW will be constructed on O‘ahu until HECO issues an RFP. For these reasons, no other sources of renewable energy are being considered by Kawailoa Wind Power.

CHAPTER 3: AFFECTED ENVIRONMENT

3.1 Climate

The climate of the Hawaiian Islands varies little throughout the year, with only minor periods of diurnal and seasonal variability. Generally, temperatures during the summer season (May through September) are warm, conditions are dry, and persistent trade winds originate from the northeast direction. The winter season (October through April) is characterized by cooler temperatures, higher precipitation, and less equable winds. Local climatic conditions and weather patterns on O‘ahu vary as a result of several different factors in the physical environment (Juvik and Juvik 1998).

Local climatic conditions within the project area are characteristic of lowland areas (and mountain slopes at the offsite communication tower facilities) on the windward side of O‘ahu, with relatively constant temperatures and persistent northeast trade winds. Average monthly temperatures in the area range from 67.3 °F in January to 76.6 °F in August (Western Regional Climate Center 2005b). Annual mean precipitation in the area ranges from 22.5 inches near the makai (seaward) portion of the project area to slightly over 56 inches near the mauka (inland) portion of the project area (Western Regional Climate Center 2005a). Prevailing northeasterly trade winds in the area generally blow from 12.3 to 15.7 mph (AWS Truewind 2004). However, during “Kona” storm conditions, the prevailing winds change to a south/ southwesterly direction. Episodic oceanic and atmosphere events, such as tropical storms, hurricanes, and El Niño Southern Oscillation (El Niño), can also influence climate in the islands during specific intervals (Juvik and Juvik 1998).

The offsite communication towers at Mount Ka‘ala are located in regions classified as rainy mountain slopes along the windward sides of the island. In these areas, rainfall and cloudiness are very high, with considerable rain during both the winter and summer months. Temperatures are equable, and humidity is higher than the other six Hawai‘i climatic regions (WRCC 2010).

3.1.1 Global Climate Change

According to the Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), global climate change is very likely due to anthropogenic greenhouse gas (GHG) concentrations (IPCC 2007a, 2007b). Greenhouse gases, which include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are chemical compounds in the Earth’s atmosphere that trap heat. Of these gases, CO_2 is recognized by the IPCC as the primary greenhouse gas affecting climate change (IPCC 2007a, 2007b). Present atmospheric concentrations of CO_2 are believed to be higher than at any time in at least the last 650,000 years, primarily as a result of combustion of fossil fuels. It is also very likely that observed increases in CH_4 are also partially due to fossil fuel use (IPCC 2007a, 2007b). Effects of global climate change include increased global average air and ocean temperatures, rising sea levels, changing precipitation patters, growing frequency and severity of storms, and increasing ocean acidification.

The maritime location of the Hawaiian Islands makes the archipelago relatively well buffered climatically (Benning et al. 2002). However, climatic changes have been documented throughout the state. Average air temperature increases of 0.3196°F per decade have been recorded in Hawai‘i (Giambelluca et al. 2008), with higher elevations warming faster than lower elevations. Tide gauges at sea level at the Honolulu Harbor estimate that sea level has risen at 0.06 ± 0.1in/year over the past century (Caccamise et al. 2005). Some estimates forecast that a 3.3 feet rise in sea level is possible by the end of the century for Hawai‘i (Fletcher 2009). Sea surface temperatures near the islands have been increasing recently, showing an average 0.72°F rise between 1957 and 1987 (Giambelluca et al. 1996). Ocean acidification and its effects on marine ecosystems are also especially relevant to the Hawaii. Marine taxa, especially those with skeletons and shells, are vulnerable to seawater carbonate system changes as a result of rising atmospheric concentrations of CO_2 (Guinotte and Fabry 2008).

3.2 Air Quality

As required by the Clean Air Act (CAA), the U.S. Environmental Protection Agency (USEPA 2008) has established National Ambient Air Quality Standards (NAAQS). These standards cover major air pollutants: carbon monoxide (CO), nitrogen oxides (NO_X), ozone (O_3), particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), sulfur oxides (SOX), and lead (CFR Title 40, Part 50).

In Hawai�much‘i, air quality is regulated and monitored by the State Department of Health (DOH), Clean Air Branch. The State of Hawai‘i has established ambient air quality standards for six of the pollutants mentioned above (all but $PM_{2.5}$), as well as hydrogen sulfide (H_2S) (HAR, Chapter 59). The State of Hawai‘i also participates in the national $PM_{2.5}$ speciation and air toxics monitoring programs (DOH Clean Air Branch 2008, 2009). Six DOH air quality monitoring stations are present on the Island of O‘ahu. No air quality monitoring stations exist on the North Shore of O‘ahu. The closest station to the project area is located in Pearl City, roughly 14.5 miles to the south of the Kawailoa project area. This station monitors PM_{10}, $PM_{2.5}$, speciation, and air toxics. Average annual criteria pollutant levels at this station are generally well below the state and federal ambient air quality standards (DOH, Clean Air Branch 2008, 2009).

Air quality in Hawai‘i is consistently one of the best in the nation, and criteria pollutant levels remain well below state and federal ambient air quality standards (DOH, Clean Air Branch 2009). There are few sources of air pollution near the project area. These include: dust that naturally arises when strong winds sweep across open fields or exposed slopes; vehicle emissions from nearby roads; wildfires or anthropogenic fires; agricultural sources; construction activities; and irregular volcanic emission from the Island of Hawai‘i.

3.3 Geology, Topography and Soils

The topography of O‘ahu is characterized by broad central valleys in the interior portions and tall, steep slopes on the coastal areas as a result of erosion from wind, rain and sea (Moore 1964; Polhemus 2007). The two mountain ranges, the Ko‘olau Mountain Range in the east and the Wai‘anae Mountain Range in the west, are roughly parallel and oriented on a northwest to southeast axis. The project area consists of various ridges gently sloping toward the ocean that are dissected by several small gulches (Hobdy 2010a, 2010b). Named gulches within the project area include: Ka‘alaea, Kawailoa, Laniākea, and Loko Ea. Elevations range from 200 feet above sea level at the western makai portion of the project area to approximately 1,280 feet above sea level at the eastern mauka side of the project area (CH2M Hill 2011). No significant topographical features exist on any of the land parcels.

The offsite communication towers are located on flat areas immediately adjacent to steep slopes within the northern portion of the Wai‘anae Mountain. The sites are near the summit of Mount Ka‘ala, the tallest peak on O‘ahu at 4,020 feet. The Hawaiian Telcom site is located at roughly 3,675 feet elevation and the Repeater Station site is located at roughly 3,773 feet elevation (SWCA 2010c).

The Hawaiian Islands were and are being formed by a series of volcanic eruptions that have occurred at various hotspots beneath the Earth’s crust. As the tectonic plate supporting the islands has slowly drifted northwestward, magma has welled up from fixed spots creating, in conjunction with subsidence and erosion, a linear chain of islands. O‘ahu, the third largest island in the Hawaiian Archipelago, was created by several geological processes. These include shield-building volcanism, subsidence, weathering, erosion, sedimentation, and rejuvenated volcanism (Hunt 1996). O‘ahu is mostly composed of the heavily eroded remnants of two large Pliocene shield volcanoes – Wai‘anae and Ko‘olau (Juvik and Juvik 1998). The extinct Ko‘olau and Wai‘anae Volcanoes were formed about 2.2 to 2.5 million years ago and 2.7 to 3.4 million years ago, respectively (Juvik and Juvik 1998; Lau and Mink 2006).

The project area is located on the Schofield Plateau, an alluvial fan of erosional unconformity that formed when lava flows from the Ko‘olau Volcano banked against the eroded slope of the Waianae Volcano (Macdonald et al. 1983). The majority of the project area is underlain by Koolau Basalt lava flows that were active 1.8 to 3 million years ago. A narrow strip of alluvial sand and gravel is present in the southern portion of the project area. No unique or unusual geologic resources or conditions are known from the site.

Various soil types have developed throughout the Island of O‘ahu as the basaltic lavas and volcanic ash from the volcanoes have weathered and decomposed (Juvik and Juvik 1998). Soils on the Island of O‘ahu were classified and defined by the U.S. Department of Agriculture (USDA) Soil Conservation Service and Natural Resource Conservation Service (NRCS) (Foote et al. 1972).

The three primary soil types underlying the project area are Helemano silty clay, 30-90% slopes; Wahiawa silty clay, 3-8% slopes; and Leilehua silty clay, 2-6% slopes. The soils in the gulches are of the Rough Mountainous Lands and Rock Lands Series (Foote et al. 1972). According to the NRCS National Hydric Soils List, none of the soils in the project area is considered hydric (NRCS 2010).

Two soil types occur at the communication facility sites: Helemano silty clay, 30-90% slopes and Kemoo silty clay, 30-70% slopes (Foote et al. 1972). These soils are not considered hydric (NRCS 2010).

3.4 Hydrology and Water Resources

The Clean Water Act (CWA), formerly known as the Federal Water Pollution Control Act, is the primary statute governing water pollution and water quality in waters subject to U.S. Army Corps of Engineers (USACE) jurisdiction. Section 404 of the CWA regulates the discharge of dredged or fill material into jurisdictional waters of the U.S. and USACE is authorized to issue permits for these activities.

Executive Order 11990 requires federal agencies to ensure their actions minimize the destruction, loss or degradation of wetlands. In carrying out their actions, each agency shall preserve and enhance the natural and beneficial values of wetlands.

Executive Order 11988 requires federal agencies to avoid adverse impacts to flood plains to the extent possible. The goal of this Executive Order is to minimize the impact of floods on public safety, health, conservation, and economics.

3.4.1 Surface Water

Hydrologic processes in Hawai‘i are highly dependent on the climatic and geological features, and stream flow is influenced by rainfall and wind patterns. Permeable underlying rock may cause some streams on O‘ahu to have lengthy dry reaches under natural conditions. The majority of the perennial streams on O‘ahu are located in the windward Ko‘olau Mountains which produce a larger amount of orographic precipitation compared to the leeward side (Polhemus 2007). The project area is located within six watersheds of the Waialua region on narrow east-west trending lands. The six watersheds from north to south are the: Waimea, Keamanea (includes Ka‘alaea and Laniākea), Kawailoa, Loko Ea, and Anahulu. Within these watersheds are several streams, ponds, and wetlands (DAR 2008; DBEDT 2011). The Jurisdictional Wetland Boundary Determination provides additional detail on these resources (SWCA 2010b). Table 3.1 provides a list of streams within the project area.

Table 3-1. Streams within the Kawailoa Project Area.

Stream	DAR Watershed	Perennial /Intermittent	Total Length
Waimea	Waimea	Perennial	64.4 mi
Ka‘alaea	Ka‘alaea	Non-perennial	5 mi
Kawailoa	Kawailoa	Non-perennial	9.2 mi
Laniākea	Laniākea	Non-perennial	7.2 mi
Loko Ea	Loko Ea	Perennial	2.2 mi
Anahulu	Anahulu	Perennial	64.6 mi
Source: DAR (2008); SWCA (2010b).			

Waimea: The Waimea River and its four tributaries – ʻElehāhā, Kaiwikoʻele, Kamananui, and an unnamed tributary – flow near the northern boundary of the project area and discharge into Waimea Bay. Only the unnamed tributary of the Waimea River and the Waimea River mainstream occur within the project parcels. Waimea River is a jurisdictional perennial water body and the unnamed tributary is non-perennial probable jurisdictional stream.

Keamanea: The Kaʻalaea stream and its tributaries are non-perennial non-jurisdictional areas within the project area. The Laniākea stream and its major tributaries are non-perennial probable jurisdictional areas within the project area.

Kawailoa: The Kawailoa stream and its major tributaries are non-perennial probable jurisdictional areas within the project area.

Loko Ea: The Loko Ea stream is a perennial probable jurisdictional area within the project area.

Anahulu: The Anahulu River runs near the southern portion of the project area and discharges into Waialua Bay. The jurisdictional Anahulu River has two perennial tributaries, Kawainui and Kawaiiki Streams, which join the mainstream immediately mauka of the eastern boundary of the project area. Each of these tributaries is diverted once, supplying water to the Kaiwainui Ditch System (DAR 2008; SWCA 2008). There are several reservoirs associated with the ditch system. Two are located on Anahulu River at 968 feet and 781 feet (SWCA 2008).

A former Hawaiian fishpond, ʻUkoʻa Pond, occurs seaward and outside of the project parcels near the intersection of Kawailoa Drive and Kamehameha Highway. The extent of this basal, spring-fed pond was reduced due to dumping and filing within the old Kawailoa Landfill (Elliott and Hall 1977; Miller et al. 1989). Loko Ea is both the name of the waterway that historically drained ʻUkoʻa Pond to the sea at Haleʻiwa Harbor (Miller et al. 1989) and of the influent intermittent gulch above the pond.

3.4.2 Flooding

The Flood Insurance Rate Maps (FIRM) prepared by the Federal Emergency Management Agency's National Flood Insurance Program depicts flood hazard areas through the state. The maps classify land into four zones depending on the expectation of flood inundation. The project area is almost entirely within Flood Zone D where analysis of flood hazards has not been conducted and flood hazards are undetermined. Near the mouths of several streams (Kawailoa, Laniākea, Loko Ea, and Anahulu) the land is identified as Flood Zone X, an area defined as having less than 0.2% annual risk of flood inundation. The proposed mountaintop Mount Kaʻala communication tower sites are in an area designated by FEMA as unstudied, and therefore have not been classified for flood hazard.

3.4.3 Groundwater

Oʻahu has a vast amount of groundwater, which supplies most of the domestic water supply (Macdonald et al. 1983; Lau and Mink 2006). The project area is located over the north hydrologic sector of the Kawailoa aquifer system (as designated by DLNR 2010). The Kawailoa aquifer system is within the central Oʻahu groundwater flow system (Oki 1998). Groundwater in the Kawailoa aquifer system is thought to drain northwest toward the Waimea coast.

The northern aquifer on the Island of Oʻahu includes three sub-aquifers: Mokulēʻia in the Waiʻanae formation, as well as the Waialua and Kawailoa in the Koʻolau formation. These areas are underlain by a deep wedge of sedimentary caprock that creates thick basal lenses (Hunt 1996). However, the Hawaii Stream Assessment (CWRM 1990) notes that the Kawailoa System, which encompasses the Anahulu River, lacks an effective caprock. This absence of a caprock boundary allows free movement of the groundwater to the ocean (Oki et al. 1999).

In the late 1970s, the USFWS Division of Ecological Services biologists used orthophoto quadrangle maps and spot field checks to map wetlands in Hawaiʻi as a part of the National Wetlands Inventory (NWI) Program according to the Cowardin et al. (1979) classification system. According to the USFWS definition, several wetland types are located within the project area including: Freshwater Pond (PUBH, PUBHh, PUBHx), Riverine (R4SBCx), Freshwater Emergent Wetland (PEM1Cx), and Freshwater Forested/Shrub Wetland (PFO3C) (SWCA 2010b).

SWCA biologists conducted a wetland assessment in the project area to identify any wetlands or other waters subject to U.S. Army Corps of Engineers (USACE) jurisdiction under Section 404 of the Clean Water Act. No wetlands meeting the three established criteria of hydrophilic vegetation, soils, and water regime were found to occur within the areas to be affected by construction and operation of the proposed wind power facility or offsite communication tower sites (SWCA 2010b).

3.5 Biological Resources - Flora

Botanical surveys of the project area were conducted by Robert Hobdy in February (Hobdy 2010a) and August 2010 (Hobdy 2010b). Hobdy walked multiple routes throughout the property and more intensively examined areas most likely to support native plants (e.g., gulches, steep slopes, and rocky outcrops). Hobdy recorded approximately 183 plant species within the project area in February (Hobdy 2010a) and an additional 40 species during the survey in August (Hobdy 2010b). No state or federally listed endangered, threatened, or candidate plant species, nor species considered rare throughout the Hawaiian Islands, were found in the project area by Hobdy. No portion of the project area has been designated as critical habitat for any listed plant species.

The vegetation in the project area is a mixture of aggressive weedy species that have taken over since the abandonment of sugarcane agriculture. Guinea grass (*Urochloa maxima*) is the most abundant species on the property, forming deep growth on all the ridge tops and in many of the gulches (Hobdy 2010a, 2010b). Other common species include: common ironwood (*Casuarina equisetifolia*), albizia (*Falcataria moluccana*), Formosan koa (*Acacia confusa*), koa haole (*Leucaena leucocephala*), Padang cassia (*Cinnamomum burmanni*), Java plum (*Syzygium cumini*), strawberry guava (*Psidium cattleianum*), cork bark passion flower (*Passiflora suberosa*) and swamp mahogany (*Eucalyptus robusta*). All of these species are non-native to the Hawaiian Islands (Hobdy 2010a, 2010b). Although the project area is believed to have been forested with a variety of native trees, shrubs, ferns, and vines in pre-Contact times, few native species persist in the project area today. The lack of native species is attributed to years of agricultural activities and invasion by non-native plant and animal species (Hobdy 2010a, 2010b). Large remnants of native vegetation occur on steep slopes of the gulches in the upper parts of the property. Thirty native plant species were identified in the project area, of which 13 are endemic to the Hawaiian Islands (found only in Hawaiʽi). Seven species that were introduced by Polynesians also occur in the project area (Hobdy 2010a, 2010b). Table 3-3 lists native plant species recorded in the project area by Hobdy (2010a, 2010b).

Table 3-3. Native Hawaiian Plants Observed in the Kawailoa Project Area.

Scientific Name	Hawaiian and Common Names	Status[1]
FERNS		
DENNSTAEDTIACEAE (Bracken Family)		
Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) R.M. Tryon	kīlau	E
DICKSONIACEAE (Dicksonia Family)		
Cibotium chamissoi Kaulf.	hāpuʽu	E
GLEICHENIACEAE (False Staghorn Fern Family)		
Dicranopteris linearis (Burm.f.) Underw.	Uluhe	I
LINDSAEACEAE (Lindsaea Fern Family)		
Sphenomeris chinensis (L.) Maxon	palaʽā	I
NEPHROLEPIDACEAE (Sword Fern Family)		
Nephrolepis exaltata (L.) Schott	niʽaniʽau	I
POLYPODIACEAE (Polypody Fern Family)		

Scientific Name	Hawaiian and Common Names	Status[1]
Lepisorus thunbergianus (Kaulf.) Ching	pākahakaha	I
PSILOTACEAE (Whisk Fern Family)		
Psilotum nudum (L.) P. Beauv.	moa	I
MONOCOTS		
ASPARAGACEAE (Asparagus Family)		
Pleomele halapepe St. John	halapepe	E
CYPERACEAE(Sedge Family)		
Carex meyenii Nees	--------------	I
Carex wahuensis C. A. Meyen	--------------	E
Cyperus polystachyos Rottb.	--------------	I
PANDACEAE(Screwpine Family)		
Freycinetia arborea Gaud.	ʽieʽie	I
POACEAE(Grass Family)		
Chrysopogon aciculatus (Retz.) Trin.	pilipili ʽula	I
DICOTS		
ASTERACEAE (Sunflower Family)		
Bidens sandvicensis Less	koʽokoʽolau	E
EBENACEAE (Ebony Family)		
Diospyros sandwicensis (A. DC.) Fosb.	lama	E
ERICACEAE (Heath Family)		
Leptecophylla tameiameiae (Cham. & Schlect.) C.M. Weiller	pūkiawe	I
FABACEAE (Pea Family)		
Acacia koa A. Gray	koa	E
Vigna marina (J. Burm.) Merr.	nanea	I
GOODENIACEAE (Goodenia Family)		
Scaevola gaudichaudiana Cham.	naupaka kuahiwi	E
LAURACEAE (Laurel Family)		
Cassytha filiformis L.	kaunaʽoa pehu	I
MENISPERMACEAE (Moonseed Family)		
Cocculus orbiculatus (L.) DC.	huehue	I
MYOPORACEAE (Myoporum Family)		
Myoporum sandwicense A. Gray	naio	
MYRTACEAE (Myrtle Family)		
Metrosideros polymorpha Gaud. var. *polymorpha*	ʽōhiʽa	E
OLEACEAE (Olive Family)		
Nestegis sandwicensis (A. Gray) Degener, I. Degener & L. Johnson	olopua	E
ROSACEAE (Rose Family)		
Osteomeles anthyllidifolia (Sm.) Lindl.	ʽūlei	I
RUBIACEAE (Coffee Family)		

Scientific Name	Hawaiian and Common Names	Status[1]
Psychotria mariniana (Cham. & Schlectend) Fosb.	kōpiko	E
Psydrax odorata (G. Forst.) A.C. Smith & S. P. Darwin	alaheʻe	I
SANTALACEAE (Sandalwood Family)		
Santalum freycinetianum Gaud. var.*freycinetianum*	ʻiliahi	E
SAPINDACEAE(Soapberry Family)		
Dodonaea viscosa Jacq.	ʻaʻaliʻi	I
STERCULIACEAE(Cacao Family)		
Waltheria indica L.	ʻuhaloa	I
THYMELAEACEAE(Akia Family)		
Wikstroemia oahuensis (A. Gray) Rock.	ʻākia	E
(1) E= endemic (native only to Hawaiʻi); I= indigenous (native to Hawaiʻi and elsewhere).		
Source: Hobdy (2010a, 2010b).		

Hobdy conducted a botanical survey of the Mount Kaʻala offsite communication tower sites in August 2010. He surveyed the two 0.1 acre communication tower sites on the ridge top, as well as a 30-foot buffer downslope of the tower sites. No state- or federally listed endangered, threatened or candidate plant species were observed during the survey, nor were any species considered rare throughout the Hawaiian Islands (Hobdy 2010c). A total of 63 plant species were recorded; 30 non-native and 33 native species. The non-native vegetation was limited to the two communication tower sites on the ridge top which were previously cleared and have been maintained in this condition for over 30 years. The native vegetation was mostly limited to the buffer outside and downslope of the proposed communication tower sites (Hobdy 2010c). A complete list of the plant species documented at the Mount Kaʻala site is included in the HCP.

Nine plant species have critical habitat designations that encompass the tower sites. The plant species are *Alsinidendron trinerve, Cyanea acuminate, Cyanea longiflora, Diplazium molokaiense, Hedyotis parvula, Labordia cyrtandrae, Phyllostegia hirsute, Tetramolopium lepidotum* ssp*. lepidotum, Viola chamissoniana* ssp*. chamissoniana.* None of the plant species with designated critical habitat that encompass the tower sites are present on-site at the two tower locations.

3.6 Biological Resources - Wildlife

Wildlife occurring on or flying over the project area has been investigated through a combination of pedestrian surveys (Hobdy 2010a, 2010b), visual bird surveys (SWCA 2010a), nocturnal radar surveys (Cooper et al. 2011), and the use of bat detection devices (SWCA 2010a). Botanical surveys and a one-time avian survey were conducted at the off-site microwave facility sites (Hobdy 2010c). A mollusk survey was also conducted at the off-site microwave facility sites (SWCA 2010c). Endangered mollusks have only been documented in recent times in native forests at elevations greater than 1,312 feet on Oʻahu (USFWS 1992). As the project site is lower in elevation and dominated by non-native vegetation, these snails are not expected to be found at the project site. Thus, no mollusk survey was conducted at the project site.

Nocturnal radar surveys were conducted on site in an effort to identify seabirds that may potentially transit the project area during crepuscular and night periods from 1800-2100 h and 0400-0600 h. Surveys were conducted in June and October 2009 and June 2011. Radar surveys were conducted at four locations to provide representative coverage of the project site. The summer surveys coincide with the incubation periods of the Hawaiian petrel and Newell's shearwater and the fall surveys coincide the fledgling periods for both species. Criteria used to identify possible shearwaters/petrels consisted of radar targets moving at airspeeds greater than 30 miles per hour, of the appropriate size, flying inland or seaward only (not parallel to shore) and exhibiting directional flight (Cooper et al. 2011).

Point counts, playbacks and driving transects were conducted on and off-site to maximize the possibility of documenting native birds on-site and at nearby water bodies. SWCA began conducting avian point count surveys in the project area in October 2009. A total of 29 point count stations were surveyed from October 2009 to February 2011. A 0.6 mile (1 km) buffer around potential turbine locations was created and an "airspace envelope" developed around each turbine string. All flight observations occurring at point count stations within the 0.6 mile (1 km) airspace envelope were considered to be within the possible area of turbine interaction and were deemed "on-site." Point count stations outside the airspace envelope were considered to be "off-site." Point count stations were located to sample representative habitats within the project area, close to potential turbine locations. Additional point counts were also added at waterbodies in the vicinity of the project area, to document waterbird activity at the nearby waterbodies. The months during which individual point counts were sampled varied over the course of the year, depending on the proposed turbine configuration which changed over time. Two to nine 200 m radius point count stations were surveyed during each session. Sessions were conducted in the morning (0600 – 1100 h), and evening (1400 – 1930 h). Each point count lasted15 minutes per station. Point counts at the nearby water features were chosen in an effort to gain a better understanding of the activity patterns of the threatened and endangered species covered by the HCP, as well as to document the arrival and activity patterns of non-listed migratory bird species.

Playbacks of moorhen calls at the ponds were also conducted from the end of May 2010 to the end of September 2010. Playbacks consisted of playing chick distress calls for 30 seconds, followed by 30 seconds of silence, then 30 seconds of moorhen territorial calls followed by another 30 seconds of listening for a response. The calls chosen were calls that are most likely to elicit a response from nearby moorhen (DesRochers et al. 2008). These calls were recorded from James Campbell Wildlife Refuge and obtained from Tufts University. Playbacks have been shown to increase detection by 30% on O'ahu (DesRochers et al. 2008). Due to time constraints, point counts were shortened to 13 minutes (2 minutes of playback plus 13 minute point count observations) when playbacks were conducted. To increase the probability of detecting waterbirds, driving transects were conducted between April and July 2010. As sightings of waterbirds primarily occurred near the ponds, driving transects were conducted between ponds to document waterbird activity between ponds. Transects were also conducted along parts of the turbine string that were accessible by road. The vehicle was driven at speeds between 5 miles per hour and 15 miles per hour and occurrences of all native birds (waterbirds and owls) were recorded. Incidental sightings of all native birds were also recorded while biologists were onsite.

To quantify bat activity in the project area, two to eight Anabat detectors (Titley Electronics, NSW, Australia) were deployed at various locations at Kawailoa Wind Power from October 2009 to present. Anabat detectors record any ultrasonic sounds emitted by bats. These sounds are subsequently downloaded and analyzed by examining the sonograms of recorded sound files to confirm the presence of bats by identifying their echolocation (ultrasonic) calls. Anabat detectors were moved to new locations to increase the coverage of the area sampled at the project site.

3.6.1 Non-Federally Listed Species

Birds: Table 3-4 identifies all birds detected during the point count and radar surveys. Included in this table are scientific and common names of each species as standardized by the American Ornithologists' Union, biogeographical status of each species throughout Hawai'i, state and federal listing status, indication of whether the observed species is protected by the MBTA, and the location where the species were detected (i.e., onsite, offsite, or both). Key avian species (i.e., waterbirds and shorebirds) that are not federally or state-listed, but occur onsite or in the vicinity of the project area, are discussed below.

Table 3-4. Bird Species within the Kawailoa Project Area, Nearby Ponds, and Vicinity.

Common Name	Scientific Name	Status[1]	MBTA	On-site	Off-site	Others
Newell's shearwater	*Puffinus auricularis newelli*	E, *T*	X	X[2]		
Great frigatebird	*Fregata minor*	I	X			X (Waimea Valley)
Cattle egret	*Bubulcus ibis*	NN	X	X	X	
Black-crowned night heron	*Nycticorax nycticorax*	I	X	X	X	
Mallard	*Anas platyrhynchos*	NN	X		X	
Hawaiian duck-mallard hybrids	*Anas* sp.	E	X	X[3]	X	
Muscovy	*Cairina moschata*	NN			X	
Domestic duck	*Anas platyrhynchos domestica*	NN			X	
Domestic geese	*Ana anser domesticus*	NN			X	
Gray francolin	*Francolinus pondicerianus*	NN		X	X	
Black francolin	*Francolinus francolinus*	NN		X	X	
Domestic chicken	*Gallus gallus*	NN		X	X	
Common peafowl	*Pavo cristatus*	NN		X		
Hawaiian coot	*Fulica alai*	E, *E*	X		X	
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	E, *E*	X		X	
Pacific golden-plover	*Pluvialis fulva*	V	X	X	X	
Spotted dove	*Streptopelia chinensis*	NN		X	X	
Zebra dove	*Geopelia striata*	NN		X	X	
Barn owl	*Tyto alba*	NN	X	X	X	
Skylark	*Alauda arvensis*	NN				X (ʻŌpaeʻula Road)
Red-vented bulbul	*Pycnonotus cafer*	NN		X	X	
Red-whiskered bulbul	*Pycnonotus jocosus*	NN		X	X	
Japanese bush-warbler	*Cettia diphone*	NN		X	X	

Common Name	Scientific Name	Status[1]	MBTA	On-site	Off-site	Others
White-rumped shama	*Copsychus malabaricus*	NN		X	X	
Red billed leothrix	*Leiothrix lutea*	NN		X	X	
Japanese white-eye	*Zosterops japonicus*	NN		X	X	
Common myna	*Acridotheres tristis*	NN		X	X	
Red-crested cardinal	*Paroaria coronata*	NN		X	X	
Northern cardinal	*Cardinalis cardinalis*	NN	X	X	X	
House finch	*Carpodacus mexicanus*	NN	X	X	X	
Common waxbill	*Estrilda astrild*	NN		X	X	
Red avadavat	*Amandava amandava*	NN		X	X	
Nutmeg mannikin	*Lonchura punctulata*	NN		X		
Chestnut munia	*Lonchura malacca*	NN		X		
	Total species			**26**	**28**	**2**

1) E= endemic; I = indigenous, V = visitor, NN = non-native permanent resident; *E* = Endangered, *T* = threatened.
2) Based on radar data, not confirmed by visual assessment.
3) Presumed.

A total of 26 bird species were detected onsite, three were native species and one a winter migrant. The native species were the threatened Newell's shearwater (presumably detected during radar surveys), the black-crowned night heron and the Hawaiian duck-mallard hybrid and the one winter migrant, the Pacific golden-plover. An additional eight species were observed at nearby ponds and in the vicinity of the project area; native birds included the endangered Hawaiian coot, the endangered Hawaiian moorhen and the great frigatebird. The remaining species were introduced species.

Birds (Herons and Egrets): The indigenous black-crowned night-heron (*Nycticorax nycticorax*) is a cosmopolitan species resident on the main Hawaiian Islands (Pratt et al. 1987; Hawaii Audubon Society 2005). The black-crowned night heron was identified as a species of "Moderate Concern" in *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). Populations of species given this designation are declining with moderate threats or distribution, stable with known or potential threats and moderate to restricted distributions, or are relatively small with relatively restricted distributions. In Hawai'i, this species is considered a nuisance by aquaculture farmers. A total of six sightings of the native black-crowned night heron have been recorded onsite (two during point count surveys, three incidental sightings, and one sighting during driving transects). All sightings were of single birds in flight. Birds were observed in flight at the ponds in the area or flying near the lower met tower on Kawailoa Road or in the area between the met tower and a nearby pond. No birds have been observed foraging at the irrigation ponds onsite. No birds were observed flying within the rotor swept zone of either turbine type.

Thirteen observations of the black-crowned night heron were recorded (nine during point count surveys and four incidental sightings) at the adjacent water bodies. Flock size ranged from one to two birds with an average of one bird. This species was observed in flight at various ponds. The black-crowned night heron is also frequently seen foraging (i.e., not in flight). The black-crowned night heron was present on-site or off-site for all months of the year except January and February. Based on observations, the black-crowned night heron is likely present on-site and in the vicinity year round.

The cattle egret was introduced to Hawai‘i from Florida for insect control in the mid-20th century and has become a widespread species across the main Hawaiian Islands. This species was identified as "Not Currently At Risk" in *The North American Waterbird Conservation Plan* (Kushlan et al. 2002). On O‘ahu, large concentrations of this species can be found at Pearl Harbor, Kāne‘ohe Bay and Kahuku. Cattle egrets eat a wide variety of prey including insects, spiders, frogs, prawns, mice, crayfish, and the young of native waterbirds (Pratt et al. 1987; Telfair 1994; Robinson et al. 1999; Brisbin et al. 2002; Engilis et al. 2002; Hawaii Audubon Society 2005; USFWS 2005a). Cattle egrets were observed rarely on-site but were common at the adjacent water bodies and at the farmland farther seaward of the project site.

<u>Birds (Other)</u>: For centuries, migratory ducks, geese and other waterfowl have wintered on the Hawaiian Islands. Shorebirds primarily utilize wetlands and tidal flats; however, estuaries, grasslands, uplands, beaches, golf courses, and even urban rooftops are important habitats for some species (Engilis and Naughton 2004). O‘ahu offers the most diverse shorebird habitat of all the Hawaiian Islands. Threats to shorebirds in the Pacific region include habitat loss (urban, industrial, military, agricultural, recreational development), invasive plants, non-native animals (predation, disease and competition), human disturbance, and environmental contaminants (Engilis and Naughton 2004).

The USFWS developed the *U.S. Pacific Islands Regional Shorebird Conservation Plan* over concerns of declining shorebird populations and loss of habitat (Engilis and Naughton 2004). This plan identifies three shorebird species of primary importance in Hawai‘i: the Hawaiian stilt, Pacific golden-plover, and bristle-thighed curlew (*Numenius tahitiensis*). The only permanent resident shorebird, the Hawaiian stilt, is discussed below. The other two species are of primary importance because Hawai‘i supports a substantial amount of Pacific golden-plovers during the winter (an estimated 15,000 to 20,000 individuals) and the bristle-thighed curlew is the only migratory species that winters exclusively in the Pacific. The wandering tattler is considered a species of importance and the ruddy turnstone is a species of secondary importance (Engilis and Naughton 2004).

The Pacific golden-plover is the only shorebird that was detected utilizing the project area during the avian surveys conducted by Kawailoa Wind Power and SWCA. Data suggests that these birds arrive in the vicinity of the project area in August and leave in May. No birds were recorded at flight altitudes within the rotor swept zone of the proposed turbines.

<u>Mammals</u>: The Hawaiian hoary bat is the only terrestrial mammal native to Hawai‘i; this species is discussed below. Several non-native mammals have been observed on the Kawailoa Wind Power project area incidental to avian surveys. Feral pigs (*Sus scrofa*) are common throughout the project area. Domestic dogs (*Canis familiaris*) were reported and the area is regularly used by hunters with dogs. Rats (*Rattus* spp.) and small Indian mongoose (*Herpestes auropunctatus*) were also observed. Although not seen, it is likely that feral cats (*Felis catus*) and mice (*Mus domesticus*) occur on site (Hobdy 2010a, 2010b). A feral cat colony occurs used to occur at the gated entrance to Kawailoa Road.

<u>Invertebrates</u>: Hobdy specifically searched for the endangered Blackburn's sphinx moth (*Manduca blackburni*) within the project area. No moths or their larvae were observed (Hobdy 2010a, 2010b). Endangered mollusks have only been documented in recent times in native forests at elevations greater than 1,312 feet on O‘ahu (USFWS 1992). As the project site is lower in elevation and dominated by non-native vegetation, these snails are not expected to be found at the project site. Thus, no mollusk survey was conducted within the project area.

<u>Non-federally listed species off-site</u>: Only four species of non-native birds were observed or heard during the one-time survey of the off-site microwave facility sites (Hobdy 2010c). These include the Japanese bush warbler (*Cettia diphone*), red-vented bulbul (*Pycnonotus cafer*), the Japanese white-eye (*Zosterops japonicas*) and house finch (*Carpodacus mexicanus*). Another non-native bird that also would occur here is the red-billed leiothrix (*Leiothrix lutea*). Thus, birds that frequent the Mt. Ka‘ala sites are non-native species common to altered rural environments on O‘ahu. Based on historical data, the following native birds may also occur: the O‘ahu ‘amakihi (*Hemignathus flavus*) and the ‘apapane (*Himantione sanguinea*). Much rarer occurrence would be the endangered O‘ahu ‘elepaio (*Chasiempis*

ibidis) and the ʻiʻiwi (*Vestiaria coccinea*), which is listed as state endangered on Oʻahu (DOFAW 1990; Hobdy 2010c).

No state- or federally listed candidate, threatened, or endangered mollusks or species of concern were found or are known to occur within the off-site microwave sites. One species of native snail was found at the Hawaii Telcom site and seven native species at the Repeater station. Six native species were also found en route to the Repeater station, of which *Kaʻala subrutila*, an endemic mollusk, may be assessed for candidate species listing in the near future (King undated). Many of the native species found were common at the sites and the majority of the native snail diversity was found on native plants along the edges of each site. Terrestrial species were found in the leaf litter and a boreal species were present on the foliage on trees and shrubs. Only two non-native mollusk species (*Oxychilus alliarius* and *Deroceras laeve*) were found during the survey. O*. alliarius* is known to feed on other mollusks and represents a potential ecological threat to native mollusks at Mt. Kaʻala. The invasive slug *D. laeve* competes with other mollusks and is also considered beneficial to native ecosystems in Hawaiʻi.

3.6.2 Federally Listed Species (Non-Covered Species)

Although not observed during the survey, DOFAW has clarified that an additional native mollusk species (*Achatinella mustelina*) was historically found on olomea (*Perrottetia sandwicensis*) adjacent to the existing facilities, and a population is present approximately 164 feet away from the Hawaiian Telcom building site; *A. mustelina* is a federally listed species (DOFAW 2011)

The one invertebrate species, the endangered Hawaiian picture-wing (pomace) fly, *Drosophila substenoptera* has designated critical habitat that encompasses the off-site microwave tower facilities*.* The Primary Constituent Elements (PCEs) for the habitat of *Drosophila substenoptera* are: (1) Mesic to wet, lowland to montane, ohia and koa forest; and (2) The larval host plants *Cheirodendron platyphyllum* ssp. *platyphyllum, C. trigynum* ssp. *trigynum*, *Tetraplasandra kavaiensis*, and *T. oahuensis* (73 FR 73795 73895, 2008)*.* None of the larval host plants are present at the site.

The endangered Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*) also has critical habitat designated that encompasses the off-site microwave tower facilities. This critical habitat for the Oʻahu ʻelepaio is currently unoccupied by the species (66 FR 63752 63782, 2001). The primary constituent elements required by the Oʻahu ʻelepaio (*Chasiempis sandwichensis ibidis*) for foraging, sheltering, roosting, nesting, and rearing of young are found in undeveloped areas that support wet, mesic, and dry forest composed of both native and introduced plant species (66 FR 63752 63782, 2001). Higher population density can be expected in tall, closed canopy riparian forest than in low scrubby forest on ridges and summits. In addition, the (PCEs) associated with the biological needs of dispersal and genetic exchange among populations are found in undeveloped areas that support wet or dry shrub land and wet or dry cliff habitat.

3.6.3 Federally Listed Species (Covered Species)

Only one federally listed species could be resident within the Kawailoa Wind Power project area. The endangered Hawaiian hoary bat has been documented flying within the project area during the radar surveys and bat activity, as evaluated using bat detectors, is higher between March and November. It is possible that the tree-roosting Hawaiian hoary bat roosts on site during the months when bats are detected. The presumed Hawaiian duck-mallard hybrid has been documented utilizing ponds within the "airspace envelope" of the turbines in Zone 1 (see Fig. 3-1). No portion of the project area has been designated as critical habitat for any listed species. The Hawaiian moorhen occurs regularly at the stream at Waimea Valley. A Hawaiian coot was observed once foraging on Kawailoa Road. No Hawaiian stilts have been observed on site or at any of the nearby water bodies during the surveys conducted over the course of a year. One state-listed endangered species, the Hawaiian short-eared owl, has not been observed at the Kawailoa Wind Power project area, but could potentially be present as suitable habitat is available.

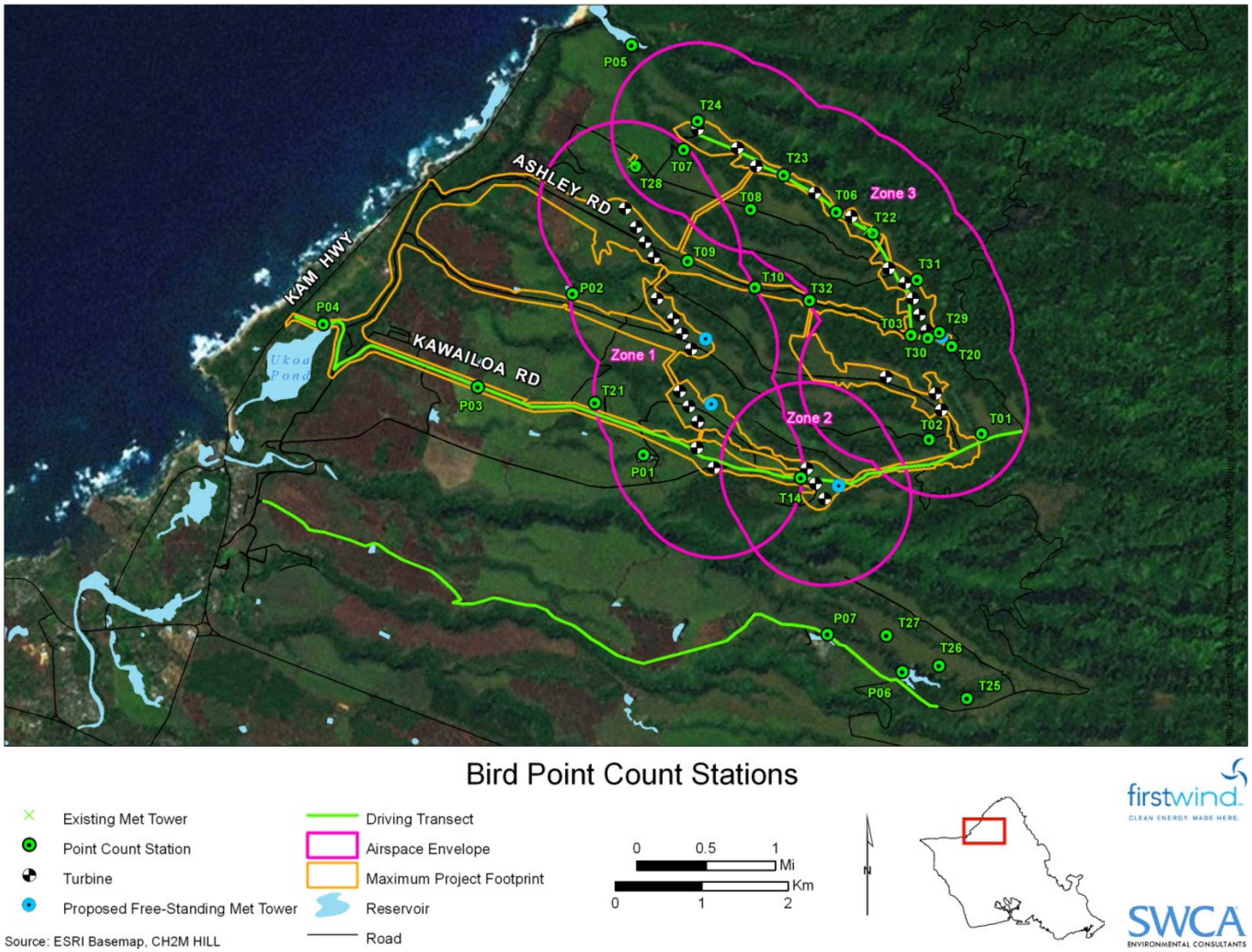
The proposed WTGs, onsite communication towers, met towers, overhead collection lines associated with the Kawailoa Wind Power project would potentially present collision hazards to the listed bird and bat species. These species may also collide with the two offsite antennae mounted on existing towers.

Lighting some of these structures pursuant to Federal Aviation Administration (FAA) regulations may increase the risk of avian collisions. Table 3-5 lists the federally and state-listed species with potential to be adversely impacted by operation of the Kawailoa Wind Power project and for which federal or state authorization of incidental take is being sought.

Table 3-5. Covered Species That May Be Affected by the Proposed Project.

Scientific Name	Common, Hawaiian Name(s)	Date Listed	Status[1]
Birds			
Puffinus auricularis newelli	Newell's shearwater, ʻaʻo	10/28/1975	T
Anas wyvilliana	Hawaiian duck, koloa maoli	3/11/1967	E
Himantopus mexicanus knudseni	Hawaiian stilt, āeʻo	10/13/1970	E
Fulica alai	Hawaiian coot, ʻalae keʻokeʻo	10/13/1970	E
Gallinula chloropus sandvicensis	Hawaiian moorhen, ʻalae ʻula	3/11/1967	E
Asio flammeus sandwichensis	Hawaiian short-eared owl, pueo	--	SE
Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat, ʻōpeʻapeʻa	10/13/1970	E
[1)]E = Federally endangered; T = Federally threatened; SE = State endangered			

Figure 3-1. Turbine Layout and Bird Airspace Envelope.



3.6.3 (a) Newell's Shearwater

Population, Biology, and Distribution

The Newell's shearwater is an endemic Hawaiian sub-species of the nominate species, Townsend's shearwater (*Puffinus a. auricularis*) of the eastern Pacific. The Newell's shearwater is considered "Highly Imperiled" in the *Regional Seabird Conservation Plan* (USFWS 2005b) and the *North American Waterbird Conservation Plan* (Kushlan et al. 2002). Species identified as "Highly Imperiled" have suffered significant population declines and have either low populations or some other high risk factor.

Based on data collected in the 1990's the population of Newell's shearwater was estimated to be approximately 84,000 breeding and non-breeding birds, with a possible range of 57,000 to 115,000 birds (Ainley et al. 1997). Radar studies on Kaua'i showed a 63% decrease in detections of shearwaters between 1993 and 2001 (Day et al. 2003a). More recently, Holmes (Planning Solutions 2010) suggest a 75% population decrease between 1993 and 2008, based on radar surveys and Save Our Shearwater (SOS) data. This puts the 2008 total population estimate on the order of 21,000 birds. The largest breeding population of Newell's shearwater occurs on Kaua'i (Telfer et al*.* 1987; Day and Cooper 1995; Ainley et al*.* 1995, 1997; Day et al*.* 2003a). Breeding also occurs on Hawai'i Island (Reynolds and Richotte 1997; Reynolds et al*.* 1997; Day et al. 2003a) and almost certainly occurs on Moloka'i (Pratt 1988; Day and Cooper 2002). Recent radar studies suggest the species may also nest on O'ahu in small numbers (Day and Cooper 2008). On Maui, radar studies and visual and auditory surveys conducted over the past decade suggest that one or more small breeding colonies are present in the West Maui Mountains in the upper portions of Kahakuloa Valley (Spencer 2009).

Newell's shearwaters typically nest on steep slopes vegetated by uluhe fern (*Dicranopteris linearis*) undergrowth and scattered 'ōhi'a (*Metrosideros polymorpha*) trees. Currently, most Newell's shearwater colonies are found from 525 to 3,900 feet above mean sea level, often in isolated locations and/or on slopes greater than 65 degrees (Ainley et al. 1997). The birds nest in short burrows excavated into crumbly volcanic rock and ground, usually under dense vegetation and at the base of trees. A single egg is laid in the burrow and one adult bird incubates the egg while the second adult goes to sea to feed. Once the chick has hatched and is large enough to withstand the cool temperatures of the mountains, both parents go to sea and return irregularly to feed the chick. The closely related Manx shearwater (*Puffinus puffinus*) is fed every 1.2-1.3 days (Ainley et al. 1997). Newell's shearwaters arrive at and leave their burrows during darkness and birds are seldom seen near land during daylight hours. During the day, adults remain either in their burrows or at sea some distance from land.

First breeding occurs at approximately six years of age, after which breeding pairs produce one egg per year. A high rate of non-breeding is found among experienced adults that occupy breeding colonies during the summer breeding season, similar to some other seabird species (Ainley et al. 2001). It was estimated by Ainley et al. (2001) that 46% of all active burrows produced an egg. No specific data exist on longevity for this species, but other shearwaters may reach 30 years of age or more (Bradley et al. 1989; del Hoyo et al. 1992).

The Newell's shearwater breeding season begins in April, when birds return to prospect for nest sites. A pre-laying exodus follows in late April and possibly May; egg laying begins in the first two weeks of June and likely continues through the early part of July. Pairs produce one egg, and the average incubation period is thought to be approximately 51 days (Telfer 1986). The fledging period is approximately 90 days, and most fledging takes place in October and November, with a few birds still fledging into December (NESH 2005).

The flight of the Newell's shearwater is characterized by rapid beats interspersed with glides, although beats tend to be fewer in high winds. The birds avoid flying with tailwinds because it decreases control. Over land, ground speed of the species has been measured to average 38 mph (Ainley et al. 1997). The wing beat pattern of Newell's shearwater is somewhat similar to that of the Hawaiian petrel.

Current Threats

Declines in Newell's shearwater populations are attributed to loss of nesting habitat, predation by introduced mammals (mongoose, feral cats, rats and feral pigs) at nesting sites, collision with powerlines and other anthropogenic structures, and fallout of juvenile birds associated with disorientation from urban lighting (Ainley et al. 1997; Mitchell et al. 2005; Hays and Conant 2007).

Occurrence in the Project Area and Offsite Communication Towers

Cooper et al. (2011) conducted surveillance radar and audiovisual sampling at the Kawailoa Wind Power project area in summer and fall 2009 to sample representative seabird passage rates over the site for use in estimating the risk of seabird take resulting from collisions with turbines and met towers. Supplementary radar surveys were conducted in June 2011 for 16 nights to measure passage rates over the northeastern most turbine string. Two new areas were sampled for five nights each to increase radar coverage of the project site. Sites sampled in 2009 were also resampled for three nights each. Preliminary analysis of the data shows similar passage rates to those measured in 2009 both at the new sites and the resampled sites. The additional data are not expected to significantly change the average passage rate over the site. The final report for the 2011 summer survey will be available in September 2011.

These surveys found an extremely low number of targets exhibiting flight speeds and flight patterns that fit the "shearwater-like" category. Over five nights of sampling in June 2009, Cooper et al. (2011) recorded one landward-flying and 20 seaward-flying radar targets that fit the criteria for shearwater-like targets. In October 2009 a single landward-flying target and 52 seaward-flying radar targets were recorded over five nights of sampling. The mean movement rate across all nights and both sites was 0.60 ± 0.07 shearwater-like targets/h in summer 2009 and 1.41 ± 0.15 shearwater-like targets/h in fall 2009 (Cooper et al. 2011).

No visual identification of these targets were possible for both the 2009 and 2011 surveys; however, Cooper et al. (2011) suggests that the individuals were more likely to be Newell's shearwaters than Hawaiian petrels due to the timing of movements and the available literature indicating that Newell's shearwaters but not Hawaiian petrels occur on O‘ahu. Based on surveys conducted on other islands, Newell's shearwaters appear to move to the interior portions of the islands starting about 30 min after sunset. Hawaiian petrel movements begin at sunset and go to about 60 min after sunset (Day et al. 2003b). Additionally, Cooper et al. (2011) indicated that the fall radar data were highly likely to include an unknown proportion of plovers (thus conservatively inflating movement rates used in the shearwater fatality models) based on observations of Pacific golden-plovers during fall sampling, the difficulty of separating plover targets from shearwater targets on radar, and the higher movement rates observed in fall when lower numbers of shearwaters are expected to occur. Due to the high possibility of high target contamination in the fall, the passage rates of Newell's shearwaters were modeled based on summer movement rates only resulting in an annual movement rate of 731 bird passes/year over the entire site.

The Newell's shearwater has not been confirmed as a nesting species on O‘ahu (Ainley et al. 1997). Assuming the birds were Newell's shearwaters, then their observed behavior of flying to and from the Ko‘olau Range suggests that at least a small number of these birds are breeding or prospecting in these mountains. Because of the few detections obtained during the Day and Cooper study and lack of radar studies from adjacent lands, it is not known whether the Kawailoa Wind Power project area lies within the primary corridor used by these few birds as they move between their nesting areas and the ocean. Observations of Newell's shearwaters in the Hawaiian Islands indicate that approximately 75% of shearwaters will fly at or below turbine height (Cooper et al. 2011)

No radar studies were conducted at the offsite communication tower sites because the proposed antennae would mounted on existing towers, the antennae are not expected to significantly increase the collision risk of any Covered Species if they should happen to transit the tower location.

3.6.3 (b) Hawaiian Duck

Population, Biology, and Distribution

The Hawaiian duck is a non-migratory species endemic to the Hawaiian Islands, and the only endemic duck extant in the main Hawaiian Islands (Uyehara et al. 2008). The Hawaiian duck is a small, mottled brown duck with emerald green to blue patches on their wings (speculums). Males are typically larger, have distinctive dark brown chevrons on the breast feathers, an olive-colored bill, and bright orange feet. Females are slightly smaller and lighter in color (Evans et al. 1994; USFWS 2005a). Compared to feral mallard ducks, Hawaiian ducks are more cryptic and about 20 to 30% smaller (Uyehara et al. 2007).

The historical range of the Hawaiian duck includes all the main Hawaiian Islands, except for the Islands of Lāna'i and Kaho'olawe. Hawaiian ducks are strong flyers and usually fly at low altitudes. Intra-island movement has been recorded, where they may move between ephemeral wetlands or disperse to montane areas during the breeding season (Engilis et al. 2002). Hawaiian ducks also fly inter-island and have been documented to fly regularly between Niihau and Kauai in response to above-normal precipitation and the flooding and drying of Niihau's ephemeral wetlands (USFWS 2005a). Hawaiian ducks occur in aquatic habitats up to an altitude of 10,000 feet in elevation (Uyehara et al. 2007). The only naturally occurring population of Hawaiian duck exists on Kaua'i, with reintroduced populations on O'ahu, Hawai'i and Maui (Pratt et al. 1987; Engilis et al. 2002; Hawaii Audubon Society 2005).

Hawaiian ducks are closely related to mallards (Browne et al. 1993). Due to this close genetic relationship, Hawaiian ducks will readily hybridize with mallards and allozyme data indicate there has been extensive hybridization between Hawaiian duck and feral mallards on O'ahu, with the near disappearance of Hawaiian duck alleles from the population on the island (Browne et al. 1993). Uyehara et al. (2007) found a predominance of hybrids on O'ahu and samples collected by Browne et al. (1993) from ducks and eggs at the Kii Unit of the James Campbell NWR found mallard genotypes. In 2005, a peak count of 141 Hawaiian duck x mallard hybrids was recorded on the Kii Unit of the James Campbell NWR (USFWS unpublished data). Populations on Maui are also suspected to largely consist of Hawaiian duck x mallard hybrids. Estimated Hawaiian duck hybrid counts on these islands are 300 and 50 birds, respectively (Engilis et al. 2002; USFWS 2005a). The current wild population of pure Hawaiian ducks is estimated at approximately 2,200 birds. Approximately 200 pure individuals occur on the Island of Hawai'i and the remainder resides on Kaua'i. Because of similarities between the species, it can be difficult to distinguish between pure Hawaiian ducks, feral hen mallards, and hybrids during field studies.

Habitat types utilized by the Hawaiian duck include natural and man-made lowland wetlands, flooded grasslands, river valleys, mountain streams, montane pools, forest swamplands, aquaculture ponds, and agricultural areas (Engilis et al. 2002; Hawaii Audubon Society 2005; USFWS 2005a). The James Campbell NWR provides suitable habitat for foraging, resting, pair formation, and breeding (Engilis et al. 2002). No suitable habitat for Hawaiian duck occurs on the Kawailoa Wind Power project area.

Breeding occurs year-round, although the majority of nesting occurs from March through June (USFWS 2005). The peak breeding season on Kauai Island occurs between December and May and the peak on Hawai'i Island occurs from April to June (Uyehara et al. 2008). Nests are placed in dense shoreline vegetation of small ponds, streams, ditches and reservoirs (Engilis et al. 2002). Types of vegetation associated with nesting sites of Hawaiian duck include grasses, rhizominous ferns and shrubs (Engilis et al. 2002). The diet of Hawaiian ducks consists of aquatic invertebrates, aquatic plants, seeds, grains, green algae, aquatic mollusks, crustaceans and tadpoles (Engilis et al. 2002; USFWS 2005a).

Current Threats

Hybridization with mallards is the largest threat to the Hawaiian duck. Reintroduction of pure Hawaiian ducks to O'ahu is being contemplated, although in order for pure Hawaiian ducks to continue to exist on O'ahu following reintroduction, the removal of all hybrids and the elimination of all sources of feral mallard ducks will need to occur (Engilis et al. 2002). James Campbell NWR at Kahuku is expected to play a key role in any future reintroduction of pure Hawaiian ducks to O'ahu (USFWS 2005a). At present it is uncertain when reintroduction would occur, but it is possible that reintroduction could occur during the 20-year life of the proposed wind energy project.

In addition to hybridization concerns, Hawaiian ducks are predated by mongoose, feral cats, feral dogs, and possibly rats (Engilis et al. 2002). Black-crowned night herons, largemouth bass (*Micropterus salmoides*), and bullfrogs have been observed to take ducklings (Engilis et al. 2002). Avian diseases are another threat to Hawaiian ducks, with outbreaks of avian botulism (*Clostridium botulinum*) occurring annually throughout the state. In 1983, cases of adult and duckling mortality on O'ahu were attributed to aspergillosis and salmonella (Engilis et al. 2002). As stated previously, the loss and degradation of coastal wetlands have been a significant factor in the decline of these birds in Hawai'i.

Little is known about the interaction of Hawaiian ducks with wind turbines. Studies of wind energy facilities located in proximity to wetlands and coastal areas in other parts of the United States and the world have shown that waterfowl and shorebirds have some of the lowest collision mortality rates at these types of facilities, suggesting that these types of birds are among the best at recognizing and avoiding wind turbines (e.g., Koford et al. 2004; Jain 2005; Carothers 2008). In support of these findings, systematic incidental observations of nene or Hawaiian goose (*Branta sandvicensis*) in flight at the Kaheawa Wind Power facility on Maui indicate this species is capable of exhibiting deliberate avoidance of wind turbines under prevailing conditions (KWP LLC 2008a).

<u>Occurrence in the Project Area and Offsite Communication Towers</u>

Ducks resembling Hawaiian ducks (but likely to be hybrids) have been seen flying over Zone 1 (corresponding to airspace envelopes of turbines 18-30) of the Kawailoa Wind Power project area. A total of 10 sightings of the Hawaiian duck-mallard hybrids have been recorded onsite (five during point count surveys, four incidental sightings and one sighting during driving transect). Flock sizes ranged from one to 15 birds with an average size of four birds. Similar to the black-crowned night heron, birds were observed in flight at the ponds in the area or flying near the lower met tower on Kawailoa road or in the area between the met tower and nearby pond. However, one incidental sighting was also reported along the road southwest of turbine 11. No flocks were seen within the altitude of the rotor swept zone (RSZ) of the proposed turbine (approximately 164 feet altitude or above).

Thus, while flying over the Kawailoa Wind Power project area, ducks may be vulnerable to colliding with the WTGs, and met towers. The risk is probably highest in Zone 1 and likely negligible in Zone 2 and 3 (Zone 2 corresponds to airspace envelopes of turbines 12-14 and Zone 3 to turbines 1-11 and 31-33), given that no waterbird activity (ducks or otherwise) was observed in these zones. Passage rates of ducks were only applied to Zone 1 and the estimated passage rate area is 0.054 birds/ha/hr. The passage rate of ducks in Zone 2 and 3 is presumed to be zero (SWCA 2010a).

There are no open water features near the proposed location of the offsite communication towers, and waterbirds have not been historically documented at Mt. Ka'ala (DOFAW 1990). In addition, none of the listed waterbird species has been observed at the site (Hobdy 2010c; Mosher 2010).

Because of the hybridization of Hawaiian ducks with feral mallards, it is questionable whether any pure Hawaiian ducks are resident on the Island of O'ahu (Browne et al. 1993; Uyehara et al. 2007; USFWS 2005a). Given the dispersal capabilities of the species, it is possible for pure Hawaiian ducks to occasionally fly over from Kaua'i. However, genetic research in 2007 showed presence of several Hawaiian ducks at James Campbell National Wildlife Refuge, and a bird struck by a plane at Honolulu International Airport in 2007 was found to be Hawaiian duck (A. Nadig, USFWS, pers comm.). Therefore, take coverage is being requested for Hawaiian ducks in the event that genetic analysis or visual identification of downed ducks on site result in the assessment of take of a pure Hawaiian duck. Take coverage is also requested in the event that pure Hawaiian ducks are reintroduced to the island of O'ahu during the project permit duration.

3.6.3 (c) Hawaiian Stilt

Population, Biology, and Distribution

The Hawaiian stilt is a non-migratory endemic subspecies of the black-necked stilt (*Himantopus mexicanus mexicanus*). The black-necked stilt occurs in the western and southern portions of North America, southward through Central America, West Indies, to southern South America and also the Hawaiian Archipelago (Robinson et al. 1999). Hawaiian stilt and black-necked stilt are part of a super species complex of stilts found in various parts of the world (Pratt et al. 1987; Robinson et al. 1999). The *U.S. Pacific Islands Regional Shorebird Conservation Plan* considers the Hawaiian stilt as highly imperiled because of its low population level (Engilis and Naughton 2004). Over the past 25 years, the Hawaiian stilt population has shown a general upward trend statewide. Annual summer and winter counts have shown variability from year to year. This fluctuation can be attributed to winter rainfall and variation in reproductive success (Engilis and Pratt 1993; USFWS 2005a). The state population size has recently fluctuated between 1,200 to 1,500 individuals with a five-year average of 1,350 birds (USFWS 2005a). Adult and juvenile dispersal has been observed both intra- and inter-island within the state (Reed et al. 1998).

Oʻahu supports the largest number of stilts in the state, with an estimated 35 to 50% of the population residing on the island. Some of the largest concentrations can be found at the James Campbell NWR, Kahuku aquaculture ponds, Pearl Harbor NWR, and Nuʻupia Ponds in Kāneʻohe (USFWS 2005a). The Kiʻi Unit of the James Campbell NWR, and the Waiawa Unit and Pond 2 of the Honouliuli Unit of the Pearl Harbor NWR are the most productive stilt habitats, with birds numbering near 100 or above during survey counts (USFWS 2002; USFWS unpublished data). Hatching success of stilt nests has been greater than 80% in the Kiʻi Unit, but chick mortality rates are high (USFWS 2002).

Hawaiian stilts favor open wetland habitats with minimal vegetative cover and water depths of less than 9.4 inches, as well as tidal mudflats (Robinson et al. 1999). Stilts feed on small fish, crabs, polychaete worms, terrestrial and aquatic insects, and tadpoles (Robinson et al. 1999; Rauzon and Drigot 2002). Hawaiian stilts tend to be opportunistic users of ephemeral wetlands to exploit the seasonal abundance of food (Berger 1972; USFWS 2005a). Hawaiian stilts nest from mid-February through late August with variable peak nesting from year to year (Robinson et al. 1999). Nesting sites for stilts consist of simple scrapes on low relief islands within and/or adjacent to ponds. Clutch size averages four eggs (Hawaii Audubon Society 2005; USFWS 2005a).

Current Threats

The most important causes of decline of the Hawaiian stilt and other Hawaiian waterbirds is the loss of wetland habitat and predation by introduced animals. Barn owls and the endemic Hawaiian short-eared owl are known predators of adult stilts and possibly their young (Robinson et al. 1999; USFWS 2005a). Known predators of eggs, nestlings, and/or young stilts include small Indian mongoose, feral cat, rats, feral and domestic dogs, black crowned night-heron, cattle egret, common mynah, ruddy turnstone, laughing gull (*Larus atricilla*), American bullfrog (*Rana catesbeiana*), and large fish (Robinson et al. 1999; USFWS 2005a). A study conducted at the Kiʻi Unit of the James Campbell NWR between 2004 and 2005 attributed 45% of stilt chick losses to bullfrog predation over the two breeding periods (USFWS unpublished data). The Kiʻi Unit has on-going control programs for mongoose, feral cats, rats, cane toads (*Bufo marinus*), and bullfrogs (Silbernagle 2008). Other factors that have contributed to population declines in Hawaiian stilts include altered hydrology, alteration of habitat by invasive non-native plants, disease, and possibly environmental contaminants (USFWS 2005a). Although the Hawaiian stilt is considered imperiled, it is believed to have high recovery potential with a moderate degree of threat.

Little is known about the interaction of black-necked stilt with wind turbines in the United States. One black-necked stilt fatality was reported at the Altamont Pass Wind Resource Area from 2005-2007 (Altamont Pass Avian Monitoring Team 2008). The annual adjusted fatality per turbine was 0.00193 stilt per turbine. In general, low mortality of waterbirds has been documented at wind turbines situated coastally despite the presence of high numbers of waterbirds in the vicinity (Kingsley and

Whittam 2007; Carothers 2008). Many studies of coastal-wind energy facilities have shown that waterbirds and shorebirds are among the birds most wary of turbines and that these birds readily learn to avoid the turbines over time (Carothers 2008).

Occurrence in the Project Area and Offsite Communication Towers

No Hawaiian stilts were seen flying over the proposed Kawailoa Wind Power facility during the avian point count surveys conducted by SWCA or Hobdy (SWCA 2011; Hobdy 2010a, 2010b). No stilts have been observed occupying the waterbodies that were surveyed. Two irrigation ponds occur within the 1 km airspace envelope around the lowest turbine string (Zone 1) that may potentially be attractive to Hawaiian stilt. No other coastal wetlands are present within the airspace envelope of the turbine strings. Waimea River is a perennial stream, and is within the airspace envelope of the upper most turbine sting (Zone 3); however, stilts are not expected to be present in Waimea River as they require early successional marshlands for nesting and foraging (USFWS 2005a). However, because of the known dispersal capabilities of these birds (Reed et al. 1998), it is expected that individual stilts can fly over the Kawailoa Wind Power project area on a very irregular basis while moving between wetlands or islands.

There are no open water features near the communication sites; therefore, no waterbirds are expected. There are no open water features near proposed location of the offsite communication towers, and waterbirds have not been historically documented at Mt. Ka'ala (DOFAW 1990). In addition, none of the listed waterbird species have been observed at the sites (Hobdy 2010c; Mosher 2010)

3.6.3 (d) Hawaiian Coot

Population, Biology, and Distribution

The Hawaiian coot is an endangered species endemic to the main Hawaiian Islands, except Kaho'olawe. The Hawaiian coot is non-migratory and believed to have originated from migrant American coots (*Fulica americana*) that strayed from North America. The species is an occasional vagrant to the Northwestern Hawaiian Islands west to Kure Atoll (Pratt et al. 1987; Brisbin et al. 2002).

The population of Hawaiian coot has fluctuated between 2,000 and 4,000 birds. Of this total, roughly 80% occur on O'ahu, Maui, and Kaua'i (Engilis and Pratt 1993; USFWS 2005a). The O'ahu population fluctuates between approximately 500 to 1,000 birds. Hawaiian coots occur regularly in the Ki'i Unit of the James Campbell NWR, with peak counts in 2005 and 2006 reaching nearly 350 birds (USFWS 2002, 2005a; unpubl. data). Population fluctuations in these areas are attributed to seasonal rainfall and variation in reproductive success. Inter-island dispersal has been noted and is presumably influenced by seasonal rainfall patterns and food abundance (USFWS 2005a).

Coots are usually found on the coastal plain of islands and prefer freshwater ponds or wetlands, brackish wetlands, and man-made impoundments. They prefer open water that is less than 11.8 inches deep for foraging. Preferred nesting habitat has open water with emergent aquatic vegetation or heavy stands of grass (Schwartz and Schwartz 1949; Brisbin et al. 2002; USFWS 2005a). Nesting occurs mostly from March through September, with opportunistic nesting occurring year round depending on rainfall. Hawaiian coots will construct floating nests of aquatic vegetation, semi-floating nests attached to emergent vegetation or nests in clumps of wetland vegetation (Brisbin et al. 2002; USFWS 2005a). False nests are also sometimes constructed and used for resting or as brooding platforms (USFWS 2005a). Coots feed on seeds, roots and leaves of aquatic and terrestrial plants, freshwater snails, crustaceans, tadpoles of bullfrogs and marine toads, small fish, and aquatic and terrestrial insects (Schwartz and Schwartz 1949; Brisbin et al. 2002).

Current Threats

The USFWS *Second Draft Recovery Plan for Hawaiian Waterbirds* (2005a) lists the Hawaiian coot as having high potential for recovery and a low degree of threats (USFWS 2005a). Introduced feral cats, feral and domestic dogs, and mongoose are the main predators of adult and young Hawaiian coots (Brisbin et al. 2002; Winter 2003). Other predators of young coots include black-crowned night heron, cattle egret and large fish. Coots are susceptible to avian botulism outbreaks in the Hawaiian Islands (Brisbin et al. 2002). Wetland loss and degradation has also been noted as contributing to the decline of this species, as stated previously. Low numbers of American coot fatalities have been reported at two wind facilities in California and Minnesota, although in these cases standing or ponded water within the project area was an attractant (Erickson et al. 2001).

Occurrence in the Project Area and Offsite Communication Towers

One observation of the Hawaiian coot was made at an adjacent water body in September 2010. This individual was foraging in the pond when observed and did not take flight. The individual was of the rare color morph, with a red frontal shield instead of white. Only 1-3% of the Hawaiian coot has the red frontal shield like the American coot, *Fulica americana* (Engilis and Pratt 1993). This individual was not present when subsequent observations were made later in September. Two irrigation ponds also occur within the 0.6 miles (1 km) airspace envelope around the lowest turbine string (Zone 1) and may be attractive to Hawaiian coots. No other coastal wetlands are present within the airspace envelope of the turbine strings. Waimea River is a perennial stream, and is within the airspace envelope of the upper most turbine string (Zone 3), however, Hawaiian coots are not expected to be present in Waimea River as they are primarily a species of the coastal plains (USFWS 2005a). Hawaiian coots are known to disperse between islands and coupled with the one-time observation of a foraging coot at Pond 03, there is potential for coots to occasionally fly over the lower elevations of Kawailoa Wind Power project area if moving between foraging sites or islands. No suitable habitat for Hawaiian coot occurs on the Kawailoa Wind Power project area.

There are no open water features near proposed location of the offsite communication towers, and waterbirds have not been historically documented at Mt. Kaʻala (DOFAW 1990). In addition, none of the listed waterbird species have been observed at the site (Hobdy 2010c; Mosher 2010).

3.6.3 (e) Hawaiian Moorhen

Population, Biology, and Distribution

The Hawaiian moorhen is an endemic, non-migratory subspecies of the cosmopolitan common moorhen (*Gallinula chloropus*). It is believed that the subspecies originated through colonization of Hawaiʻi by stray North American migrants (USFWS 2005a). Originally occurring on all of the main Hawaiian Islands (excluding Lānaʻi and Kahoʻolawe), the Hawaiian moorhen is currently limited to regular occurrence on the Islands of Kauaʻi and Oʻahu (Hawaii Audubon Society 2005; USFWS 2005a). A population was reintroduced to Molokaʻi in 1983, but no individuals remain on the island today.

Hawaiian moorhen are very secretive; thus, population estimates and long-term population trends are difficult to approximate (Engilis and Pratt 1993; Hawaii Audubon Society 2005; USFWS 2005a). The population of Hawaiian moorhen appears to be stable, with an average annual total of 314 birds estimated between 1977 and 2002. Approximately half of this population occurs on Oʻahu. Seasonal fluctuations in population have been recorded, although this is believed to be an artifact of sparser vegetation allowing greater visibility in fields in winter than in summer (USFWS 2005a). In 2006, a peak of over 90 moorhen was recorded at the Kiʻi Unit of the James Campbell NWR.

In Hawaii, moorhen largely depend on agricultural and aquaculture habitats. They prefer freshwater marshes, taro patches, reservoirs, wet pastures, lotus fields, and reedy margins of water courses. The habitats in which they occur are generally below 410 feet in elevation (Pratt et al. 1987; Engilis and Pratt 1993; Hawaii Audubon Society 2005; USFWS 2005a). According to the *Second Draft Recovery Plan for Hawaiian Waterbirds* (USFWS 2005a), the key components of moorhen habitat are: 1) dense stands of emergent vegetation near open water; 2) slightly emergent vegetation mats; and 3) shallow, freshwater areas. No such habitat is present on the Kawailoa Wind Power project area.

Hawaiian moorhens will nest on open ground and wet meadows, as well as on banks of waterways and in emergent vegetation over water (Bannor and Kiviat 2002). Typically, nesting areas have standing water less than 24 inches deep. Nesting occurs year-round with the majority of nesting activity occurring from March through August (Bannor and Kiviat 2002; USFWS 2002). Timing of nesting by the Hawaiian moorhen is dependent on water levels and growth of suitable emergent vegetation (USFWS 2002).

Although the specific diet of the Hawaiian moorhen is not known, it is presumed the birds are opportunistic feeders (USFWS 2005a). Moorhens are very closely related to coots, and it is presumed that the diet of Hawaiian moorhens is generally similar to that described above for Hawaiian coot.

Current Threats

As previously stated, coastal wetland loss and degradation as a result of commercial, residential, and resort developments have been identified as a key threat to the Hawaiian moorhen (Evans et al. 1994; USFWS 2005a). Feral cats, feral and domestic dogs, mongoose, and bullfrogs are known predators of Hawaiian moorhen. Black-crowned night herons and rats are also as possible predators (Byrd and Zeillemaker 1981; Bannor and Kiviat 2002; USFWS 2005a). The Hawaiian moorhen is highly susceptible to disturbance by humans and introduced predators (Bannor and Kiviat 2002). The moorhen is considered to have a high potential for recovery with a moderate degree of threats (USFWS 2005a).

There have only been a few published reports of the closely related common moorhen colliding with turbines in Europe; Ireland (Percival 2003) and Netherlands (Hötker et al. 2006); none in the United States. This is despite the fact that common moorhen are frequently found around wind turbines located near wetlands. However, one study in Spain lists the common moorhen at "some" collision risk with power lines due to their flight performance and also records one instance of mortality due to collision (Janss 2000).

Occurrence in the Project Area and Offsite Communication Towers

No Hawaiian moorhens were detected during the year of avian point count surveys on the Kawailoa Wind Power project area. However, Hawaiian moorhen have been seen regularly at nearby water bodies and may potentially be attracted to the two irrigation ponds within the airspace envelope of the lower turbine string (Zone 1). Hawaiian moorhen were observed in flight only once in December, where two individuals made a short flight 23 feet below the stream bank northwest of Zone 3. A total of three individuals have been seen/heard at Pond 05 (Figure 3-1) and have responded to moorhen call playbacks on three occasions. These moorhen are likely resident. Hawaiian moorhen were also seen at two locations at ʻUkoʻa Pond during a site visit by SWCA biologist on November 30, 2010. Hawaiian moorhen have not been seen at any of the other water bodies and moorhen playbacks have not elicited any response in any of these areas.

A total of 10 moorhen are also resident in the lotus ponds in Waimea Valley (Pool 2010). Three moorhen adults and two chicks were seen by SWCA biologists on a visit conducted on April 23, 2010. However, Hawaiian moorhen are not expected to be present in the upper reaches of Waimea River, within the airspace envelope of Zone 3, due to the lack of suitable habitat. Given their ability to fly and their occurrence at Waimea Valley, it is possible that individual Hawaiian moorhens will fly over the project area, especially the lower elevation portion.

There are no open water features near proposed location of the offsite communication towers, and waterbirds have not been historically documented at Mt. Kaʻala (DOFAW 1990). In addition, none of the listed waterbird species have been observed at the site (Hobdy 2010c; Mosher 2010).

3.6.3 (f) Hawaiian Hoary Bat

Population, Biology, and Distribution

The Hawaiian hoary bat is the only native land mammal present in the Hawaiian Archipelago. It is a sub-species of the hoary bat (*Lasiurus cinereus*), which occurs across much of North and South America. Both males and females have a wingspan of approximately one foot, although females are typically larger-bodied than males. Both sexes have a coat of brown and gray fur. Individual hairs are tipped or frosted with white (Mitchell et al*.* 2005).

The species has been recorded on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i, but no historical population estimates or information exist for this subspecies. Population estimates for all islands in the state in the recent past have ranged from hundreds to a few thousand bats (Menard 2001). The Hawaiian hoary bat is believed to occur primarily below an elevation of 4,000 feet. This subspecies has been recorded between sea level and approximately 9,050 feet in elevation on Maui, with most records occurring at or below approximately 2,060 feet (USFWS 1998).

Hawaiian hoary bats roost in native and non-native vegetation from 3 to 29 feet above ground level. They have been observed roosting in ohia, hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Prosopis pallida*), avocado (*Persea americana*), mango (*Mangifera indica*), shower trees (*Cassia javanica*), pūkiawe *(Leptecophylla tameiameiae*), and fern clumps; they are also suspected to roost in eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands. The species has been rarely observed using lava tubes, cracks in rocks, or man-made structures for roosting. While roosting during the day, Hawaiian hoary bat are solitary, although mothers and pups roost together (USFWS 1998).

Preliminary study of a small sample of Hawaiian hoary bats (n=18) on the Island of Hawai'i have estimated short term (1-2 weeks) core range habitat sizes of 84.3 acre (34.1ha; n=14) for males and 41.2 acre (16.7 ha; n=11) for a female bat (USGS unpublished data). The size of home ranges and core areas varied widely between individuals. Core areas included feeding ranges that were actively defended, especially by males, against conspecifics. Female core ranges overlapped with male ranges. Bats typically feed along a line of trees, forest edge or road and a typical feeding range stretches around 300 yd (275 m). Bats will spend 20 to 30 minutes hunting in a feeding range before moving on to another (Bonaccorso 2011).

It is suspected that breeding primarily occurs between April and August. Lactating females have been documented from June to August, indicating that this is the period when non-volant young are most likely to be present. Breeding has only been documented on the Islands of Hawai'i and Kaua'i (Baldwin 1950; Kepler and Scott 1990; Menard 2001). Seasonal changes in the abundance of Hawaiian hoary bat at different elevations indicate that altitudinal movements occur on the Island of Hawai'i. During the breeding period (April through August), Hawaiian hoary bat occurrences increase in the lowlands and decrease at high elevation habitats. In the winter, bat occurrences increase in high elevation areas (above 5,000 feet) especially from January through March (Menard 2001; Bonaccorso 2011).

Hawaiian hoary bats feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes and termites (Whitaker and Tomich 1983). They appear to prefer moths ranging between 0.6 and 0.89 inches in size (Bellwood and Fullard 1984; Fullard 2001). Koa moths (*Scotorythra paludicola*), which are endemic to the Hawaiian islands and use koa (*Acacia koa*) as a host plant (Haines et al. 2009), are frequently targeted as a food source (Gorresen 2009). Prey is located using echolocation. Water courses and edges (e.g., coastlines and forest/pasture boundaries) appear to be important foraging areas (Grindal et al. 1999; Francl et al. 2004; Brooks and Ford 2005; Morris 2008; Menzel et al. 2002). In addition, the species is attracted to insects that congregate near lights (USFWS 1998; Mitchell et al. 2005). They begin foraging either just before or after sunset depending on the time of year (USFWS 1998; Mitchell et al. 2005).

Current Threats

Possible threats to the Hawaiian hoary bat include pesticides (either directly or by impacting prey species), predation, alteration of prey availability due to the introduction of non-native insects, and roost disturbance (USFWS 1998). Management of the Hawaiian hoary bat is also limited by a lack of information on key roosting and foraging areas, food habits, seasonal movements, and reliable population estimates (USFWS 1998).

In their North American range, hoary bats are known to be more susceptible to collision with wind turbines than most other bat species (Johnson et al*.* 2000; Erickson 2003; Johnson 2005). Most mortality has been detected during the fall migration period. Hoary bats in Hawai'i do not migrate in the traditional sense, although as indicated, some seasonal altitudinal movements occur. Currently, it is not known if Hawaiian hoary bats are equally susceptible to turbine collisions during their altitudinal migrations as hoary bats are during their migrations in the continental U.S. At the Kaheawa Wind Power facility, two Hawaiian hoary bat fatalities have been observed since the start of project operations.

Occurrence in the Project Area and Offsite Communication Towers

Two to nine Anabat detectors have been deployed at various locations on the Kawailoa Wind Power project area beginning in October 2009. These studies are presently on-going, with detectors being moved to new locations from time to time to increase the area sampled. Anabat detectors detect the presence of bats by recording ultrasonic sounds emitted by bats during echolocation.

A total of 2,466 detector nights were sampled from October 2009 to January 2011 at 19 locations. During this period, bat activity over the entire site occurred at an average of 0.12 bat passes/detector night. The bat activity rates on site were divided into higher and lower activity periods. Higher activity periods were months with an average bat activity greater than 0.1 passes/detector night. Lower activity periods were months with an average of less than 0.1 passes/detector night. The higher activity period for Kawailoa Wind Power was between the months of March to November with an average activity rate of 0.15 passes/detector night for that period. February was excluded as a month with higher bat activity as 95% of the call sequences were detected on February 28. June and October were included in the higher bat activity period as these months are bracketed by months that are considered "higher activity." The low activity period occurs during the months of December through February with an average activity rate of 0.045 passes/detector night. The data suggest that bat activity increases from March through November and is lowest or absent in the winter. Bat activity was recorded throughout the project area within a wide variety of landscape features, including clearings, along roads, along the edges of treelines, in gulches and at irrigation ponds. Bat calls are also distributed throughout the night. The overall detection rates at Kawailoa Wind Power are approximately five times lower than the detection rates at Hakalau National Wildlife Refuge (0.66 passes/detect or night) (Bonaccorso 2011) but are ten times the rates at Kaheawa Wind Pastures and Kahuku Wind Power, both of which have an activity rate of approximately 0.01 bat passes/detector night (SWCA 2010d).

The actual number of bats represented by the detections made by the Anabat detectors on the Kawailoa Wind Power site is not known. The reported bat activity rates are also relative, rather than absolute measures of bat activity at the site. While the Anabats were placed in a variety of locations and vegetation types to ensure good representation of the site, these Anabats were not randomly placed at each location but situated in spots sheltered from wind, along roads or edges of vegetation to maximize the probability of detecting a bat. Hence the average bat activity over the Kawailoa Wind Power site is likely to be much less than the measured rate.

Cooper et al. (2009) visually observed two Hawaiian hoary bats on-site incidental to the seabird radar survey in June 2009, but no bats in October 2009. Those observations translated to an estimated summer occurrence rate of two bats in 84 25-min observation sessions (i.e., 0.057 bats/hour). Both bats were flying at an altitude of ≤5 m (Cooper et al. 2009). Given these results, it is presumed that a number of Hawaiian hoary bats forage over the Kawailoa Wind Power project area on a somewhat regular, though possibly seasonal, basis. These bats may also roost in the area.

No surveys for Hawaiian hoary bats were conducted at the microwave facility sites. Given the native forest that surrounds the microwave facility sites, bats may be expected to forage in the area at least occasionally.

3.6.4 State of Hawaiʻi Listed Covered Species

3.6.4 (a) Hawaiian Short-eared Owl

Population, Biology, and Distribution

The Hawaiian short-eared owl is an endemic subspecies of the nearly cosmopolitan short-eared owl

(*Asio flammeus*). This is the only extant owl native to Hawai‘i and is found on all the main islands from sea level to 8,000 feet. The Hawaiian short-eared owl is listed by the State of Hawai‘i as endangered on the Island of O‘ahu and is included as a Covered Species.

Unlike most owls, Hawaiian short-eared owls are active during the day (Mostello 1996; Mitchell et al. 2005), though nocturnal or crepuscular activity has also been documented (Mostello 1996). Hawaiian short-eared owls are commonly seen hovering or soaring over open areas (Mitchell et al. 2005).

No surveys have been conducted to date to estimate the population size of Hawaiian short-eared owl. The species was widespread at the end of the 19th century, but numbers are thought to be declining (Mostello 1996; Mitchell et al. 2005).

Hawaiian short-eared owl occupy a variety of habitats, including wet and dry forests, but are most common in open habitats, such as grasslands, shrublands and montane parklands, including urban areas and those actively managed for conservation (Mitchell et al. 2005). Evidence indicates the owls became established on Hawai‘i in relatively recent history, with their population likely tied to the introduction of Polynesian rats (*Rattus exulans*) to the islands by Polynesians.

Pellet analyses indicate that rodents, birds and insects, respectively, are their most common prey items of Hawaiian short-eared owls (Snetsinger et al. 1994; Mostello 1996). Birds depredated by Hawaiian short-eared owl have included passerines, seabirds and shorebirds (Snetsinger et al. 1994; Mostello 1996; Mounce 2008). The Hawaiian short-eared owl relies more heavily on birds and insects than its continental relatives (Snetsinger et al. 1994), likely because of the low rodent diversity of the Hawaiian Islands (Mostello 1996).

Hawaiian short-eared owls nest on the ground. Little is known about their breeding biology, but nests have been found throughout the year. Nests are constructed by females and consist of simple scrapes in the ground lined with grasses and feather down. Females perform all incubating and brooding, while males feed females and defend nests. The young may leave the nest on foot before they are able to fly and depend on their parents for approximately two months (Mitchell et al. 2005).

<u>Current Threats</u>

Loss and degradation of habitat, predation by introduced mammals, and disease threaten the Hawaiian short-eared owl. Hawaiian short-eared owls appear particularly sensitive to habitat loss and fragmentation. Ground nesting birds are more susceptible to the increased predation pressure that is typical within fragmented habitats and near rural developments (Wiggins et al. 2006). These nesting habits make them increasingly vulnerable to predation by rats, cats and the small Indian mongoose (Mostello 1996; Mitchell et al. 2005).

Some mortality of Hawaiian short-eared owls on Kaua‘i has been attributed to “sick owl syndrome,” which may be caused by pesticide poisoning or food shortages. They may be vulnerable to the ingestion of poisoned rodents. However, in the one study on mortality that has been conducted, no evidence was found that organochlorine, organophosphorus, or carbamate pesticides caused mortality in Hawaiian short-eared owls (Thierry and Hale 1996). Other causes of death on Maui, O‘ahu, and Kaua‘i have been attributed to trauma (apparently vehicular collisions), emaciation, and infectious disease (pasteurellosis) (Thierry and Hale 1996). However, persistence of these owls in lowland, non-native and rangeland habitats suggests that they may be less vulnerable to extinction than other native birds. This is likely because they may be resistant to avian malaria and avian pox (Mitchell et al. 2005), and because they are opportunistic predators that feed on a wide range of small animals.

Little information is available on the impacts of wind facilities on owls. However, four fatalities of short-eared owl (*Asio flammeus flammeus*) have been recorded at McBride Lake, Alberta, Canada, Foote Creek Rim, Wyoming, Nine Canyon, Wyoming, and Altamont Wind Resource Area, California (Kingsley and Whittam 2007). Hawaiian short-eared owls are present year-round and observed regularly in the vicinity of the Kaheawa Wind Power facility on Maui, with one turbine related fatality reported since the start of project operations. In the vicinity of turbines, most observations of Hawaiian short-eared owl have been below the rotor swept zone of the turbines and thus their susceptibility to collision appears to be low (Spencer 2009). At Wolfe Island, Ontario, it was observed that short-eared owls were most vulnerable to colliding with turbine blades during predator avoidance and during aerial flight displays (Stantec Consulting, Ltd. 2007). Short-eared owls on O‘ahu have no aerial predators and thus may only be vulnerable to colliding with turbines during flight displays.

Occurrence in the Project Area and Offsite Communication Towers

Hawaiian short-eared owls were not detected at the Kawailoa Wind Power project area or at the nearby water bodies. Because these owls are active during daytime and crepuscular periods, it seems probable that they would have been detected during the avian point counts if resident onsite. Regurgitated owl pellets of rodent hair and bones were observed on a trail on a grassy ridgetop in the upper part of the site (Hobdy 2010a) and numerous pellets have been found during the monitoring of the met towers at Kawailoa (SWCA, personal observations). However, it is probable that these belong to the barn owl (*Tyto alba*) which does occur on site. Despite these observations, as suitable grassland habitat does occur at the project site, the Hawaiian short-eared owl may occasionally be present.

No Hawaiian short-eared owls were seen during the wildlife surveys at the Mt. Ka‘ala communication tower sites. It has not been historically documented at Mt. Ka‘ala (DOFAW 1990).

3.7 Historical, Archaeological, and Cultural Resources

The archaeological integrity of the tablelands and the coastal plain behind Waialua Bay have for the most part been compromised by historic period ranching, cultivation, silviculture, military activities, and modern habitation, though nearby river valleys contain intact remnants of prehistoric and historic period Hawaiian occupation and use. The following section summarizes the historical, archaeological, and cultural resources. Additional detail is provided in the *Archaeological Inventory Survey of the First Wind Kawailoa Wind Project Area*, contained in Appendix A.

3.7.1 Pre-Historic and Historic Context and Land Uses

The proposed wind farm site is located within the Kawailoa ahupua‘a. The Kawailoa ahupua‘a, and many of the places named within it, have traditional legends and historical accounts associated with them. In particular, the Waimea River valley to the north and the ‘Uko‘a Pond makai of the project area are associated with legends, most of which relate to this area’s long-standing association with very old lines of prominent priests on O‘ahu. Historical accounts reference the *heiau* at Waimea, one being Pu‘u o Mahuka, on a high bluff north of where the river enters the ocean, and the other being Kupopolo, near the beach south of the river mouth (Takemoto 1974).

Numerous caves within the high cliffs that separate the bluff-sides of Waimea Valley from the ocean below contained human remains and associated burial goods, including canoes and kapa cloth (Takemoto 1974). The seaside cliffs marked the line of transition between the land of the living and the land of the dead, the latter being the ocean. The fertile soils of the valley and the water of the river were modified through human action to form cultivatable terraces and irrigation channels. Before the arrival of Europeans to the area, the valley was known for its taro, sweet potatoes, ‘awa, and breadfruit. Following his visit to the Waimea River Valley, McAllister (1933) reported the remains of agricultural terraces on both sides of the river for up to a distance of two miles inland from the bay. Irrigation ditches and numerous housing enclosures support historic observations that the valley around Waimea Bay was once heavily populated. According to the records of Thrum (1907) and McAllister (1933), the broader and flatter landscape around Waialua Bay was marked by ponds, irrigated pond fields, irrigation ditches, various heiau, and akua stones (Kirch 1992).

3.7.2 Archaeological and Historical Accounts

Soon after going ashore at Waimea Bay in 1779, Captain Clerke walked up the Waimea River valley, which he described as “well cultivated and full of villages” (Kuykendall 1938). Generally speaking, the coastal lands southwest of the project area and southeast of Waimea Bay were occupied by houses, occasional fishponds, and small cultivation plots containing kalo and sweet potato (Pfeffer and Hammatt 1992). Mauka of the coastal plain, irrigated taro fields were created in the bottoms of river valleys, such as those within the Anahulu River valley. Higher up the valley slopes were hillside, or kula, cultivation of crops and trees. Isolated pockets of planted areas occurred even higher up in the narrower confines of the valleys and their numerous tributaries. Families owned plots in these different zones so that they could use the diverse resources. At the very high end of the river valleys Hawaiians collected a variety of wild plants and hunted birds.

It is only after the armed forces of Kamehameha I permanently occupied Oʻahu in 1804 that the interior of the Anahulu River valley became used and modified more intensively, which included the construction of irrigation canals and terraced fields for as much as three miles up the valley. A variety of stone features have been identified on the colluvial and talus slopes of the Anahulu valley uplands. Among these are stone piles, stone walls, stone-lined planting circles, small stone-walled garden plots, and terraces cleared of talus; these features were probably related to the growing of sweet potato, paper mulberry, yam, and banana (Kirch 1992).

Handy and Handy (1972) maintain that the dry gulches between Anahulu and Waimea Rivers (those within the project area) probably never watered taro. It is likely that cultivators within the Anahulu valley used the rich tablelands on both sides for shifting cultivation even before the settlement of Europeans in the area. In Māhele land claims, for example, some of the upper valley claimants refer to swidden-like garden plots in the flat portions of mountains, which could refer to the surrounding tablelands (Kirch 1992). Moreover, maps of land claims in upper portion of the valley, known as Kawailoa-uka, show winding trails connecting valley bottom residences and terraced fields with tableland top ridge spurs (Kirch 1992).

As part of the Māhele of 1848, Kawailoa ahupuaʻa was awarded to Victoria Kamāmalu, thus ownership eventually fell to the Bishop Estate (now Kamehameha Schools). According to the Waihona ʻĀina database there were 95 kuleana claims made for Kawailoa ahupuaʻa. Most of these were for land makai of the project area and in Anahulu Valley. However, Cane Haul Road, which follows a former railway alignment, traverses four small kuleana parcels.

Between 1850 and 1900, substantial portions of the project area were planted in sugarcane (Pfeffer and Hammatt 1992). Early in the plantation history sugarcane did not extend higher than the 200 feet contour above sea level. Above this elevation, pineapples were grown. However, sometime after that date, with increased technology sugarcane supplanted pineapples in the upper fields. By 1936, irrigation reservoirs, wells, and canals were introduced, an infrastructural development that drastically increased production output. The sugar and pineapple companies modified and used most of the land within the project area, clearing original vegetation, leveling original landforms, digging ditches, constructing reservoir walls, and building roads and railroads. These alterations virtually obliterated material traces left by both traditional Hawaiian and early historical agricultural modification of the tablelands. Substantial amounts of foreign laborers (mostly Chinese, Filipino, and Japanese) were imported to work the fields, with labor camps dotting the landscape (Pfeffer and Hammatt 1992). As far as can be ascertained, the Kawailoa plantation field camp partly overlapped the Kawailoa Road corridor. The largest of the camps in this area, the Kawailoa Camp, included over 500 homes, an elementary school, a gym, a swimming pool, a theater, two stores, two barber's shops, three community baths, a Japanese-language school, and a Buddhist temple (the Kawailoa Ryusenji Soto Mission) (Clark 2007).

By 1920, the Oʻahu Railway and Land Company, originally started in 1886, built tracks that skirted the island's shoreline (Dorrance and Morgan 2000); a rail line zigzags across the lower portion of the project area. As early as World War I, the U.S. Army considered using the railway system in the event of an enemy attack on the northern side of the island; over the course of time, several military operations were undertaken in the vicinity of the project area. In 1942, the U.S. Army-built Battery Carroll Riggs on a plantation workers camp in an area currently known as Opaeula Ranch, southwest of the project area. South of Battery Riggs, Brodie Camp No. 4 had a cable hut and a 100-pair cable installed (Bennett 2002), as part of a circum-island command and fire control communication system. Northeast of the project area, the Waimea Battery Battle Position serves as the southernmost perimeter of the Waimea Battery, with gun emplacements constructed on a bluff above Kaiwikoele Stream. In addition, Drum Road, which runs from Helemano to the Army's Kahuku training range, was constructed by the U.S. Army in the 1930s to handle increases in military vehicle traffic and to provide an alternative route to the north of the island in the event of potential damage to Kamehameha Highway.

In 1947, the O'ahu Railway and Land Company went out of business, and by 1950, much of the railroad infrastructure had been dismantled. The plantation railways were also dismantled, with hauling of sugarcane conducted by truck. Cultivation continued through the modern era, with the plantation growing to include over 12,000 acres of planted lands. However, over time, sugar production in the Hawaiian Islands became largely unprofitable, resulting in the closure of sugar plantations throughout the islands toward the end of the century. The last sugarcane fields in this area date to 1996 (Dorrance and Morgan 2000). This final episode of sugar planting was marked by heavy machinery creating a virtually continuous wall of push piles along the edges of the fields, and in so doing obliterated much of the older irrigation ditches on the tablelands.

3.7.3 Archaeological Investigation

No archaeological work has been previously conducted within the project area; however, the results of previous archaeological research in the vicinity of the project area provide an indication of the types of sites one would expect to encounter given the physical setting. A detailed account of previous archaeological studies in surrounding areas is provided in the *Archaeological Inventory Survey of the First Wind Kawailoa Wind Project Area* (Rechtman et al. 2011), contained in Appendix B of the accepted EIS (CH2M Hill 2011).

To identify archaeological and historical resources within the project area, a detailed archaeological investigation was conducted by Rechtman Consulting, LLC. The first round of fieldwork for the current project was conducted between April 12 and May 14, 2010, and between February 15 and February 25, 2011, with follow-up field days on March 30, April 14, and April 27, 2011. Portions of the project area addressed during the first round of fieldwork include the eastern tableland array, Kawailoa Road, the southern end of Cane Haul Road, and Ashley Road. The second round of fieldwork focused on the western tableland array, Mid-Line Road, and the remainder of Cane Haul Road. Follow-up fieldwork addressed the makai interconnection facility and the overhead collector lines.

In addition to the archaeological fieldwork, archival cartographic material concerning plantation infrastructure was obtained and correlated with the field findings. Also, whenever possible, individuals knowledgeable about the area and past land use practices were consulted.

As a result of the current study, 17 archaeological sites have been identified within the project area. All of these sites date from the historic period and were likely associated with either former military operations or former plantation activities. Given the extensive disturbance of the project area by the sugarcane industry, it is likely that any earlier archaeological features within the project area were significantly impacted if not completely destroyed. In addition to the sites identified within the study area, 6 previously identified archaeological sites and 19 newly identified sites were inspected during the current study. These sites are near to, but outside of, the study area footprint, and represent both Precontact and Historic use of the area.

Of the 17 Historic Period sites found within the project area, 5 are associated with the irrigation of sugarcane. A sixth site is a possible concrete field marker identifying the location of one of the mauka-most agricultural plots within the project area.

A 1929 Hale'iwa Quadrangle map shows an extensive network of irrigation features along Kawailoa Road. Historical documents, such as Dorrance and Morgan 2000, suggest that plantation agricultural may have begun impacting the Kawailoa landscape as early as 1898, and that by the late 1920s, irrigated fields covered vast portions of the project area, which included ditches, pipes, tunnels, a few pump houses, several reservoirs/ponds, roads, and railway lines; this infrastructure was identified as the Kamananui Ditch System.

Dates incised into the cement capping of ditch and sluice gate walls of the four defined ditch complexes suggest that the Kamananui Ditch System was in place by at least 1913, and dates incised in other concrete features recorded at the site suggest that by 1926 and 1927, the main channels were well established. A spurt of activity occurred in 1937, with ongoing maintenance to the ditch occurring during the war years, as attested by a few early 1940s dates. Judging from the incised dates, a second spurt of activity occurred between 1950 and 1954, and further maintenance and update activities occurred between 1981 and 1990. Even though sugarcane cultivation was terminated at the end of 1996, the ditch complex continued to be used and maintained along certain sections, as attested by the 2008 and 2009 dates incised on portions of the lower Mid-Line Road and the main Kawailoa Road ditches.

Features associated with the transport of sugarcane within the project area include the concrete bridge along Cane Haul Road, the four stone-walled road culverts, and stone abutments and kebstone alignment within the Kawailoa Road corridor. An additional plantation-related site recorded within the Kawailoa Road Corridor appears to be the location of a former stable.

Sites seemingly associated with World War II (or slightly earlier) military activities include three separate concrete pillar foundations along the northern mauka-most ridge within the project area. These three related sites are most probably remnants of a military cable-communication and signaling network. These, along with one other site, are the only sites that were found in the vicinity of any of the proposed wind turbines tower locations.

3.7.4 Traditional Cultural Practices and Uses

A Cultural Impact Assessment (CIA) was conducted by Cultural Surveys Hawaii (2011). The OEQC Guidelines identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources, associated with cultural practices and beliefs that are subject to assessment. These are essentially natural features of the landscape and historic sites, including traditional cultural properties. "Traditional" as it is used, implies a time depth of at least 50 years, and a generalized mode of transmission of information from one generation to the next, either orally or by act. "Cultural" refers to the beliefs, practices, lifeways, and social institutions of a given community. The use of the term "Property" defines this category of resource as an identifiable place. Traditional cultural properties are not intangible; they must have some kind of boundary. With one important exception, they are subject to the same kind of evaluation as any other historic resource; the exception stems from the fact that, by definition, the significance of traditional cultural properties is determined by the community that values them.

The process used to conduct a CIA typically includes first generating the cultural and historical background, based on a synthesis of relevant archaeological, ethnographic and historic information. Sources of data include archaeological reports, ethnographies, historic documents, collected moʻolelo (oral traditions), Land Commission Awards of the Māhele, previously recorded life histories/interviews, and historic maps, aerial images, and photographs.

The second component of the CIA involves a series community consultation and interviews. A list of approximately 30 Hawaiian organizations and individuals was compiled. This list of organizations and individuals reflects the extensive community outreach and consultation conducted by Kamehameha Schools for their North Shore master planning effort. A total of 37 individuals were contacted to request an interview; these individuals include kamaʻāina (Native-born) and kūpuna (elders) with knowledge of the study area. Of these, 17 responded and 9 participated in formal interviews from January 2011 to April 2011. The interviews included questions from the following five broad categories: wahi pana (storied places) and moʻolelo, agriculture and gathering practices, freshwater and marine resources, cultural and historic properties, and burials.

Participants in the community consultation and interviews shared a range of manaʻo (thoughts and opinions) on cultural sites, beliefs, and practices, as related to the proposed wind farm. For example, participants described numerous pre-Contact cultural sites in the vicinity of the proposed project. Several sites were identified within the makai section of Kawailoa, particularly those that are near the existing access roads that would be used for the proposed project; these include Kahōkūwelowelo Heiau, Kahōkūwelowelo Hale, burials, an enclosure, a wall, a rock carving, an altar, and other rock structures. Several heiau, former habitation sites, and other cultural sites in the mauka lands of Kawailoa were also referenced, although the locations of these sites were not specified. With respect to post-Contact sites, one participant recalled the presence of sugarcane across the entire landscape of Waialua during the first half of the twentieth century. The immigrant plantation camps were described, particularly the Kawailoa Camp, which included Japanese, Chinese, Korean, and Filipino laborers and their families, and were located near the existing access roads to be used for the proposed project. Two Japanese graveyards, located near the intersection of Cane Haul Road and Kawailoa Road, were also discussed.

The participants described abundant ocean and forest resources that were once caught or gathered in the makai and mauka lands of Kawailoa. A variety of cultivars were also grown in the makai portion of Kawailoa, but the historic research and community consultation suggest that the mauka lands of Kawailoa (including the proposed locations for the wind turbines and appurtenant facilities) were mostly covered in sugarcane. As the fields were left fallow in the 1990s, there does not appear to have been any recent use of the land for cultivation or gathering of resources. A response letter provided by the History and Culture Branch Chief of SHPD states that certain families, practitioners, and/or groups continue to practice Hawaiian spirituality, traditional burials, and other activities, such as hunting and hiking.

<u>3.7.5 Mt. Kaʽala Communication Sites</u>

From a traditional Hawaiian perspective, Mt. Kaʽala is revered and honor as a sacred place. A review of the records on file at the Hawaiʽi Department of Land and Natural Resources State Historic Preservation Division (DLNR-SHPD) suggests that no archaeological studies have been conducted at the upper elevations on Mt. Kaʽala, and that no sites are known to exist in the vicinity of the proposed communication sites. However, there was one Section 106 consultation/determination made for the existing Hawaiian Telcom facility located along Mt. Kaʽala access road, which is one of the two sites that is the subject of the current study. In May 2005, the Hawaiʽi State Historic Preservation Office (SHPO) (DLNR-SHPD Doc. No. 1005RS47) concurred with an Applicant determination that the proposed co-location of cellular communication antennae and a 100-square-foot ground sublease would not affect historic properties. A field inspection of both of the existing facility locations was conducted by Rechtman Consulting, LLC on July 16, 2010. There were no archaeological resources observed at either site. The Mt. Kaʽala communication sites are also being addressed as part of the CIA.

3.8 Visual Resources

The project is located in a relatively rural area known for its scenic shoreline, expansive agricultural lands, and natural character. In general, the region has a high aesthetic quality, which is generally attributed to the sweeping landscape views of the ocean and open lands, with the backdrop of the Koʽolau and Waiʽanae mountain ranges. There are frequent opportunities for views of both the coastline and the mountains from Kamehameha Highway, the main roadway which runs the length of the coastline. Two small towns, Haleʽiwa and Waialua, and several residential communities, including Pūpūkea, are also located in the project vicinity. This section of the coastline also includes many well-known beaches, including Waimea Bay, Chun’s Reef, Laniākea, Puaʽena Point, and Haleʽiwa Beach Park.

The North Shore Sustainable Communities Plan (City and County of Honolulu 2011) addresses the scenic quality of this region and identifies protection of scenic views as a general policy. Within the context of this policy, one of the planning principles identified in the plan is the preservation of views of the mountains, coastline, and Pacific Ocean from public places, including major roadways. The plan establishes specific guidelines including the need to evaluate the impact of land use proposals on the visual quality of the landscape, but recognizes that the protection of roadway views should be balanced with the operating requirements of diversified agriculture. Furthermore, the guidelines specify that alternative energy systems should be sited to minimize their impact on visual resources, including clustering and techniques to blend the equipment into the natural landscape. Where possible, utility lines should be placed underground and artificial lighting should be minimized.

The visual character of the wind farm site is defined by the broad agricultural fields with the Koʽolau Mountains as a backdrop. The site is comprised of a series of broad upland plateaus interspersed with steep gulches. The uplands support either actively maintained agricultural crops or overgrown, weedy vegetation. The gulches are densely vegetated with a well-developed canopy, which blocks portions of the mauka views from Kamehameha Highway. In addition, a steep bluff occurs along the lower edge

of the Kawailoa property, just mauka of Kamehameha Highway, further limiting the views of the wind farm site from the highway. The site is visible at a distance from areas to the north (including Pūpūkea) and to the south (including Haleʻiwa, Waialua, and Mokulēʻia
), as well as from the ocean.

The proposed project site would be located at an elevation ranging between approximately 100 and 1,300 feet above mean sea level (msl). The turbines would be located a minimum of approximately 0.7 mile from Kamehameha Highway, 0.85 mile fromPūpūkea, and 3.8 miles from Haleʻiwa Town. The proposed communication tower sites are located on rocky mountain ridges, surrounded by steep mountainous slopes. These sites each include existing Hawaiian Telcom structures that have been in place for several decades. The ridges are part of the Mokulēʻia Forest Reserve, and are heavily vegetated with a well-developed canopy and dense undergrowth. The lower communication tower site is generally visible from the Mt. Kaʻala access road. The repeater communication site is along the DuPont Trail, but is not visible from the access road.

3.9 Noise

Noise is defined as any unwanted sound. Whether sound is perceived as a noise by a receiver depends on subjective factors, including the amplitude and duration of the sound (Rodgers and Manwell 2004). The frequency of a sound also greatly influences the ability of a receiver to hear a sound; people are generally more sensitive to certain higher frequency sounds than lower frequency sounds. The A-weighted sound level, or dBA, is the sound level measurement (in decibels) that accounts for this preferential response to frequency and provides some correlation with the sensitivity of the human ear to that sound.

The State of Hawaiʻi regulates noise levels through the DOH regulations (HAR Title 11, Chapter 46, Community Noise Control). These regulations are also intended to protect public health and welfare, and to prevent significant degradation of the environment and quality of life. Maximum permissible sound levels are dependent on zoning designations, time of day, and apply to sound levels at the property boundary (Table 3-2).

The proposed wind energy facility uses would be subject to the Community Noise Control Rule. The project area is surrounded by Class A (preservation lands) and C (agricultural) Zoning Districts. Noises produced by the project in Class A Zoning Districts cannot exceed 55 dBA[9] during the daytime or 45 dBA during the nighttime *at the project area property line*. In Class C Zoning Districts, noise levels from the project cannot exceed 70 dBA during the daytime or nighttime (CH2M Hill 2011). Additional details are available in Appendix B: Environmental Noise Assessment Report for Kawailoa Wind Farm.

Table 3-2. Maximum Permissible Sound Levels in dBA.

Zoning Districts	Daytime (7AM to 10PM)	Nighttime (10PM to 7AM)
Class A (residential, conservation, preservation, public space, open space)	55	45
Class B (multi-family dwellings, apartment, business, commercial, hotel, resort)	60	50
Class C (agriculture, country, industrial, similar)	70	70
Source: HAR Title 11, Chapter 46, Community Noise Control.		

Ambient sound level measurements and wind speed data were collected between January and March 2011 to assess the existing acoustical environment within various representative areas within project site and the community. Data were collected from various locations within the project site, as well as in community areas, including areas readily accessible to the public or residential areas. The community sampling locations include:

[9]dBA is the sound level, in decibels, read from a standard sound-level meter using the “A-weighting network.”

- Pu‘u o Mahuka Heiau
- Pūpūkea Residence
- Waimea Valley
- Punalau Residence (adjacent to Ashley Road and Kamehameha Highway)
- Kawailoa Road (*mauka* of Transfer Station)
- Hale‘iwa (*mauka* of Joseph P. Leong Highway)
- Dole Plantation (along Kamehameha Highway

At each location, continuous 1-hour statistical sound levels were recorded for up to two weeks with a tripod-mounted microphone located generally about five feet above grade, and covered by a windscreen. Simultaneous weather data (such as wind speed, direction, and temperature) were also collected with a tripod-mounted anemometer near the sound level meter, generally at a height of about seven feet above grade. A handheld Garmin global positioning system (GPS) unit was used to adjust the wind vane to accurately measure wind direction. Wind speed measurements were validated using a handheld Kestrel 3000 Pocket Weather Meter.

The data used to calculate the range of equivalent sound levels, Leq, during the day (7 a.m. to 10 p.m.) and night (10 p.m. to 7 a.m.), as well as the day-night average, Ldn. The average calculated Ldn ranged from 43 to 69 dBA on the project site and 42 to 63 dBA in the surrounding community. Contributing noise sources included environmental noise sources such as wind and birds, vehicular traffic, community noises, landscaping or grading equipment, and aircraft flyovers. Additional detail, including the measurement results for each sampling location, is provided in the Environmental Noise Assessment Report for the Kawailoa Wind Farm (DLAA 2011), contained in Appendix B.

3.10 Land Use

The proposed facility is situated in the Waialua District on the north central portion of O‘ahu. The project area encompasses portions of five parcels (TMKs 6-1-005:001, 6-1-006:001, 6-1-007:001, 6-2-009:001, 6-2-011:001). All parcels are owned by Bishop Estate/ Kamehameha Schools. The entire Kamehameha Schools Kawailoa property is roughly 7,000 acres in size (CH2M Hill 2011). Portions of the parcels are leased for various agricultural uses with roughly 2,200 acres in cultivation (Kamehameha Schools 2005).

In the late 1800s, the Kawailoa area was used for extensive sugarcane production by the Waialua Sugar Co. The fields were plowed, burned, harvested, and planted in continuous cycles for about 100 years. Some of the broader gulches within the project area were used to pasture plantation horses and mules (Hobdy 2010a).

There are no planned land uses identified in any state or local plans for the project area.

The following land uses currently occur within the vicinity:

- Kawailoa Training Area: The largest U.S. Military training area on O‘ahu, covering 23,348 acres (U.S. Army Environmental Command 2008).
- Kawailoa Refuse Transfer Station: Site for the temporary collection and storage of waste.
- Waimea Valley: Roughly 1,875 acre valley owned by the Office of Hawaiian Affairs and managed by Hi‘ipaka, a non-profit organization which operates Hawaiian based recreational and educational activities (http://waimeavalley.net/default.aspx).

- Drum Road: A military access road running along the west slope of the Koolau Mountain Range and across the Schofield Plateau (SWCA 2008).

Nearby urban areas include the residential communities of Kawailoa, Haleʻiwa, and Pūpūkea. Pūpūkea is beyond Waimea Bay and roughly 5.2 miles to the north of the project area. Haleʻiwa is the nearest commercial center, located approximately 1.9 miles to the south of the project area.

Most of the Kawailoa Wind Power project area is designated as an Agricultural District according to HRS Chapter 205; however, portions of some of the parcels are designated as General and Limited subzones of a State Conservation District. Lands mauka of the project area are also designated as Conservation. Both of the proposed offsite communication towers are located on Conservation District land. Lands within a Conservation District are typically utilized for protecting watershed areas, preserving scenic and historic resources, and providing forest, park, and/or beach reserves (subsection 205-2[e] HRS). The communication towers are planned to be located on a single parcel (TMK 6-7-003:024) owned by the State of Hawaiʻi.

Applicable regulations, plans, and policies related to land use are discussed in Section 1.3.

3.11 Transportation and Traffic

This section addresses publicly accessible transportation infrastructure, including harbors, airports and roadways as well as privately owned project site roadways. Kalaeloa Harbor on Oʻahu is a heavy lift berthing facility located on the western coast of Oʻahu, suitable for unloading and temporary storage of the large turbine components needed for the proposed project. Turbine blades, nacelles, and tower components would be removed from barges at Kalaeloa Harbor and loaded onto vehicles for transport to the wind farm site.

3.11.1 Roadways

Access to the wind farm site is provided via a network of state, county, and privately-owned roadways. These roads range from multi-lane highways with paved shoulders to privately-owned paved or dirt roads. The existing roads within the proposed wind farm project area are owned and maintained by Kamehameha Schools.[10] Based on the size and weight of the turbine components and the dimensions and capacities of existing roadway infrastructure (including bridges and overpasses), transportation routes between Kalaeloa Harbor and the wind farm site were identified by ATS International. The following routes are proposed for transporting the various turbine components to the project site. The proposed route from Kalaeloa Harbor to the wind farm site for the transport of the wind turbine blade components is as follows:

- Take Kalaeloa Harbor to Malokili Drive
- Left on Malokili Drive toward Kalaeloa Boulevard
- Left on Kalaeloa Boulevard
- Merge on to H-1 East
- Exit H-1 East to Wahiawa heading northeast
- Exit on to H-2 north
- Continue on H-2 north to Wilikina Drive
- Right on Kamananui Road
- Turn west on Kamehameha Highway
- Continue on Kamehameha Highway west to Joseph P. Leong Highway (Highway 99)
- Continue on Highway 99 to Kamehameha Highway west (Highway 83)
- Continue on Highway 83 to proposed entrance on Kawailoa Drive
- Right from Kamehameha Highway into the wind farm site

[10] The existing onsite access roads traverse several small properties owned by other entities. Kamehameha Schools currently has grants of easement with these other landowners for long-term access through their properties for both Kamehameha Schools and its lessees and tenants, which includes Kawailoa Wind. In addition, Kawailoa Wind has a separate access agreement with three of these landowners that allows for access and road improvements as needed for delivery of equipment.

No modifications to infrastructure or tree trimming are expected to be required along this route. Given the roadway slope of several of the overpasses, this route is not suitable for transporting the tower sections or nacelle components. The proposed route from Kalaeloa Harbor to the wind farm site for the transport of the tower sections is as follows:

- Take Kalaeloa Harbor to Malokili Drive
- Left on Malokili Drive toward Kalaeloa Boulevard
- Left on Kalaeloa Boulevard
- Merge on to H-1 East
- Exit H-1 East to Kamehameha Highway west
- Take Exit 8 from Kamehameha Highway
- Right on Ka Uka Road
- Left on to H-2 North
- Continue on H-2 North to Wilikina Drive
- Right on Kamananui Road
- Turn west on Kamehameha Highway
- Continue on Kamehameha Highway west to Joseph P. Leong Highway (Highway 99)
- Continue on Highway 99 to Kamehameha Highway west (Highway 83)
- Continue on Highway 83 to proposed entrance on Kawailoa Drive
- Right from Kamehameha Highway into the wind farm site

All trees along the section of Kamehameha Highway in Waipahu would require trimming to a clearance height of 17 feet. In addition, police escorts would be needed to stop traffic at the intersection of Kamehameha Highway and Ka Uka Road in order for the trailers carrying oversized loads to navigate the right hand turn.

The transport of the oversized nacelle components would require 19-axle trailers; the proposed route from Kalaeloa Harbor to the wind farm site for this equipment is as follows:

- Take Kalaeloa Harbor to Malokili Drive
- Left on Malokili Drive toward Kalaeloa Boulevard
- Left on Kalaeloa Boulevard
- Merge on to H-1 East
- Exit H-1 East to Kunia Road exit
- Left on to Kunia Road
- Continue on Kunia Road to Wilikina Drive
- Left on to Wilikina Drive
- Right on Kamananui Road
- Turn west on Kamehameha Highway
- Continue on Kamehameha Highway west to Joseph P. Leong Highway (Highway 99)
- Continue on Highway 99 to Kamehameha Highway west (Highway 83)
- Continue on Highway 83 to proposed entrance on Kawailoa Drive
- Right from Kamehameha Highway on to Kawailoa Drive

Trees along the golf driving range on Kunia Road and trees approximately 0.3 mile before Foote Avenue would require trimming to a clearance height of 17 feet. In addition, police escorts would be required to stop east-west bound traffic at the intersection of Kunia Road and Wilikina Drive in order for the trailers carrying oversized loads to navigate the left hand turn.

Access to the Mt. Kaʽala communication site is via an existing single-lane access road, which is owned and maintained by the Kaʽala Joint Use Coordinating Committee (JUCC).

<u>3.11.2 Airports and Airfields</u>

The nearest airfield to the Kawailoa wind farm site is Dillingham Airfield, approximately 9 miles to the west. Wheeler Army Airfield is located approximately 12 miles to the south, in central Oʽahu. The Honolulu International Airport is approximately 25 miles to the south on the coast of the island.

In addition, the U.S. Army leases property from Kamehameha Schools for the Kawailoa Training Area that, along with other nearby training areas (such as the Kahuku Training Area), comprises a TFTA(Tactical Flight Training Area) for high-density air traffic from the ground surface to 500 feet above ground level (known as the A-311 alert area). This area is used for aviation and ground training by multiple branches of the Department of Defense, and includes flight routes and helicopter landing zones. Nine of the proposed turbine locations in the eastern portion of the project area overlap with the TFTA.

3.11.3 Harbors

Kalaeloa Harbor on O‘ahu is a heavy lift berthing facility located on the western coast of O‘ahu, suitable for unloading and temporary storage of the large turbine components needed for the proposed project. Turbine blades, nacelles, and tower components would be removed from barges at Kalaeloa Harbor and loaded onto vehicles for transport to the wind farm site.

Honolulu Harbor is a heavy lift berthing facility located on the southern coast of O‘ahu suitable for unloading and temporary storage of heavy equipment and construction materials needed for the proposed project. Rotor hubs, drive trains, and all other miscellaneous turbine components and construction equipment would be unloaded from barges at Honolulu Harbor and transported to the site.

3.12 Military Operations

The U.S. Army utilizes the Kahuku Training Area and Kawailoa Training Area for aviation and ground training by the Army as well as the Marine Corps, Air Force and Navy. The Army-owned lands comprising the TFTA are contiguous and stretch from their northern extent at the uplands mauka of Kawela Bay to Kahuku Town, eastward following the spine of the Ko‘olau Mountains, westward to the agricultural lands of the Schofield Plain and as far south as Whitmore Village. The majority of these lands are zoned for preservation; those lower in elevation and closest to roads are zoned for agriculture and commercial.

The TFTA is an FAA-designated alert area of high-density air traffic from the ground surface to 500 feet above ground level, known as the A-311 alert area. According to the FAA Air Traffic Organization Policy ORDER JO 7400.8T Part II – Nonregulatory Special Use Airspace Areas, Subpart C – Alert Areas, an alert area is defined as airspace which may contain a high volume of pilot training activities or an unusual type of aerial activity, neither of which is hazardous to aircraft. Activities include pilot training or an unusual type of aeronautical activity.

The TFTA is the military’s low level, day, night, and night vision device (NVD) tactical training area, and is used by several branches, or services, of the Department of Defense including the U.S. Army, Marine Corps, Navy, and Air Force. The services fly thousands of hours in day, night, and multi-ship helicopter operations at low altitudes in the area for aviation and ground training. Key to using A-311 is a series of low-level flight routes and helicopter landing zones (LZs) that have been developed over the years; these accommodate tactical LZ operations, air-assault operations, sling load operations, and other activities. Drum Road, which is used by the military for training and was recently improved with a paved surface, is also in the TFTA and portions of the road pass through the wind farm site.

As indicated in an EISPN consultation letter from Marine Corps Base Hawai‘i, roughly 70% of all Marine Corps Hawai‘i unit aviation training takes place within the TFTA. Continued access by aircraft in support of ground combat training operations is vital because the existing road network is limited and often impassable because of wet weather conditions. The U.S. Army 25th Combat Aviation Brigade (CAB) also conducts aviation and ground training in the area. The Army also serves as the host for multi-service, land-based training requirements; these requirements are continuing to grow as the military prepares its service members for combat and modernizes the force.

Wheeler Army Airfield maintains a non-directional beacon (NDB 152) as a navigational aid for instrument-only aircraft approaches to its airfield in central O‘ahu. This instrument approach is used primarily for instrument recovery to the airfield from the TFTA and the Kahuku Training Area, and while this approach technology is not often employed, the designated approach area and elevations cross over portions of the wind project. The services also operate radar facilities in the general area that could potentially be affected by the wind farm turbines.

3.13Hazardous Substances and Materials

The Kawailoa project area is located within agricultural plantation lands with no known activities that produced hazardous waste or involved the disposal of hazardous waste in the area, though contaminants related to former agricultural use (e.g., herbicides) may be present in the soils. A Phase I Environmental Site Assessment (Phase I) has not been prepared for the Kawailoa project area.

The communication towers are located on state land leased by Hawaiian Telecom. The facility includes a subsurface underground storage tank (UST). Available information indicates that a release from the UST may have been documented, but that response actions for the documented UST releases have been completed (CH2M Hill 2011). No other activities are known to have generated potentially hazardous waste (or the disposal of hazardous waste) at the communication facilities.

3.14 Socioeconomic Characteristics

The proposed Kawailoa Wind Power facility is located in Kawailoa, within the District of Waialua, on the Island of Oʻahu. The total resident population of the Island of Oʻahu is approximately 905,034 individuals (Table 3-6, DBEDT 2009). The majority of the resident population on Oʻahu lives in the District of Honolulu. In 2000, the District of Waialua had a resident population of 14,027 individuals representing roughly 1.6% of the entire island's population. The district experienced a 21.5% change in population between 1990 and 2000 (DBEDT 2009).

Table 3-6. Resident Population for Selected Areas.

Area	1980	% change	1990	% change	2000
State of Hawaiʻi	964,691	14.9	1,108,229	9.3	1,211,537
O'ahu Island	762,534	9.7	836,231	4.8	876,156
Waialua District	9,849	17.3	11,549	21.5	14,027
Haleʻiwa CDP			2,442	-8.9	2,225
Pūpūkea CDP			4,111	3.4	4,250
Source: DBEDT (2009); US Census Bureau (2000).					

The nearest communities to the proposed project area are Haleʻiwa and Pūpūkea. Haleʻiwa Town is approximately 3.8 miles to the south and Pūpūkea is less than one mile to the north. The population of the Haleʻiwa Census Designated Place (CDP) in 2000, as defined at the U.S. Census Bureau, was approximately 2,225 individuals. The population in the Pūpūkea CDP is roughly double, with an estimated 4,250 individuals (U.S. Census Bureau 2000).

In 1999, the median household income in the Haleʻiwa CDP was $39,643 and the median per capita income was $16,504. During that year, approximately 15.0% of families and 17.6% of individuals in the Haleʻiwa CDP had an income below poverty level. The Pūpūkea CDP had a median household income of $56,146 and a median per capita income of $25,682. Roughly 11.4% of families and 15.2% of individuals in the Pūpūkea CDP had an income below poverty level in 1999. Combined, 13% of families and 16% of individuals had an income below poverty level. In comparison, throughout the State of Hawaiʻi, approximately 7.6% of families and 10.7% of individuals were considered to be living below poverty level in 2000 (U.S. Census Bureau 2000).

Demographic information for 2000 indicates that the population of the Haleʻiwa CDP was primarily composed of Asians (29%), Whites (25%), and Native Hawaiian and other Pacific Islander (10%). Almost 35% of the CDP's population reported two or more races (U.S. Census Bureau 2000). In the Pūpūkea CDP, 56% of the population identified themselves as White, 15% as Asians, 7% as Native Hawaiian and other Pacific Islanders, and 21% as two or more races combined, the population was 45% White, 19% Asian, 8% Native Hawaiian and other Pacific Islander, and 26% two or more races. In comparison, the State of Hawaiʻi was 42% Asian, 24% White, and 9% Native Hawaiian and other Pacific Islander, and 21% two or more races (U.S. Census Bureau 2000).

The visitor and recreational industries are a major part of the economy in the area providing small-scale, country-style visitor accommodations. Agriculture is also an important component of the economy of the region. Diverse crops and forest products production provide a multitude of jobs for area residents (DBEDT 2009).

3.15 Natural Hazards

A natural hazard is a threat of a naturally-occurring event that could negatively affect people or the environment. Many natural hazards can be triggered by another event, though they may occur in different geographical locations (for example, an earthquake can trigger a tsunami). Natural hazards that can affect Hawaiʻi include hurricanes and tropical storms, tsunamis, volcanic eruptions, earthquakes, flooding, and wildfire.

3.15.1 Hurricanes and Tropical Storms

Hurricanes develop over warm tropical oceans, and have sustained winds that exceed 74 mph. Tropical storms are similar to hurricanes, except that the sustained winds are below 74 mph. These events can also produce torrential rains. Given the steep and complex topography of the islands, wind can amplify across ridges and through channels, and rain can be focused down valleys, resulting in destructive flash floods and landslides. As a result, even a relatively weak tropical storm can potentially result in considerable damage (Businger 1998). The Central Pacific Hurricane season runs from June 1 to November 30.

True hurricanes are very rare in Hawaiʻi, indicated by the fact that only five have affected the islands over the last 50 years (Businger, 1998). Tropical storms occur more frequently than hurricanes, and typically pass sufficiently close to Hawaiʻi every one to two years to affect the weather in some part of the Islands (WRCC 2010). Historically, the hurricanes have made landfall at (or passed more closely to) the northern Hawaiian Islands, such as Kauaʻi (Businger 1998). No hurricane or tropical storm has historically made landfall on Oʻahu.

3.15.2 Tsunamis

Tsunamis are large, rapidly moving ocean waves triggered both by disturbances around the Pacific Rim (that is, teletsunamis) and earthquakes and landslides near Hawaiʻi (that is, local tsunamis). The Pacific Disaster Center reports that tsunamis have resulted in more lost lives in Hawaiʻi than the total of all other natural disasters (Pacific Disaster Center 2010a). In the 20th century, an estimated 221 people have been killed in Hawaiʻi by tsunamis. One of the largest and most devastating tsunamis to hit Hawaiʻi occurred in 1946, resulting from an earthquake along the Aleutian subduction zone. Wave runup heights reached a maximum of 33 to 55 feet and 159 people were killed. A total of 32 tsunamis with run-up greater than 1 meter have occurred in Hawaiʻi since 1811 (USGS 2010). The western-most edge of the wind power facility, consisting of onsite access roads, is within the Civil Defense Tsunami Evacuation Zone (Hawaiʻi State Civil Defense 2010).

3.15.3 Volcanic Eruptions

There are currently no active volcanoes on Oʻahu.

3.15.4 Earthquakes and Seismicity

Earthquakes in Hawaiʻi are linked with volcanic activity. Small earthquakes are generally triggered by eruptions and magma movement within the active volcanoes (e.g., Kīlauea, Mauna Loa). Larger earthquakes (that is, tectonic earthquakes) tend to occur in areas of structural weakness at the base of these volcanoes or deep within the Earth's crust beneath the island. Several strong tectonic earthquakes (magnitude 6 to 8) have occurred in Hawaiʻi and caused extensive damage to roads, buildings, and homes, triggered local tsunami, and resulted in loss of life. The most destructive earthquake in Hawaiʻi had a magnitude 7.9 and occurred on April 2, 1868, when 81 people lost their lives (USGS 2001).

3.15.5 Flooding

Potential flood hazards are identified by the Federal Emergency Management Agency (FEMA) National Flood Insurance Program and are mapped on the Flood Insurance Rate Maps (FIRM). The maps classify land into four zones depending on the potential for flood inundation. According to the FIRM, the project area is almost entirely within Flood Zone D, where analysis of flood hazards has not been conducted and flood hazards are undetermined. The western-most edge of the wind farm site, throughout which the onsite access roads traverse, is near the mouths of several streams (Kawailoa, Laniākea, Loko Ea, and Anahulu) and is designated as Flood Zone XS and Flood Zone X. Flood Zone XS includes areas between the limits of the 100-year (1% annual probability) and 500-year (0.2% annual probability) floodplains, including areas inundated by 100-year flooding with average depths of less than one foot. Zone X is assigned to those areas that are determined to be outside the 500-year floodplain with less than 0.2% annual probability of flooding (FEMA 2010). All of the wind turbines and appurtenant structures would be located within areas classified as Zone D; no development would occur within a special flood hazard zone.

The proposed Mt. Kaʻala communications sites are within an area designated by FEMA as Flood Zone D, where analysis of flood hazards has not been conducted and flood hazards are undetermined.

3.15.6 Wildfire

Wildfire occurs on all of the major Hawaiian Islands, with human activity as the primary cause. Because Hawaiʻi's native ecosystems are not adaptive to wildlife, they can result in extinction of native species and increased coverage of nonnative, invasive species. Other effects include soil erosion, increased runoff and decreased water quality (Pacific Disaster Center 2010b).

3.16 Public Safety

Public safety concerns associated with the operation of a wind power project are the focus of this section. In many ways, wind energy facilities are safer than other forms of energy production because combustible fuel and fuel storage are not required. In addition, use and/or generation of toxic or hazardous materials are minor when compared to other types of generating facilities. However, wind turbines are generally more accessible to the public, and risks to public health and safety can be associated with these facilities. Examples of such safety concerns include tower collapse, blade throw, stray voltage, fire in the nacelle, and lighting strikes.

3.16.1 Tower Collapse/Blade Throw

It is very rare for a wind turbine tower to collapse or a rotor blade to be dropped or thrown from the nacelle, but such incidents have been documented and are potentially dangerous for project personnel, as well as the general public. Past occurrences of these incidents have generally been the result of manufacturing defects, poor maintenance, wind gusts that exceed the maximum design load of the engineered turbine structure, extreme seismic events, or lightning strikes (AWEA 2011). Most instances of blade throw and turbine collapse were reported during the early years of the wind industry. Technological improvements and mandatory safety standards during turbine design, manufacturing, and installation have largely eliminated such occurrences.

3.16.2 Stray Voltage

Stray voltage is an effect that is primarily a concern of farmers/ranchers, whose livestock can receive electrical shocks. Stray voltage is a low level of neutral-to-earth electrical current that occurs between two points on a grounded electrical system. In a farm setting, stray voltage typically originates from low levels of AC voltage on the grounded conductors of a farm wiring system. These voltages are termed stray when they are large enough to form a circuit when a person or an animal simultaneously touches two objects that are part of an electrical system. Stray voltage results from damaged or poorly connected wiring systems, corrosion, or weak/damaged insulation. Livestock may encounter stray voltage when they contact two surfaces with voltage differences, resulting in a small electrical current flowing through the animal and creating a shock.

Stray voltage can occur at electric facilities (such as wind power projects) because of factors such as operating voltage, geometry, shielding, rock/soil electrical resistively, and proximity. Stray voltage from such facilities usually only occurs if the system is poorly grounded and located in proximity to ungrounded or poorly grounded metal objects (such as fences or buildings).

3.16.3 Fire

Although the turbines contain relatively few flammable components, the presence of electrical generating equipment and electrical cables, along with various oils (lubricating, cooling, and hydraulic), does create the potential for fire within the tower or the nacelle. Other project activities create the potential for a fire or medical emergency because of the storage and use of diesel fuels, lubricating oils, and hydraulic fluids. Storage and use of these substances may occur at the collector substation, staging and laydown area, and the O&M building.

3.16.4 Lightning Strikes

Because of their height and metal/carbon components, wind turbines and communications facilities are susceptible to lightning strikes. Statistics on lightning strikes to wind turbines are not readily available, but it is reported that lightning causes four to eight faults per 100 turbine-years in northern Europe, and up to 14 faults per 100 turbine-years in southern Germany (Korsgaard and Mortensen 2006). Most lightning strikes hit the rotor, and their effect is highly variable, ranging from minor surface damage to complete blade failure. All modern wind turbines include lightning protection systems, which generally prevent catastrophic blade failure.

3.16.5 Shadow Flicker

Shadow flicker is the term used to refer to the alternating changes in light intensity that can occur at times when the rotating blades of wind turbines cast moving shadows on the ground or on structures. Shadow flicker occurs only when the wind turbines are operating during sunny conditions, and is most likely to occur early and late in the day when the sun is at a low angle in the sky. The intensity of shadow flicker is " … defined as the difference or variation in brightness at a given location in the presence or absence of a shadow" (National Research Council 2007). The intensity of the shadows cast by the moving blades of wind turbines and thus the perceived intensity of the flickering effect is determined by the distance of the affected area from the turbine, with the most intense, distinct, and focused shadows occurring closest to the turbine. The frequency of shadow flicker is a function of the number of blades making up the wind turbine rotor and rotor speed.

There are two kinds of potential concerns that have been raised about severe shadow flicker conditions. One is that shadow flicker could have the potential to trigger epileptic seizures, and the other is that shadow flicker could become a source of annoyance to residents living in close proximity to wind turbines. The Epilepsy Foundation notes that for a small minority (about 3%) of the three million people in the U.S. who are affected by epilepsy, there is a potential for epileptic seizures to be triggered by flashing light. These seizures have the potential to be triggered when the light flashes are in the 5 to 30 Hz range. Because the frequency of the shadow flicker created by modern wind turbines is in the range of 0.6 to 1.0 Hz, the shadow flicker effects created by wind turbines do not have the potential to trigger epileptic seizures.

The second issue is of annoyance and is considered more subjective. There could be cases in which shadow flicker cast on dwellings in very close proximity to wind turbines could be significant enough to be considered a nuisance to residents. The National Research Council has observed that shadow flicker is more likely to be a concern in the higher latitude regions of Northern Europe, where the sun is likely to be at a low angle (particularly in winter) than in lower latitudes, where it states that " … shadow flicker has not been identified as causing even a mild annoyance" (National Research Council 2007).

3.17Public Infrastructure and Services

3.17.1 Water Supply

Water resources and distribution on O‘ahu is managed by the Board of Water Supply (BWS). A connection to the BWS' facilities is not anticipated to be needed for the proposed wind energy project. A connection to City and County water facilities is not anticipated to be needed for the proposed project. Kawailoa Wind Power plans to truck in and store water in onsite holding tanks for its water requirements at the wind farm facility. Given the nature of the proposed project and small number of people working onsite, water usage would be limited to that provided by water tanks installed onsite; the tanks would be refilled monthly, as needed. There is no expected need for water supply at the Mt. Ka‘ala communications facilities.

3.17.2 Wastewater and Solid Waste

It is anticipated that an onsite septic tank system would be constructed to deal with project-associated wastewater generated from the few people working onsite. The wastewater discharge from the project area would be within the City and County requirement of less than 1,000 gallons per day. The waste that accumulates in the septic tank system would be collected by a private contractor and transported to an appropriate wastewater treatment facility or other approved location for disposal. The small amount of wastewater that this represents can easily be accommodated in the existing treatment and disposal facilities.

Solid waste generated by the residents in the area is disposed of at Waimānalo Gulch landfill or the H-POWER facility, the City's waste-to-energy facility. Materials collected at the nearby Kawailoa Transfer Station are transported to the H-POWER facility.

3.17.3 Telecommunications

Telecommunication services that are used in the vicinity of the wind farm may include a variety of radio, cell phone, internet, and radar technologies. These types of services can be affected by electromagnetic interference generated by electrical infrastructure, particularly transmission lines. Electromagnetic interference is the result of corona, or the electrical ionization of the air that occurs near the surface of the energized conductor and suspension hardware because of very high electric field strength at the surface of the metal during certain conditions. Corona most commonly results in radio and television reception interference.

3.17.4 Energy

The State of Hawai‘i uses a higher percentage of petroleum to generate electricity than any other state in the U.S. In 2007, petroleum was used to produce 76.9% of the electricity generated in the State. The remaining electricity generation during that year was supplied by coal (14.0%), municipal solid waste (2.7%), wind (2.1%), geothermal (2.0%), biomass (1.4%), hydroelectricity (0.8%), and solar photovoltaics (0.1%) (DBEDT 2009). On O‘ahu, electrical energy is primarily supplied from oil (77.7%) and coal (18.3%). Municipal solid waste (3.7%), biomass (0.4%), and solar photovoltaics (0.02%) produced the remainder of the energy consumed on O‘ahu during that year (DBEDT 2009). Imported oil costs Hawai‘i between $2 and $4 billion annually (DBEDT 2008b). As a result, Hawai‘i pays among the highest electricity costs in the country and faces a high level of energy insecurity due to volatile oil prices and potential for disruptions in petroleum supply and shipping.

Fortunately, Hawai'i has abundant renewable resources, including a robust wind resource on several islands. Significant potential for small or distributed wind energy projects is believed to exist throughout the Hawaiian Islands (Global Energy Concepts LLC 2006). It has been estimated that the state has a combined wind energy potential of 1,000,000 kWh (State of Hawai'i and Hawaiian Electric Companies 2008). Due to increasing fossil fuel costs, energy security issues, and concerns over climate change, the State of Hawai'i is striving to utilize its own renewable energy (M & E Pacific Inc. 2008). State and federal government agencies are taking important steps to reduce Hawai'i's dependence on fossil fuel. Hawaii's Renewable Portfolio Standards (HRS Chapters 269-91 to 269-95) present a timeline to increase the amount of electricity generated using renewable resources.

According to these standards, each electric utility company that sells electricity for consumption in the state shall establish a renewable portfolio standard of 15% of its net electricity sales by December 31, 2015 and 20% of its net electricity sales by December 31, 2020.

In January 2008, the State of Hawai'i and the U.S. Department of Energy (DOE) signed an agreement to establish the Hawaii Clean Energy Initiative (HCEI). The goal of this agreement is to have 70% or more of the state's energy derived from clean, renewable energy for electricity and transportation by 2030. This goal has the potential of reducing Hawai'i's current crude oil consumption by 72% (State of Hawai'i and USDOE 2008). In October 2008, the State of Hawai'i signed an Energy Agreement with the HECO to help reach the state's energy objectives by facilitating the production of renewable energy sources on the islands, such as wind resources (State of Hawai'i and Hawaiian Electric Companies 2008). The agreement includes a commitment by Hawaiian Electric Industries to encourage and explore the development of known project proposals.

In order to meet the 70% clean energy goal, local renewable energy alternatives need to be developed in Hawaii; a collaborative approach to explore these opportunities between private industry and policymakers is ongoing.

HECO provides electrical service to the entire Island of O'ahu. Power is generated by Hawaiian Electric power plants and independent power producers and transported via transmission lines to substations in the North Shore area (Helber Hastert & Fee Planners 2009).

3.17.5 Hospitals, Police, and Fire Protection Services

The nearest hospital to the proposed project area is the Wahiawa General Hospital, which is roughly 9 miles from the Kawailoa Road access road and roughly 12 miles from the Mount Ka'ala access road. The Kahuku Medical Center is just over 13 miles from the Kawailoa access road and roughly 19 miles from the Mount Ka'ala access road. In case of emergencies, paramedic/ambulance services are also available.

The Wahiawā Police Station is the closest station to the proposed project area. It is located at 330 North Cane Street, almost 11 miles southeast of the access road to the project area. The Kahuku Police Headquarters is located at 56-470 Kamehameha Highway roughly almost 22 miles from the project area.

The closest fire stations are the Waialua Fire Station and the Sunset Beach Station located approximately 2 miles and 4 miles from the Kawailoa access road, respectively. The Waialua Fire Station is the closest station to the offsite communication tower sites.

CHAPTER 4: POTENTIAL IMPACTS

Potential impacts to the affected environment as a result of the Proposed Action/Alternative 1 (issuance of an ITL/ITP and approval of an HCP for the proposed Kawailoa project), Alternative 2 (Alternative Communications Site Layout), and Alternative 3 (No Action and non-issuance of an ITL/ITP) are discussed in this section. The potential impacts of constructing and operating the facility are evaluated and discussed in relation to the existing conditions in the proposed project area and on the Island of O‘ahu. In addition to the potential direct and indirect environmental affects, cumulative impacts of the alternatives are addressed.

When applicable, avoidance, minimization, and mitigation measures for activities expected to, or with potential to, adversely impact environmental resources are also discussed. Kawailoa Wind Power has coordinated with biologists from USFWS, DLNR-DOFAW, USGS, First Wind, SWCA, and members of the ESRC to identify and select appropriate mitigation measures. The criteria used to determine the most appropriate mitigation measures for the Covered Species are discussed in detail in the Draft Kawailoa Wind Power HCP (SWCA 2011).

4.1 Climate

4.1.1 Alternative 1 (Proposed Action)

The proposed Kawailoa Wind Power project is expected to have a beneficial impact on the climate by decreasing fossil fuel consumption and decreasing GHG emissions. Burning fossil fuels is known to emit several GHGs which contribute to climate change, mainly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (ICF International 2008). Of these gases, CO_2 is considered the most important. Present concentrations of CO_2 are believed to be higher than at any time in at least the last 650,000 years, primarily as a result of combustion of fossil fuels (IPCC 2007a, b). It is also very likely that observed increases in CH_4 are also partially due to fossil fuel use (IPCC 2007a, 2007b).

Kawailoa Wind Power estimates that the Proposed Action could provide HECO with approximately70 MW of renewable electricity annually, thereby eliminating the use of roughly 304,200barrels of oil per year (CH2M Hill 2011). Eliminating the consumption of this amount of oil would reduce emissions of $CO_2$by more than 134,400 tons. Although construction and operation of the facility would result in some emissions of CO_2 (e.g. employee trips, transporting materials, etc.), reductions that would result from replacing fossil fuel-generated power with wind-generated power produced by the Proposed Action would more than offset these emissions.

WTGs of the type and number that are proposed do not have the potential to affect temperature, rainfall, humidity, or most other meteorological parameters. By altering the atmospheric mixing that occurs as wind passes over a site, the WTGs do have the potential to affect slightly certain aspects of the wind regime; however, Kawailoa would extract only a small percentage of the wind energy at elevations above ground level and no existing or proposed uses in the area would be affected by minor changes in wind speed and/or velocity.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed for the project under the HCP are not expected to affect the local climate surrounding the area.

Impacts of Mitigation Measures

To the proposed mitigation for seabirds, waterbirds, bats and owls are not expected to affect the local climate surrounding the area.

4.1.2 Alternative 2 (Alternative Communications Site Layout)

Overall, impacts to climate would be expected to be the same as described for the Proposed Action (Alternative 1).

4.1.3 Alternative 3 (No Action Alternative)

Under the No Action Alternative, no adverse impacts to the existing climate would be expected because the facility would not be constructed and operated. This alternative also would not result in the beneficial impacts to climate expected from the Proposed Action and beneficial measures proposed in the HCP would not be implemented.

No climate impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.2 Air Quality

4. Alternative 1 (Proposed Action)

The construction, operation, and monitoring phases of the Proposed Action would result in emission of low levels of air pollutants. These emissions would be temporary or infrequent, and would be generated primarily through combustion of gasoline and diesel fuel for vehicles.

Potential air pollutants that may be emitted (depending on the equipment used) during the construction phase include fugitive dust or particulate matter (PM), hydrocarbons (HC), CO, NO_2, CO_2, and SO_2. Estimated emissions in tons per year are: 123.1 for $PM_{2.5}$, 26.2 for PM_{10}, 1.2 for HC, 21.5 for CO, 8.0 for NO_2, 1493 for CO_2, and 0.05 for SO_2 (CH2M Hill 2011). These pollutants would be released by construction equipment, fugitive construction dust, haul truck exhaust, and worker commute exhaust. Emissions are anticipated to primarily occur locally, intermittently, and at low levels.

Because emissions during the construction phase would be temporary and of relatively low level, and would be minimized by the measures stated above, no significant adverse short-term impacts to air quality are anticipated to result from construction of the Proposed Action. Therefore, construction of the project is not expected to result in appreciable degradation of air quality.

Construction-related emissions would comply with HAR Title 11 Chapter 60.1 regarding air pollution control, specifically Section 11-60.1-33, regarding fugitive dust and the prohibition of visible dust emissions at property boundaries. To minimize any adverse effect on air quality, Kawailoa Wind Power would require construction contractors to adhere to specific minimization measures (see below).

During operation, including environmental monitoring, minor air emissions would result from staff and vendor vehicle traffic, maintenance equipment, and facility electricity usage. It is estimated that there would be a maximum of 16 one-way vehicle trips per day during operation. There would also be minor emissions associated with infrequent use of cranes used for maintenance of the project components. In addition to the maintenance equipment and vehicle emissions, operation of the electrical substation and BESS equipment would result in minor indirect emissions as a result of fossil fuel energy use for electricity. Estimated emissions in tons per year are: 0.003 for $PM_{2.5}$, 0.002 for PM_{10}, 0.09 for HC, 0.83 for CO, 0.06 for NO_2, 146.5 for CO_2, and 0.0004 for SO_2 (CH2M Hill 2011).

These very low emission levels, similar to construction, would not be expected to significantly affect air quality. At a broader scale, the project would provide a substantial net beneficial impact to global climate conditions by replacing energy generated by burning fossil fuels with renewable energy, thereby reducing emissions of greenhouse gases.

At the Mt. Ka`ala communications site, very low emissions are expected from construction and approximately 20 vehicle trips. Installation of the antennas and appurtenant equipment on the existing structures would not require any ground disturbance. Similar to construction, operation of the project would result in an extremely minor amount of emissions in association with maintenance vehicles; a total of approximately 4 vehicle trips per year are expected. Collectively, the emissions associated with construction and operation of the communications sites is extremely low, and in combination with the wind farm site, would not be expected to significantly affect air quality.

Thus, the Proposed Action has the potential to cause a reduction in the emission of major air pollutants that are products of generating electricity through combustion of fossil fuel.

Minimization and/or Mitigation Measures During Construction:

Construction BMPs detailed in Kawailoa Wind Power's NPDES General Permit Notice of Intent would include measures relative to dust control, including ESC10 (Seeding and Planting), ESC11 (Mulching), ESC21 (Dust Controls), ESC23 (Construction Road Stabilization), and ESC24 (Stabilized Construction Entrances). Kawailoa Wind Power would use only water with no chemical additives for dust control.

In order to minimize any adverse effect on air quality, Kawailoa Wind Power would require construction contractors to adhere to the following measures:

- Maintain all construction equipment in proper tune according to manufacturer's specifications.
- Fuel all off-road and portable diesel powered equipment, including but not limited to bulldozers, graders, cranes, loaders, scrapers, backhoes, generator sets, compressors, auxiliary power units, with motor vehicle diesel fuel.
- Maximize to the extent feasible, the use of diesel construction equipment meeting the latest certification standard for off-road heavy-duty diesel engines.
- Minimize the extent of disturbed area where possible.
- Use water trucks or sprinkler systems in sufficient quantities to minimize the amount of airborne dust leaving the site.
- Cover or continuously wet dirt stockpile areas containing more than 100 cubic yards of material.
- Implement permanent dust control measures identified in the project landscape plans as soon as possible following completion of any soil disturbing activities.
- Stabilize all disturbed soil areas not subject to revegetation, paving, or development using approved chemical soil binders, jute netting, or other methods.
- Lay building pads and foundations as soon as possible after grading unless seeding or soil binders are used.
- Limit vehicle speed for all construction vehicles moving on any unpaved surface at the construction site to 15 mph or less.
- Cover all trucks hauling dirt, sand, soil, or other loose materials.

<u>Impacts of Avoidance and Minimization Measures</u>

The avoidance and minimization measures proposed for the project under the HCP are not expected to affect the air quality surrounding the area.

<u>Impacts of Mitigation Measures</u>

Seabird Mitigation: Only minor impacts are expected due to actions implemented for seabird mitigation. The self-resetting cat trap will need to be checked at regular intervals (monthly or weekly) and if translocation or predator trapping occurs, regular visits (monthly or weekly) to the seabird colony will be required to implement management measures and document reproductive success. The minor air quality impacts will be primarily due to vehicles using fossil-fuel fired internal combustion engines transporting staff and equipment to the study site.

Waterbird Mitigation: Only minor impacts are expected due to actions implemented for waterbird mitigation. During the first year when fencing and vegetation removal at the wetland will occur, vehicles using fossil-fuel fired internal combustion engines will be used to transport staff and equipment to the wetland site. Light machinery may be used for fence building or vegetation removal. The visits during fence building and vegetation removal may occur several times a week. Once the fencing and vegetation removal is completed and regular visits (weekly during the seabird breeding season) to the wetland will be required to implement management measures such as trapping, ungulate control and to document reproductive success. The minor air quality impacts will be primarily due to vehicular transport of staff and equipment to the mitigation site.

Bat Mitigation: Minor impacts to air quality are similarly expected to be primarily due to vehicular transport of staff and equipment to the study site for research, forest or wetland restoration activities, monitoring or research activities. During the wetland or forest restoration period (two to three years), site visits may occur several times a week, but when the restoration is complete, regular visits (weekly or less) are expected.

Owl Mitigation: Insignificant air quality impacts for owl rehabilitation are expected as vehicles will only be used to transport the owls to and from the rehabilitation center. During the implementation of management activities, vehicles may be used on a regular basis to staff and equipment to the mitigation site and may result in minor impacts to air quality.

4.2.2 Alternative 2 (Alternative Communications Site Layout)

Compared to the Proposed Action (Alternative 1), construction and operation of the Mt. Kaʻala communication facilities under this alternative would result in a very small amount of emissions associated with construction and maintenance vehicles. In addition, a small amount of ground disturbance would be required for excavation of the tower foundations (approximately 144 square feet per tower). Collectively, the emissions associated with construction and operation of the alternative communications site layout is extremely low, and similar to the Proposed Action, would not be expected to significantly affect air quality. Mitigation and minimization measures implemented during construction would be the same as Alternative 1.

Air quality impacts due to avoidance and minimization measures or mitigation measures as prescribed in the HCP are expected to be the same at Alternative 1.

4.2.3 Alternative 3 (No Action Alternative)

Under the No Action Alternative, no new emissions or changes in air quality over the baseline conditions would occur. Furthermore, the alternative would decrease the potential to replace energy derived from burning fossil fuels with renewable energy. As such, the air quality benefits from reduced greenhouse gas emissions of greenhouse gases and other air pollutants would not be realized.

No air quality impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.3 Geology, Topography, and Soils

4.3.1 Alternative 1 (Proposed Action)

Construction of the project would require grading for both temporary and permanent project features. Temporary features that would require grading include the equipment laydown areas and temporary work areas adjacent to each turbine location. Permanent structures that would require grading include the wind turbine generators, substation and BESS facility, the electrical collector system, the O&M building, HECO interconnection facilities, meteorological towers, the communication tower, and onsite access roads. The site civil design is still being developed; however, the estimate of the total area of disturbance is approximately 335.1 acres, of which 21.7 acres would be permanent, within the 4,200 acre project area. During the operations and maintenance phase of the project, grading is expected to be limited to replacement of the underground collector lines and/or maintenance of the onsite access roads. These events are expected to occur infrequently.

Ground-disturbing activities would be conducted using graders, multiple cranes, dump trucks, concrete mix trucks, front end loaders, bulldozers, excavators, and heavy haul trucks. In general, grading would be limited to areas that have been extensively disturbed through repeated discing and grading as part of former agricultural activities. In some cases, shallow bedrock may be disturbed. To the extent possible, the earthwork would be designed to minimize cut and fill, and to avoid impacts to the major topographic features (including the gullies and streams); some components of the project may result in localized topographic changes and increased potential for erosion.

Minimization and/or Mitigation Measures During Construction:

The BMPs outlined below would be implemented to avoid and minimize erosion associated with ground-disturbing activities:

- Sequence construction activities to minimize the exposure time of cleared areas.
- Minimize the extent of disturbed areas, where possible.
- To avoid fugitive dust emissions, cover soil stockpile areas containing more than 100 cubic yards of material, or keep continuously wet.
- Stabilize all disturbed soil that is not subject to re-vegetation, paving, or development, using approved chemical soil binders, jute netting, or other methods.
- Lay building pads and foundations as soon as possible after grading, unless seeding or soil binders are used.
- Cover all trucks hauling dirt, sand, soil, or other loose materials.
- Install erosion and sediment control measures (for example, silt fences) before initiating earth moving activities, and properly maintain throughout the construction period.
- Minimize the extent of clearing and grubbing to only what is necessary for grading, site access, and equipment operation.
- Properly implement all stormwater runoff and erosion control BMPs, as specified in the Construction Stormwater Permit to be obtained from HDOH.
- During dry periods, inspect BMP features once weekly and repair as necessary. Inspect and repair features as needed within 24 hours after a rainfall event of 0.5 inches or greater in a 24-hour period. During periods of prolonged rainfall, inspect daily would occur.
- Maintain records for all inspections and repairs, on site.
- Apply permanent soil stabilization (that is, graveling or re-planting of vegetation) as soon as practical after final grading.

Given that the majority of the site has been extensively disturbed as part of previous site activities and that no major existing topographic features are expected to be affected (including the gullies and intermittent streams), construction and subsequent operation of the project is not expected to result in significant impacts to geology and topography. With implementation of BMPs, impacts to soils would be minimal.

<u>Impacts of Avoidance and Minimization Measures</u>

The avoidance and minimization measures proposed for the project under the HCP are not expected to affect the geology, topography and soils in surrounding the area.

Impacts of Mitigation Measures

Seabird mitigation: Minor impact to topography and soil resources due to trampling by monitors may occur during the monitoring of cat traps or implementation of translocation protocols and predator control. Regular visits to the mitigation site will occur and existing trails will be used whenever possible to reduce impacts to the topography and soil.

Waterbird mitigation: Minor impact to topography and soil resources due to trampling by monitors may occur during the monitoring or implementation of waterbird management measures such as fencing, vegetation maintenance and predator control. Regular visits to the mitigation site will occur (daily, weekly, or monthly) and existing trails will be used whenever possible to reduce impacts to the topography and soil.

The removal of invasive vegetation at the wetland will result in temporary impacts to the topography and soils but the reestablishment of native vegetation will result in reduced erosion (Vitousek 1993). Fencing will result in some permanent disturbance of the soil and topography due to fence posts. The fence is estimated to be 4,900 feet, with posts driven into the ground every 10 feet approximating roughly 490 posts. The fenceline will be buried (approximately six inches deep) to prevent ungulates from digging through the fence. These narrow swaths of disturbance would be widely distributed over geography, and local impacts of constructing the fence would be minimal. Soil and topographical disturbance is expected to be short term with no significant impacts expected.

Bat Mitigation: Minor impact to topography and soil resources due to trampling by monitors may occur during the monitoring or implementation of bat management measures such as fencing, vegetation maintenance and predator control at either wetland or forest site. Regular visits to the mitigation site will occur (weekly or monthly) and existing trails will be used whenever possible to reduce impacts to the topography and soil.

The removal of invasive vegetation at the wetland or forest will result in temporary impacts to the topography and soils but the reestablishment of native vegetation will result in reduced erosion (Vitousek 1993). Ungulate control will reduce the number of ungulates within the mitigation area and impacts to the topography and soil will be reduced overall due to the reduction of trampling, rooting and grazing by introduced ungulates.

If wetland restoration is chosen for Tier 1 and higher take level mitigation, fencing at the wetland will result in an addition of 6,200 feet in addition to the fence constructed for waterbird mitigation. Permanent disturbance to the soils and topography will occur when posts driven into the ground every 10 feet approximating roughly an additional 620 posts. The fenceline will be buried (approximately six inches deep) to prevent ungulates from digging through the fence. These narrow swaths of disturbance would be widely distributed over geography, and local impacts of constructing the fence would be minimal. Soil and topographical disturbance is expected to be short term with no significant impacts.

If forest restoration is conducted for bat mitigation at Tier 2 take levels, fencing may also be needed for 400 acres or more of forest restoration. The fenceline may be up to 32,424 feet in length. Permanent disturbance to the soils and topography will occur when posts driven into the ground, up to 7,065 posts may be driven into the ground. The fenceline will be buried (approximately six inches deep) to prevent ungulates from digging through the fence. These narrow swaths of disturbance would be widely distributed over geography, and local impacts of constructing the fence would be minimal. Soil and topographical disturbance is expected to be short term with no significant impacts expected.

An equivalent amount of fencing may be required for another 400 acres of forest if Tier 3 mitigation is implemented. Similarly, soil and topographical disturbance due to fencing an additional 400 acres is expected to be short term with no significant impacts expected.

Owl mitigation: No soil and topographical impacts are expected due to owl rehabilitation or research. Depending on the owl management measure chosen, minimal soil disturbance may occur due to regular visits to the management site to monitor owls or carry out management measures.

4.3.2 Alternative 2 (Alternative Communications Site Layout)

Under this alternative, a new communication tower would be installed at either one or both of the Mt. Ka‘ala communication sites in previously disturbed areas adjacent to the existing Hawaiian Telcom structures; access would be via existing roads and trails. Installation of each tower would require minor excavation for the tower foundations (approximately 144 square feet per tower). Construction would not result in significant changes to the soils or geology or soils of the site. Mitigation and minimization measures would be the same as Alternative 1.

Soil and topography impacts due to avoidance and minimization measures or mitigation measures as prescribed in the HCP are expected to be the same at Alternative 1.

4.3.3 Alternative 3 (No Action Alternative)

Under the no build scenario, no impacts to geologic features or soils would be expected because the wind facility would not be constructed or operated in the project area.

No soil and topography impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.4 Hydrology and Water Resources

4.4.1 Alternative 1 (Proposed Action)

Construction of the project components would require minimal subsurface work, with the maximum depth of excavation expected to be approximately 10 feet. These depths are well above the water table and, therefore, no direct interaction with groundwater is anticipated. Other types of impacts to groundwater that could result from construction and/or operation of the project include reductions in recharge, availability, or quality. Specific to groundwater recharge, the project would increase the total impervious surface across the property by approximately 21.7 acres; however, these surfaces would only comprise a very small percentage of the overall area, and there is still sufficient open space such that groundwater recharge is not expected to measurably decrease. Total water consumption would be minimal (for example, watering roads and stockpiles), and would be addressed using water tanks that would be periodically filled with water trucked onto the site (or obtained from the onsite irrigation ditches). As such, the project is not expected to adversely affect groundwater availability.

Finally, construction and operation activities would require the use of some hazardous materials, which if handled inappropriately, could affect groundwater quality. However, appropriate management practices, including preparation and implementation of a Spill Prevention, Countermeasure, and Control (SPCC) Plan, would be in place throughout construction and operation to avoid and minimize impacts associated with these materials. With implementation of these measures, no impacts to groundwater quality are expected.

The project footprint has been designed to avoid potentially jurisdictional features to the maximum extent possible; these features include Loko Ea, Laniākea, Kawailoa, Ka‘alaea, and the unnamed tributary to Waimea River. The only locations where potentially jurisdictional features occur within the footprint are those areas where they intersect with the existing onsite roads. In general, the waterways are culverted under the roads, and road improvements would be conducted so as to avoid impacts to these features. The only unculverted road crossing within the project footprint is along Laniakea Stream, an intermittent waterway, where it washes over Cane Haul Road. Work that would be conducted in this area would be limited to repair and maintenance of the road surface; no work would be conducted outside the existing footprint of the road.

Although construction is not expected to directly impact any potentially jurisdictional features, ground-disturbing activities during construction have the potential to increase the amount of sediment and other pollutants in stormwater runoff, which could adversely affect the water quality in the onsite waterways, as well as downstream receiving waters. Of all of the components of the project, the access roads are expected to have the greatest potential to contribute sediment (and associated pollutants) to stormwater runoff, primarily because dirt roadways function as both a source area and transport mechanism. The project has been designed to use the existing access roads to the extent possible, thereby minimizing construction of new roadways. To reduce the potential for sediment and pollutant delivery from both the existing and new roadways to be used for the project, gravel would be applied to the road surfaces and rock-lined swales would be installed along the edge of the roadways. Large rock (typically Surge-B) would be used to line each swale, helping to slow the flow and allowing sediment to settle out. Swales would generally be located in areas where conveyance of stormwater is focused, with dimensions based on anticipated flow volume. Each swale would also include "level spreaders," which would allow a portion of the runoff to flow from the swale and disperse onto an adjacent vegetated field (or other relatively flat area). The swales would be installed and maintained during construction and throughout the life of the project, such that impacts to water quality are expected to be minimal; given the large network of existing, unimproved dirt roads on the site, it is likely these features would decrease sediment delivery on a per-unit area basis below existing levels.

Minimization and/or Mitigation Measures During Construction:

In addition to the roadway swales, other general BMPs would be implemented as part of construction to avoid and minimize impacts. These BMPs include sequencing of activities to minimize the exposure time of cleared and excavated areas; in addition, to the extent possible, excavation for the turbines would be timed to avoid the wet winter months.

Because the area to be disturbed is over an acre, Kawailoa Wind Power would be required to prepare a Notice of Intent for construction-related stormwater runoff pursuant to National Pollutant Discharge Elimination System (NPDES) regulations. The NPDES application would identify potential receiving waters for runoff, quantify the anticipated volume of runoff, and identify BMPs that would be used to prevent pollutants from leaving the site. BMPs anticipated to be used for the project are identified in Table 4-1. These practices are designed to prevent toxic substances and other pollutants from reaching receiving waters. The use of silt fences, construction entrance stabilization, geotextile mats, earthen berms, and watering for dust control would retain or contain soil/sediment within the project area, thereby reducing the amount of sediment discharged into nearby water bodies. Regular inspection and maintenance of vehicles and equipment, as well as proper containment and storage of potential pollutants, would also minimize or prevent the pollution of storm water runoff.

Table 4-1. Potential Pollutants from Construction Activities and BMPs.

Pollutant	Source/Activity	BMP
Vegetation/ Rock	Excavation, grubbing, grading, stockpiles	Silt fences, temporary soil stabilization
Soil/ Sediment	Excavation, grading, stockpiles, watering for dust control	Silt fences, protection of stockpiles, natural vegetation, sand bags, construction entrance stabilization, temporary soil stabilization, geotextile mats (internal access road slopes), avoid excess dust control watering
Oil and Gas	Construction equipment, vehicles	Regular vehicle and equipment inspection, prohibition of onsite fuel storage, drip pan for onsite tanker fueling, spill kits
Construction Waste	Construction debris, select fill, paint, chemicals, etc.	Protection of stockpiles, dumpsters, periodic waste removal and disposal, compaction and swales, containment pallets
Concrete Wash Water	Pouring of WTG foundations	Containment in wash water pits, silt fences
Equipment and Vehicle Wash Water	Construction equipment	Containment berms around equipment washing area, offsite vehicle washing
Sanitary Waste	Portable toilets or septic tank	Sanitary/septic waste management
Source: Department of Environmental Services, City and County of Honolulu (1999).		

In addition to these BMPs, the following general construction management techniques would be incorporated to reduce impacts to hydrology, drainage, and water features under the Proposed Action:

- Clearing and grubbing would be held to the minimum necessary for grading, access and equipment operation.
- Erosion and sediment control measures would be in place prior to initiating earth moving activities. Functionality would be maintained throughout the construction period.
- Construction would be sequenced to minimize the exposure time of the cleared surface area.
- Areas that are disturbed during the course of construction would be protected and stabilized according to BMPs approved by DOH following its review of the Construction Stormwater Permit application for the project.
- Control measures (i.e., silt fences, sand bag barriers, sediment traps, geotextile mats, and other measures intended for soil/sediment trapping) would be inspected once weekly during dry periods and repaired as necessary.
- Control measures (i.e., silt fences, sand bag barriers, sediment traps, geotextile mats, and other measures intended for soil/sediment trapping) would be inspected and repaired as needed within 24 hours after a rainfall event of 0.5 inches or greater over a 24-hour period. During periods of prolonged rainfall, daily inspection will occur, unless extended heavy rainfall makes access impossible or hazardous.
- Records for all inspections and repairs will be maintained on site.
- Permanent soil stabilization (i.e., graveling or re-planting of vegetation) will be applied as soon as practical after final grading, as discussed in the Kawailoa Revegetation Plan. Kawailoa Wind Power will coordinate with DLNR and other specialists regarding selection of appropriate species for revegetation.

<u>Impacts of Avoidance and Minimization Measures</u>

The hydrology in a few small areas on site may be altered to a minor extent to prevent standing water from accumulating on site to prevent attraction to waterbirds. However, currently no standing water occurs at the project site and the alteration of hydrology to prevent standing water may not be necessary. No other avoidance and minimization measures are expected to have any effect on the hydrology or water resources in the area.

<u>Impacts of Mitigation Measures</u>

Monitoring, fencing, ungulate control, predator control and weed control may affect hydrology and water resources. These mitigation activities could be part of seabird, waterbird, bats and owl mitigation.

Some impacts to the hydrology or water resources may occur due to trampling when monitoring the success of mitigation measures or while implementing measures such as trapping. However, impacts will be kept to a minimum as existing trails will be used as much as possible.

No significant impacts to surface waters are anticipated from fence construction. Vegetation would be hand-cleared in areas adjacent to the fence if necessary, with stumps and roots remaining in the ground to prevent soil disturbance. In the event that fencelines are constructed adjacent to surface waters, surrounding vegetation would remain in place to prevent runoff from feral ungulates traversing the outside of the fenceline.

Ungulate control and predator control can potentially improve the water quality at the site due to by decreasing the number of ungulates and reducing soil erosion. Predator trapping will limit the input of disease-causing organisms (such as leptospirosis caused by rats) into stream water by reducing the number of feral animals present within the mitigation area. Rodenticides which will be used for waterbird mitigation will be contained within bait boxes and will comply with all labeled instructions accompanying the use of the rodenticide. No significant impacts to water resources are expected from the use of rodenticides for waterbird mitigation.

Weed control may consist of the application of herbicides. Only appropriate herbicides for the area (wetland or forest) will be used, in accordance with labeled instructions to ensure that no significant impacts to water resources are expected from the use of herbicides for weed control.

4.4.2 Alternative 2 (Alternative Communications Site Layout)

Under this alternative, installation of the communication towers would require a minimal amount of excavation and ground disturbance. No surface water features are present within either communications site, so no direct impacts would occur. The tower footings would only slightly increase the impervious surfaces at each site and indirect impacts to surface water quality would be insignificant. Construction at the communications site is also not expected to affect the recharge, availability, quality of the groundwater. Mitigation and minimization measures would be the same as Alternative 1. Hydrology or water quality impacts due to avoidance and minimization measures or mitigation measures as prescribed in the HCP are expected to be the same at Alternative 1.

4.4.3 Alternative 3 (No Action Alternative)

Water resources in the area would not be impacted under the No Action Alternative because the wind facility would not be constructed or operated in the area. No hydrology or water quality impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.5 Biological Resources - Flora

4.5.1 Alternative 1 (Proposed Action)

Construction of the facility would have a minor impact on existing flora at the project area due to ground clearing. The proposed roads, construction activities, and regular operation of the Proposed Action would result in disturbance of approximately 335.1 acres of the project area. To improve searcher efficiency during monitoring of the WTGs and met towers, vegetation may be removed from search plots if such vegetation creates unsearchable conditions within the required search areas.

No state or federally listed threatened, endangered, or candidate plant species have been documented within the Kawailoa project area (Hobdy 2010a, 2010b). No critical habitats have been designated for plant species at the project site. Vegetation occurring in areas that would be disturbed consists mostly of non-native grasses and trees. These species are common throughout O‘ahu and the main Hawaiian Islands. Due to the general condition of the area and the specific lack of any environmentally sensitive native plant species within the project area, the Proposed Action is not expected to result in any significant adverse impact on botanical resources in this part of O‘ahu.

Although native vegetation occurs in the vicinity of the proposed offsite communication tower sites, areas that would be directly disturbed by construction of the offsite towers were previously cleared and consist of non-native species common throughout O‘ahu and the main Hawaiian Islands. However, no impacts to flora are anticipated as the communication equipment would be installed on the two existing towers and ground disturbance is expected to be minimal.

Executive Order 13112 was signed to prevent the introduction of invasive species and provide for their control. According to this Executive Order, an invasive species is defined as "an alien species (a species that is not native to the region or area) whose introduction does or is likely to cause economic or environmental harm or harm to human health." HRS Chapter 152 (Noxious Weed Control) also prohibits the introduction or transport of "specific noxious weeds or their seeds or vegetative reproductive parts into any area designated pursuant to section 152-5 as free or reasonably free of those noxious weeds" (§152-3). A list of plant species designated as noxious weeds by the Hawaiʽi Department of Agriculture (DOA) for eradication or control purposes is provided in HAR, Title 4, Chapter 68. Several invasive plants occur in the Kawailoa project area and the vicinity. Due to the existing conditions of the project area, the potential for the project to result in an increase in the number or distribution of invasive plant species would be minor. However, to minimize the potential for introducing new invasive plants to the project area, Kawailoa Wind Power will implement the minimization measures described below.

None of the nine plant species with critical habitat designations that encompass the tower sites are present on-site at the two tower locations and no impacts to these plant species are expected. Any vegetation that would be disturbed at the off-site microwave facility sites consists of non-native species common throughout Oʽahu and the main Hawaiian Islands. However, no impacts to flora are anticipated as the communication equipment will be installed on the two existing towers and ground disturbance is expected to be minimal.

Minimization and/or Mitigation Measures During Construction:

- Revegetation: Following construction, Kawailoa Wind Power intends to stabilize the project area using suitable ground cover. Where practical, native species will be used to stabilize bank slopes along constructed access roads or cut and fill slopes within the project area, as recommended by Hobdy (2010a). Although native species may be re-introduced, the primary goal of the revegetation would be to immediately stabilize soil and prevent erosion following construction. Kawailoa Wind Power would also replant an equivalent or greater number of native trees in the vicinity of the project to replace any native trees that may be removed during construction.

- Invasive Species Control:

  Kawailoa Wind Power intends to minimize and avoid the introduction of new invasive species to the project area during the proposed wind farm development using the following best management practices. To avoid the unintentional introduction or transport of these species through soil and debris, all construction equipment and vehicles arriving from outside of the Island of Oʽahu will be washed prior to entering the project area. In addition, Kawailoa Wind Power will ensure that construction materials arriving from outside of Oʽahu are washed and/or visually inspected (as appropriate) for excessive debris, plant materials, and invasive or harmful non-native species prior to transportation to the project area. Most inspection and cleaning activities will be conducted at a vacant 6.8 acre parcel immediately adjacent to the Barbers Point Harbor, will be leased by Kawailoa Wind Power. Equipment and material arriving through Honolulu Harbor will be inspected and/or cleaned (as appropriate) at a designated location prior to entering the project area. Kawailoa Wind Power will document all inspection and cleaning activities using inspection forms. Kawailoa Wind Power will ensure that off-site sources of revegetation materials (seed mixes, gravel, mulches, etc.) are certified weed-free or inspected prior to transport to the project area. Furthermore, weed establishment will be limited by minimizing ground disturbance and vegetation removal to the maximum extent practicable. Erosion of the job site and the potential transport of weedy species will be prevented through implementation of storm water runoff Best Management Practices.

  At the end of the construction period, areas altered by construction of the project will be surveyed to ensure that no problematic and/or invasive species have been introduced. All areas that are hydroseeded will be monitored for at least six months to ensure removal of any invasive plants that have established from seeds inadvertently introduced as part of the seed mixes. Appropriate remedial actions will be undertaken as needed, in consultation with DLNR and USFWS (as appropriate) to facilitate containment or eradication of the target species as soon as reasonably possible.

- To avoid the unintentional introduction or transport of invasive species through soil and debris, all construction equipment and vehicles arriving from outside of the Island of Oʽahu would be washed prior to entering the project area.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed for the project under the HCP are not expected to affect the flora surrounding the area.

Impacts of Mitigation Measures

Botanical surveys will be conducted prior to the implementation of mitigation measures for all species, and listed plant species, ecologically sensitive or culturally valuable plant species will be avoided during the implementation of any mitigation measure.

Seabird mitigation: Minor impact to flora may occur due to trampling by monitors may occur during the monitoring of cat traps or implementation of seabird colony management measures such as ungulate control and predator control. Regular visits to the mitigation site will occur (daily, weekly, or monthly) and existing trails will be used whenever possible to reduce impacts to the flora.

Waterbird mitigation: Minor impact to flora due to trampling by monitors may occur during the monitoring or implementation of waterbird management measures such as fencing, vegetation maintenance and ungulate control. Regular visits to the mitigation site will occur (daily, weekly, or monthly) and existing trails will be used whenever possible to reduce impacts to the topography and soil.

The removal of invasive vegetation at the wetland will reduce the number of alien species on site and the reestablishment of native vegetation will result in an increase in the percentage of native vegetation at the mitigation site and will have a positive effect on the native species assemblage present at the site. Ungulate control will reduce the number of ungulates within the mitigation area and impacts to the flora will be reduced overall due to the reduction of trampling, rooting and grazing by introduced ungulates.

Fencing will result in the temporary disturbance of the flora along the fenceline. The fence is estimated to be 4,900 feet long, with up to a 10-foot corridor resulting up to a maximum of 1.1 acres of vegetation disturbance. These narrow swaths of disturbance would be widely distributed, and local impacts to the flora due to constructing the fence would be minimal. Flora disturbance is expected to be short term with no significant impacts expected. Most of the flora around the fenceline is also expected to consist mostly of alien species.

Bat Mitigation: Minor impact to the flora due to trampling by monitors may occur during the monitoring or implementation of bat management measures such as fencing, vegetation maintenance, and restoration at either wetland or forest site. Regular visits to the mitigation site will occur (daily, weekly, or monthly) and existing trails will be used whenever possible to reduce impacts to the flora.

The removal of invasive vegetation at the wetland or forest will reduce the number of alien species on site and the reestablishment of native vegetation will result in an increase in the percentage of native vegetation at the mitigation site and will have a positive effect on the native species assemblage present at the site. Ungulate control will reduce the number of ungulates within the mitigation area and impacts to the flora will be reduced overall due to the reduction of trampling, rooting and grazing by introduced ungulates.

If wetland restoration is chosen for Tier 1 and higher tier mitigation, fencing at the wetland will result in an addition of 6,200 feet in addition to the fence constructed for waterbird mitigation. This fenceline will also have a 10 feet corridor resulting up to a maximum of 1.4 acres of vegetation disturbance. These narrow swaths of disturbance would be widely distributed over geography, and local impacts to the flora due to the constructing the fence would be minimal. Flora disturbance is expected to be short term with no significant impacts expected. Most of the flora around the fenceline is also expected to consist mostly of alien species.

If forest restoration is conducted for bat mitigation at Tier 2, fencing may also be needed for 400 acres of forest restoration. The fenceline may be up to 32,424 feet in length with a 10-foot corridor resulting up to a maximum of 7.4 acres of vegetation disturbance. These narrow swaths of disturbance would be widely distributed over geography, and local impacts to the flora due to the constructing the fence would be minimal. Flora disturbance is expected to be short term with no significant impacts expected. As stated above, botanical surveys will be conducted prior to the erection of the fences and all ecologically sensitive or culturally valuable plant species will be avoided to minimize impacts to the native plant species.

An equivalent amount of fencing and ground disturbance may be required for another 400 acres of forest if the highest level mitigation is reached. Similarly, impacts to flora due to fencing an additional 400 acres is expected to be short term with no significant impacts expected.

Owl mitigation: No flora impacts are expected due to owl rehabilitation or research. Depending on the owl management measure chosen, minimal impacts to flora may occur due to regular visits to the management site to monitor owls or carry out management measures.

<u>4.5.2 Alternative 2 (Alternative Communications Site Layout)</u>

Under Alternative 2, impacts would be similar to the Proposed Action. Disturbance at the wind farm site would be the same with minor additional disturbance at the communications site. Construction and operation of the equipment at the Mt. Ka‘ala communication sites would involve installation of a new tower within those areas where vegetation has been previously cleared and maintained adjacent to each of the existing Hawaiian Telcom facilities. These areas do not support any protected plant species or habitats, and therefore, no impacts are expected. Nonetheless, the same mitigation measures described for the Proposed Action would be implemented to reduce the likelihood of invasive species being introduced to the area.

Impacts to flora due to avoidance and minimization measures or mitigation measures as prescribed in the HCP are expected to be the same at Alternative 1.

No trimming of vegetation along the trails is anticipated. No vegetation will be cleared if the endangered *Achatinella* species are detected. If *Achatinella* species are detected at the location of the proposed towers, the towers will not be erected and there will be no impacts to the vegetation. Leaf litter will be collected before the area is graded and distributed to the surrounding area to allow any native snails in the leaf litter to move on to undisturbed ground. If a helicopter is used to deliver construction materials, it will remain 100 ft (30.5 m) agl to avoid the impact of rotor wash on any forest habitat that have been designated as critical habitat for the O‘ahu ‘elepaio.

<u>4.5.3 Alternative 3 (No Action Alternative)</u>

No change in existing floristic conditions would occur in the project area under this alternative because the wind facility would not be constructed or operated.

No flora impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.6 Biological Resources - Wildlife

Construction and operation of the Proposed Action has potential to impact wildlife through disturbance of onsite habitats and by creating a potential for collisions with WTGs, unguyed met towers, and other project components. The potential for WTGs to adversely affect birds and bats is well-documented in the continental United States (e.g., Horn et al. 2008; Kunz et al. 2007; Kingsley and Whittam 2007; Kerlinger 2005; Erickson 2003; Johnson et al. 2003a, 2003b). Documented avian fatality rates at wind energy facilities differ throughout the world (Erickson et al. 2001) and some species appear to have a higher risk of collision with wind energy facilities than others. For example, passerines are known to have comparatively high fatality rates (Erickson et al. 2001; Kingsley and Whittam 2007), while waterfowl and shorebirds seem to avoid turbines (Curtis 1977; Olsen and Olsen 1980; Kingsley and Whittam 2007; Powlesland 2009).

In the State of Hawai‘i, wind energy generation facilities are relatively new; thus, few wildlife monitoring impact studies have been conducted to document the direct or indirect impact of wind energy facilities on particular species. Post-construction monitoring to document downed wildlife has been conducted at the Kaheawa Wind Project (KWP) facility on Maui since operations began in June 2006 (KWP LLC 2008b, 2008c). This information offers the best presently available insight into the potential impacts of WTGs in Hawaii, as well as a means to assess the accuracy of pre-construction mortality estimates. No Covered Species were found downed or dead during the first year of construction and operation of the KWP project (KWP LLC 2008a). During the subsequent years of monitoring, KWP documented observed direct take of three federally listed species – a single adult Hawaiian petrel, six full-grown nene, and two Hawaiian hoary bats (KWP LLC 2008c; KWP 2009; KWP 20010). Rates of adjusted take (i.e. adjusted for searcher efficiency, scavenging, and indirect take) at KWP fall within "Baseline" or "Lower" ranges as described in the KWP HCP (KWP LLC 2008b, 2009, 2010), meaning that rates of take were the same as, or lower than, those predicted for the project prior to construction. Documented fatalities of non-federally listed species include two ring-necked pheasants, three black francolins, two gray francolins, one barn owl, two white-tailed tropic birds, one great frigate bird, and two Hawaiian short-eared owls.

4.6.1 Alternative 1 (Proposed Action)

4.6.1.1 Non-Listed Species

The Proposed Action would result in the alteration of approximately 335.1 acres, most of which has been previously disturbed and is overwhelmingly comprised of non-native species; of this area, a total of approximately 21.7 acres would be permanently displaced. The vegetated areas within the maximum project footprint for Kawailoa Wind Power consist mostly of agricultural land, alien grassland, shrubland and forest. The vegetated areas that are not permanently displaced will likely be converted to short-stature shrubs and grasses. Non-listed species that use this habitat could be either directly impacted by construction activities (for example, through collision with construction vehicles), or indirectly impacted by loss of habitat.

No habitat loss or related impacts to wildlife resources are anticipated at the Mt. Ka‘ala communications sites because the proposed antennas are static features attached to existing Hawaiian Telcom structures. The existing structures are relatively low, with a small profile, and the proposed equipment is similar in size and type to equipment currently onsite; therefore, installation of the equipment is not expected to create a significant collision hazard to any non-listed or Covered Species, if they should happen to transit the tower location.

Non-listed bird species occurring in the project area are largely common and widespread on O‘ahu and most are tolerant of some degree of development and human presence. The Proposed Action could reduce the amount of habitat available for non-listed bird species. This could result in the displacement of some individuals and slight reduction in some local numbers. However, because these birds are generally common and widespread, the amount of habitat alteration represents a very small part of the total range available to each species. Consequently, any impacts to non-listed bird species are not expected to be significant at the population level. Clearing for the project may be slightly beneficial to Pacific golden-plover because grasslands in the project area are mostly too tall for use by this species; the cleared pads and road edges may provide increased foraging area for some members of this species (SWCA 2011).

During operation, non-listed birds also have potential to collide with WTGs and the unguyed met towers. In particular, passerines are known to have comparatively high fatality rates (Erickson et al. 2001; Kingsley and Whittam 2007). Any of the bird species occurring in the general project area have potential to collide with the proposed WTGs and unguyed met towers. Potential for collision with the met towers would be minimized through the use of streamers and bird diverters.

The black-crowned night heron, the great frigate bird and Pacific goldenplover are native or migratory birds protected by the Migratory Bird Treaty Act (Table 3-4).

Based on observations, the black-crowned night heron is likely present on-site and in the vicinity year round. As no birds were recorded within the rotor swept zone of the turbines, night-herons are expected to be at very low risk of colliding with project components. No irrigation ponds will be impacted by the construction of the project thus no foraging habitat will be lost and no waterbodies will be created by the project (see section 5.3) and will not attract the night-heron to the site. No impacts to the local population of night herons is anticipated.

No birds were recorded at flight altitudes within the rotor swept zone of the proposed turbines and are not expected to be at very low risk of colliding with project components. The creation of roads and open spaces during project construction and the maintenance of the search plots are likely to marginally benefit the pacific golden plover by creating more usable habitat. No impacts to the population of Pacific golden plovers that utilize the site are anticipated.

No great frigate birds were observed over the site either during systematic surveys or within incidental sightings. The one observation was of a bird flying in Waimea valley (Table 3-4). Given that these birds can be expected to fly over the site very rarely, they are anticipated to be a low risk of collision with project components. No impact to the local population of frigate birds is anticipated.

Non-listed mammals expected to occur in the project area are limited to alien species that are generally considered harmful to native bird species (e.g., rats, mongoose, and feral cats). Non-native mammals can degrade ecosystems by consuming or trampling native flora and fauna, accelerating erosion, altering soil properties, and promoting the invasion of non-native plants (Stone et al. 1992; Courchamp et al. 2003; USFWS 2008). Because native Hawaiian flora and fauna did not evolve with these mammals, native species are not adapted to take advantage of, or protect themselves from, the activities of these animals (Stone 1985; Stone et al. 1992). Some non-native mammals can also be predators of some ESA-listed bird species.

Alteration of onsite habitat from one vegetation type to another (e.g., from alien forest to short-stature grass and shrubs) may reduce the amount of habitat available for mammals in the project area. As with birds, alteration of the surrounding habitat could result in displacement of some individual mammals and slight reduction in some local numbers. Loss of mammals may also occur occasionally as a result of collisions with project vehicles. Potential to cause adverse impacts to introduced mammals could be considered a positive effect of the Proposed Action, although given the scale of the project, any actual change in local mammal numbers is likely to be so low as to be insignificant. Therefore, the Proposed Action is generally expected to have a neutral effect on mammals.

Construction-related impacts to mollusk species could also occur, and similar to mammals, could include both direct impacts because of collisions with project vehicles and indirect impacts associated with habitat loss and alteration. However, the only mollusk species observed within the wind farm site are non-native and are generally widespread; consequently, any impacts to non-listed mollusk species are not expected to be significant at the population level.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures to reduce collision risk of the Covered Species with project components or vehicles will likewise reduce the collision risk for non-listed native and non-native species. Barn owl which may also perch on overhead lines will also be minimal risk of electrocution.

The avoidance and minimization measures will have no effect on ground dwelling species.

For the off-site communications towers, measures will also be implemented to avoid impacts to native mollusks at the off-site antennae locations. The antennae will be mounted on existing towers. A limited amount of tree trimming may be required during installation and ongoing maintenance, to provide adequate line-of-sight between the antennas. A helicopter will be used to transport the antennae to the repeater station to minimize the need for vegetation trimming along the access trail. In addition, all vegetation trimming activities will be directly coordinated with USFWS and DOFAW staff to minimize the potential for impacts to native vegetation. Because native vegetation at the site could potentially support native mollusk species (including at least one federally and state- listed species, *Achatinella* spp.), additional mollusk surveys will be conducted before any vegetation trimming at either site, also in coordination with USFWS and DOFAW staff. If the endangered *Achatinella* spp. is detected during the surveys, no vegetation will be trimmed. If no *Achatinella* are detected, then vegetation will be trimmed by hand.

In addition to minimize the potential for introduction of non-native invasive ant species at either of the Hawaiian Telcom sites, baseline surveys of ant fauna would be conducted before and following installation of the antennas, in coordination with DOFAW staff. In addition, all materials and vehicles would be inspected for the presence of ants before transport to the site. With implementation of these measures, impacts to native invertebrate species would be insignificant. If new species of ants are detected in the post-construction survey, and are attributed to the construction work, control measures will be implemented to remove the new species from the area.

Impacts of Mitigation Measures

Fencing, ungulate control, predator control can affect non-listed non-native fauna present at the mitigation sites. These mitigation activities could be part of seabird, waterbird, bats and owl mitigation.

The construction of fences is expected to exclude feral ungulates from mitigation sites. Ungulate control will potentially eradicate ungulates within the mitigation sites. Predator control is expected to decrease the number of introduced predators present within the mitigation sites. Overall, these measures are expected to decrease the number of introduced ungulate and mammal species present at the mitigation sites, and increase the number of native species present at each of the mitigation sites.

4.6.1.2 Federally Listed Non-Covered Species

No impacts to *Drosophila substenoptera* are anticipated at the off-site communications towers. None of the larval host plants are present at the site. If a helicopter is used to deliver construction materials, it will remain 100 feet above ground level to avoid the impact of rotor wash on any *Drosophila substenoptera* that may be present in the vicinity.

The endangered O‘ahu ‘elepaio (*Chasiempis sandwichensis ibidis*) critical habitat is currently unoccupied by the species (Federal Register 2001) at the off-site communications towers. No impacts to the habitat for the O‘ahu ‘elepaio are anticipated for foraging, sheltering, roosting, nesting, rearing of young or dispersal. If a helicopter is used to deliver construction materials, it will remain 100 feet above ground level to avoid the impact of rotor wash on any forest habitat.

Impacts of Avoidance and Minimization Measures

No impacts are expected from the proposed avoidance and minimization measures.

Impacts of Mitigation Measures

No impacts are expected from the proposed mitigation measures.

4.6.1.3 Federally Listed Covered Species

Construction and operation of the Kawailoa Wind Power project under the Proposed Action would create the potential for the Covered Species to collide with the WTGs, temporary and permanent met towers, overhead collection lines, and cranes during the construction phase of the project. Cranes used during construction are typically comparable in height to the turbine towers; however, cranes are intended for daytime use during a portion of the construction phase (three to four months) and would be lowered to a position that would reduce the risk of flight collision when not in use. The crane that would permanently be available for Kawailoa would be used only during the day and stored in its horizontal position at ground level when not in use. Therefore, the potential for Covered Species to collide with cranes onsite is considered to be negligible and not discussed further.

Estimating the potential for each Covered Species to collide with project components (i.e., "direct take") was done using the results of the onsite surveys and information about the Proposed Action design. The fatality estimate models developed for Kawailoa incorporated rates of species occurrence, observed flight heights, encounter-rates with turbines and met towers, and estimates of the species abilities to avoid project components. Due to the very low observed levels of bird and bat activity at Kawailoa for most of the Covered Species, the mortality modeling provides very low estimated rates of direct take. In addition to "direct take," it is possible (depending on time of year and breeding status of the individual) that adult birds directly taken during certain times of the year could have been tending to eggs, nestlings, or dependent fledglings, or that adult bats could have been tending to dependent juveniles. The loss of these adults could then also lead to the loss of eggs or dependent young. Loss of eggs or young would be "indirect take" attributable to the Proposed Action.

Pre-construction estimates of rates of take will not necessarily be accurate for all of the Covered Species. Post-construction monitoring will be used to estimate actual rates of take. The number of dead individuals of listed species found during monitoring will be used to reach an extrapolated level of "total direct take" that accounts for individuals that may not have been found because of limits to searcher efficiency and carcass removal by scavengers. "Total direct take" attributed to the Kawailoa project will be the sum of "observed direct take" (actual individuals found during post-construction monitoring) and "unobserved direct take" (individuals not found by searchers for various reasons, including vegetation cover and scavenging).

Computed "take" for each Covered Species will be classified as "Baseline" or Tier 1 and "Higher" or Tier 2. For bats, an additional higher tier, Tier 3, was added to account for the uncertainty surrounding the susceptibility of non-migrating Hawaiian hoary bats colliding with turbines. The continental subspecies of hoary bats is most susceptible to turbine collisions during their fall migration period but the same migration behavior does not occur in Hawaii, thus the take levels encompass a wider range to accommodate the possible differences in susceptibility.

Requested take at Tier 1 is the baseline amount requested to be authorized by the ITL/ITP for the life of the project and best approximates the 20-year expected rate of take for the project. A Tier 2 or 3 (Higher or Greater) rate of take would be that which exceeds the authorized Tier 1 rate. In this HCP, a Tier 2 take level may be up to twice the Tier 1 requested take. For bats, the Tier 3 requested take is three times greater than Tier 1. Exceeding the five- or 20-year take limit for Tier 1 for any Covered Species would indicate that the rate of take has moved to Tier 2 or Tier 3 (in the case of bats). At this point, the Applicant will also consult with DLNR and USFWS to implement adaptive management strategies. Exceeding only the one-year limit will not move take to a higher tier, but will be used as an "early warning" to spur investigation into why a higher annual rate of take is occurring and whether steps may be able to be taken to reduce future take.

Expected impacts to the Covered Species from the Proposed Action are described below. The sections below identify the number of individuals of each Covered Species for which Kawailoa Wind Power is seeking take authorization under an ITL/ITP. A summary of the estimated and requested take of the Covered Species is provided in Table 2-3.

4.6.1.3 (a) Newell's Shearwater

Pre-construction surveys suggest that Newell's shearwaters are likely to be at risk of collision with the turbines and met towers throughout the project site at Kawailoa Wind Power. For the 30 turbines anticipated on site, the total fatality therefore ranges between 0.45 shearwaters/year (assuming 99% avoidance), 2.3 shearwaters/year (95% avoidance) and 4.59 shearwaters/year (90% collision avoidance rates).

Fatality rates due to Newell's shearwaters striking the met towers are 0.004 birds/tower/year (assuming a 99% avoidance rate), 0.02 birds/tower/year (95% avoidance rate) and 0.043 birds/tower/year (90% avoidance rate).

No Newell's shearwater mortality has been documented at the KWP facility on Maui since operations began. However, modeling suggests that for the measured passage rates, at 95% avoidance, approximately three Newell's shearwater fatalities should have occurred already. Since that scenario seems unlikely, given that no carcasses have been found, a 99% avoidance rate was assumed for Kawailoa Wind Power. Thus, the estimated average fatality rate at a 99% avoidance level for all turbines is estimated at 0.45 shearwaters/year. Fatality at the (up to) two permanent met towers is estimated at 0.008 shearwaters/year at the 99% avoidance rate. The total expected fatality for the turbines and met towers combined is calculated to be 0.46 shearwaters/year. However, this estimated fatality may still be inflated as during the radar survey, it was evident that some of the targets observed on radar were likely not Newell's shearwater but other seabirds or shorebirds that have similar flight speeds and sizes, such as the Pacific golden-plover, black-crowned night heron or white-tailed tropic bird (Day et al. 2003b). Coupled with the uncertainty over whether the species still breeds on the Island of O'ahu, Kawailoa Wind Power proposes to assume that approximately only one quarter of the targets are Newell's shearwater and projects a mortality rate of 0.12 shearwaters/year for all turbines and met towers on site.

Potential for shearwaters to collide with the on-site communication towers, off-site antennae and utility poles also exists. All these structures are 60 ft tall or less. Studies have shown that only 1% of Newell's shearwaters (n = 688 birds; B. Cooper/ABR, pers. comm.) fly below 60 ft and of these individuals, the estimated collision avoidance rate is 97% (Day et al., in prep). Given that the seabird traffic rate on O'ahu is extremely low, the likelihood of a seabird flying at such low altitudes and colliding with the communication towers, antennae, and utility poles related to the project is considered to be remote.

The possibility of Newell's shearwater colliding with overhead lines is also considered remote. On Kaua'i, take associated with 1145 miles of transmission, distribution, and secondary lines in 2008 was estimated to be 15.5 breeding adults, and 63 non-breeding or immature Newell's shearwaters (Planning Solutions et al. 2010). Kaua'i is estimated to host 75% of the total population of Newell's shearwater population, which is estimated at 21,250 breeding and non-breeding birds in 2008 (Planning Solutions et al. 2010). This amounts to 0.067 mortalities per year per mile of power line. Most of the remaining birds are believed to nest on Hawai'i and Maui, but some birds could potentially be nesting on O'ahu. If 1% of the Newell's shearwater population still uses O'ahu (approximately two hundred individuals which is likely an overestimate), the total mortality for the 4 miles of proposed overhead lines at Kawailoa would be 0.07 Newell's shearwaters over 20 years. However, with a total of 2995 miles of transmission and distribution lines on O'ahu, the fallout rates associated with power line strikes alone, assuming 1% of the population utilizing this area would be expected to be 2.67 birds per year. In reality, although multiple records do exist fallout rates on O'ahu are only a fraction of this (roughly one a decade).

Some potential exists for construction or maintenance vehicles to strike downed shearwaters (birds already injured by collision with turbines or towers) while traveling along the onsite access roads. This source of mortality does not result in an increase in the amount of direct take expected from the proposed project because these birds are accounted for in the take modeling.

(In the unlikely event seabird mortality is found and mortality can be attributed to the onsite construction cranes, communication facilities, overhead cables or utility poles, their loss will be mitigated at a level commensurate with any take recorded onsite. The take will be assessed as part of the project)

The expected rates of take for Newell's shearwater are as follows:

Annual average	=	0.12 adults/immatures and 0.12 chicks (0.40 birds/year)
20-year project life	=	3 adults/immatures and 2 chicks

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for Newell's shearwater is nine individuals (six adults and three chicks).

To mitigate for these impacts, Kawailoa Wind Power is proposing to support the development of improved traps for predators and subsequently testing the effectiveness of the prototype at a Newell's shearwater colony on Kaua'i or Maui, or provide support for colony-based protection and productivity enhancement for a seabird colony on Kaua'i, Maui, or elsewhere.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed are likely to minimize collision risk of seabirds with project components take by increasing visibility and reducing collision risk. Marking guy wires from temporary met towers and overhead collection lines will increase visibility of these structures and the placement of overhead lines parallel to the treelines where practicable will reduce collision risk. The reduction in on-site lighting and minimization of night-time construction activity will reduce light attraction of Newell's shearwater to the site. Low wind speed curtailment, while implemented mainly for bats will also have the potential to reduce seabird collision as the turbines will not be spinning during nights with wind speeds less than 5m/s. Seabirds are most likely to transit the site at night.

Impacts of Mitigation

If mitigation consists of developing a self-resetting cat trap, the pilot study is expected to demonstrate that the traps successfully function in the field at a Newell's shearwater colony by dispatching cats with no impact to the seabirds. The cat trap will be deployed for one breeding season and based on modeling of a reduction from medium to mild predation, the cat trap deployment is expected to result in a 10% increased breeding probability, 7.5% increased breeding success and 1.5-2.5% increase in survival of Newell's shearwater adults and sub-adults that are protected within the trapping area. Modeling shows that within one year, for 20 active burrows protected, the reduction of cat predation could potentially result in the additional survival of 0.5 adults, 4.1 juveniles and 2 fledglings. For 30 burrows, the accrual after one season is expected to be 0.8 adults, 6.1 juveniles and 2.9 fledglings (HT Harvey and Associates 2011). The preferred location for the seabird colony is Kaua'i, but Maui may be selected with USFWS and DOFAW concurrence. Seabird colonies currently under consideration include, but are not limited to, Wainiha Valley, Limahuli Valley and Hono o Na Pali on Kaua'i, or Makamakaole and a potential seabird colony at Upper Kahakuloa Valley on Maui. Mitigation will be deemed successful if the self-resetting cat trap is successfully developed and is demonstrated to successfully function in the field at a Newell's shearwater colony for one breeding season, is efficient and effective in dispatching cats, with no adverse impact to the seabirds.

With the low requested take at Tier 1, the proposed mitigation measures of the development of a self-resetting cat trap and its implementation at a seabird colony as part of a pilot study, are expected to produce a net benefit in the form of an increase in the species' population by increasing productivity and survival rates. As stated above, the pilot study will result in an immediate increase in adult and subadult survival at the colony as well as increased reproductive success, above the unmanaged state. While the area managed is anticipated to be small, trap development as outlined is expected to more than compensate for the requested take at Tier 1. A more effective cat trap for Newell's shearwater predator management will help to meet a milestone identified as necessary for the recovery of the species, and the eventual implementation at additional colonies will increase survival and reproduction. The new trap is anticipated to have far reaching benefits beyond the mitigation measures implemented by the Applicant. The development of the trap will enable managers to conduct predator control at sites that are currently not suitable for trapping because of their remoteness and the intensive labor required to maintain a trapping grid. It is anticipated that the cat trap will be less labor intensive to operate and more effective than the cat traps currently available (current cat traps, once sprung, are inactive and need to be manually reset by a person) and will be utilized extensively by most parties involved in the management of Newell's shearwater colonies once developed. This is expected to yield improvements in protection, reproductive success and survival over current management methods, for many currently unmanaged colonies, with benefits extending years into the future.

For Tier 2, if the mitigation consists of developing the Newell's shearwater translocation protocol, the development of a Newell's shearwater translocation protocol will help to meet a milestone identified as necessary for the recovery of the species. The protocol development and its implementation are anticipated to have far reaching benefits beyond the mitigation measures implemented by the Applicant. This is expected to lay the foundation for the establishment of multiple new colonies of Newell's shearwater at sites that are managed for predators and are at low risk from fallout due to powerline collisions and light attraction. The future establishment of new colonies is expected to help increase the population and range of Newell's shearwaters with benefits extending years into the future.

If Tier 2 mitigation contributes to a restoration fund, the contribution to a restoration fund that includes predator trapping and translocation of Newell's shearwater to create a new colony will help to meet a milestone identified as necessary for the recovery of the species. The new colony will be established at a site that is managed for predators and where birds are at low risk from fallout due to powerline collisions and light attraction. The establishment of a new colony is expected to help increase the population of Newell's shearwaters and may also contribute to a range expansion of the species.

4.6.1.3 (b) Hawaiian Duck

Ducks are only expected to be at risk of collision with the turbines at Zone 1; 13 turbines and two meteorological towers are anticipated in Zone 1. The estimated average rate of mortality at 99% avoidance is 0.017Hawaiian ducks/year.

Ducks also have the potential to collide with communication towers, overhead collection lines, relocation distribution lines and utility poles. However, as Hawaiian hybrid ducks are primarily diurnal, they are expected to easily avoid the communication towers which would be highly visible during daylight hours. Observations of ducks conducted at wetlands at Kahuku in 2008 and 2009 demonstrated that Hawaiian duck hybrids easily negotiated the overhead powerlines strung across the wetland habitat (SWCA 2010a). No ducks were observed to have any collisions or near-collisions with the overhead powerlines or utility poles (147 flocks observed, average of two birds per flock). Consequently, potential for hybrid Hawaiian ducks to collide with communication towers, overhead collection lines, relocated distribution lines and utility poles onsite is considered negligible.

Some very limited and temporary potential risk would also exist for ducks to collide with cranes during the construction phase of the project. However, the cranes would be highly visible, and so should be readily avoided. In addition, as discussed for Newell's shearwater, the cranes are only expected to be present onsite for a brief period. Consequently, potential for hybrid Hawaiian ducks to collide with construction cranes is considered negligible. Some potential also exists for construction or maintenance vehicles to strike downed ducks (ducks already injured by collision with turbines or towers) while traveling project roads.

Even though few pure Hawaiian ducks are expected to be present on O'ahu, given the dispersal capabilities of the species, it is possible for pure Hawaiian ducks to occasionally fly over from Kaua'i. In addition, genetic research in 2007 showed presence of several Hawaiian ducks at James Campbell National Wildlife Refuge, and a bird struck by a plane at Honolulu International Airport in 2007 was found to be Hawaiian duck (A. Nadig, USFWS, pers comm.). Browne (1993) found absence of pure Hawaiian ducks on O'ahu due to extensive hybridization with feral mallards. Uyehara et. al (2007) found a predominance of hybrids on O'ahu. An estimated 300 Hawaiian duck-like birds are found on O'ahu, but the majority of these, given the genetic evidence, are thought to be hybrids (USFWS 2005a). Mallard control and possible reintroduction of Hawaiian ducks to O'ahu may increase the population of Hawaiian ducks on the island within the 20-year life of the project. Given a very small starting population and a very high proportion of hybrids, it is conservatively assumed that only 10% of the ducks seen may have the potential to be pure Hawaiian ducks, though the proportion of pure Hawaiian ducks to Hawaiian duck-mallard hybrids is expected to be much less as described above. Thus the expected fatality rate of pure Hawaiian ducks is projected to occur at one-tenth the rate of Hawaiian duck-mallard fatalities at 0.017 ducks/year.

The expected rates of take for the Hawaiian Duck, based on the information provided in the HCP (SWCA 2011) are as follows:

Annual average	=	0.017 adults/immatures and 0.021 ducklings (0.04 birds/year)
20-year project life	=	1 adult/immature and 1 duckling

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian duck is 12 individuals (adults or fledglings).

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed are likely to minimize collision risk of waterbirds with project components take by increasing visibility and reducing collision risk. Marking guy wires from temporary met towers and overhead collection lines will increase visibility of these structures and the placement of overhead lines parallel to the treelines where practicable will reduce collision risk. Improving the drainage of the site will reduce waterbird attraction to the site and decrease their risk of collision with the turbines and other structures. Low wind speed curtailment, while implemented mainly for bats will also have the potential to reduce waterbird collision as the turbines will not be spinning during nights with wind speeds less than 5m/s. Waterbirds may occasionally transit the site at night. The on-site speed limit of 15 mph will also reduce the likelihood of injuring downed waterbirds.

Impacts of Mitigation

Currently, as few pure Hawaiian ducks are believed to exist on O‘ahu due to hybridization, mitigation for Hawaiian ducks may consist of removal of feral ducks, mallards and Hawaiian duck hybrids at ‘Uko‘a Pond. Removals will be coordinated with DOFAW and USFWS. This will prevent the continued dilution of the Hawaiian duck gene pool. Furthermore, if pure Hawaiian ducks are reintroduced to O‘ahu, the elimination of all sources of feral mallard ducks will need to occur (Engilis et al. 2002). The control of ducks at ‘Uko‘a Pond will contribute to this effort. The wetland restoration, fencing, and predator control at ‘Uko‘a Pond is also expected to protect any pure Hawaiian ducks that may utilize the pond in the future.

4.6.1.3 (c) Hawaiian Stilt

No Hawaiian stilts were observed flying over the project site during the avian surveys. Consequently, modeling would result in an estimated take rate of zero because known stilt passage rate is zero. Because Hawaiian stilts have historically occurred in the wetlands in the Kawailoa area, it is assumed that the project would create some risk of causing take of this species, however small. The estimated rate of take of the Hawaiian stilt would be assumed to be the same as for Hawaiian duck hybrids, or an average of 0.17 stilts/year lost through interaction with turbines, met towers, onsite and offsite communication towers and overhead cables, utility poles and other associated structures, as well as mortality because of construction-related fatalities and vehicular strikes. The expected rates of take for the Hawaiian stilt, based on the information provided in the HCP (SWCA 2011e) are as follows:

Annual average	=	0.17 adults/immatures and 0.08 fledglings (0.25 birds/year)
20-year project life	=	4 adults/immatures and 2 fledglings

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian stilt is 18 individuals (adults or fledglings).

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures proposed are likely to minimize collision risk of waterbirds with project components take by increasing visibility and reducing collision risk. Marking guy wires from temporary met towers and overhead collection lines will increase visibility of these structures and the placement of overhead lines parallel to the treelines where practicable will reduce collision risk. Improving the drainage of the site will reduce waterbird attraction to the site and decrease their risk of collision with the turbines and other structures. Low wind speed curtailment, while implemented mainly for bats will also have the potential to reduce waterbird collision as the turbines will not be spinning during nights with wind speeds less than 5m/s. Waterbirds may occasionally transit the site at night. The on-site speed limit of 15mph will also reduce the likelihood of injuring downed waterbirds.

Impacts of Mitigation Measures

Measures intended to increase waterbird population sizes have been generally aimed at reducing or eliminating predation through exclusion (i.e., fencing) and eradication of predators from an enclosed breeding area. Garrettson and Rohwer (2001) found that lethal predator control using professional trappers was an effective way to increase waterfowl production; average nest success was nearly twice as high at trapped sites than at untrapped sites. Nest success of several dabbling ducks was also determined to be higher under predator management (by trapping, shooting, or lethal baiting) than at sites without predator management, although this relationship varied with climatic conditions (Drever et al. 2004). Long-term removal of feral mink (*Mustela vison*) via trained animals also resulted in an increase in the breeding densities of four waterfowl species compared to densities in control areas (Nordström et al. 2002). On O'ahu, the restoration and management of Hamakua Marsh has also been demonstrated to increase the reproductive success of the endangered waterbird species (SWCA 2010d).

Mitigation efforts at 'Uko'a Pond, which will include fencing, predator control, weed control, and monitoring, are expected to increase the productivity of the endangered waterbirds, as well as increase juvenile and adult survival rates.

Mitigation will be deemed successful if the number of fledglings and adults accrued exceed the requested take for the required level for the Hawaiian coot, Hawaiian stilt and Hawaiian moorhen and result in a net benefit for the three Covered Species over the entire permit term as measured in annual increments and based upon banding and resight studies. Net benefit will also be considered to have been achieved as these mitigation efforts will have contributed to wetland restoration, a reduction in introduced predator populations, and will have contributed to the recovery of the species.

4.6.1.3 (d) Hawaiian Coot

A small number of fatalities of American coot have been reported at wind facilities in North America, although these involved projects where surface waters occurred within the project area. No coots were observed flying through the project area during the avian surveys but one Hawaiian coot was observed foraging in a pond adjacent to Kawailoa Road. The Hawaiian coot was absent in subsequent observations. Because the coot was not observed in flight, mortality modeling for this species would result in a projected rate of take of zero. As the Hawaiian coot presumably took flight to arrive and depart from the pond, Hawaiian coots may occasionally occur in or near the airspace envelope of the turbines. Therefore, it seems the potential for take of this species occurring from the Proposed Action, while very low, is not zero. Therefore, it is assumed that the rate of take of Hawaiian coot would be the same as for hybrid Hawaiian ducks, or an average of 0.17 coots/year resulting from interactions with turbines, met towers, and onsite and offsite communication towers associated overhead cables, utility poles, and other associated structures, as well as mortality because of construction-related fatalities and vehicular strikes. The expected rates of take for the Hawaiian coot, based on the information provided in the HCP (SWCA 2011) are as follows:

Annual average = 0.17adults/immatures and 0.08 fledglings (0.25 birds/year)
20-year project life = 4 adults/immatures and 2 fledglings,

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian coot is 18 individuals (adults or fledglings).

Impacts of Avoidance and Minimization Measures

Impacts of the avoidance and minimization measures for the Hawaiian coot are as described for the Hawaiian stilt.

Impacts of Mitigation Measures

Impacts of the proposed mitigation measures for the Hawaiian coot are as described for the Hawaiian Stilt.

4.6.1.3 (e) Hawaiian Moorhen

Hawaiian moorhens were not detected at the Kawailoa wind farm site during the year-long avian point count survey, but are known to occur in the nearby waterbodies. However, Hawaiian moorhen are also thought to be at very low risk of collision with turbines because of their sedentary habits. However, for similar reasons discussed for Hawaiian stilt and Hawaiian coot, risk of collision by this species is not zero, and would be assumed to occur at the same rate assumed for those species, or on an average of 0.17 moorhens/year as a result of collision with turbines, met towers, onsite and offsite communication towers, associated overhead cables, utility poles and other associated structures, as well as mortality because of construction-related fatalities and vehicular strikes. The expected rates of take for the Hawaiian coot, based on the information provided in the HCP (SWCA 2011) are as follows:

Annual average	= 0.17 adults/immatures and 0.08 fledglings (0.25 birds/yr)
20-year project life	= 4 adults/immatures and 2 fledglings, 50 by harassment

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian moorhen is 18 individuals (adults or fledglings), and 50 individuals for harassment from trapping activities.

Impacts of Avoidance and Minimization Measures

Impacts of the avoidance and minimization measures for the Hawaiian moorhen are as described for the Hawaiian Stilt.

Impacts of Mitigation Measures

Primary impacts of the proposed mitigation measures for the Hawaiian moorhen are as described for the Hawaiian Stilt.

In addition to the anticipated take by the project, predator trapping poses some risk of harassment due to capture, and could result in injury or mortality to the Covered waterbird species and is accounted for in Section 6.3.5.4 of the HCP. Moorhen are attracted to traps (DesRochers et al. 2006) and moorhen on O‘ahu have been documented entering live traps (DesRochers et al. 2006; Nadig/USFWS, pers. comm.). USFWS recommends additional take of not more than ten Hawaiian moorhen annually in the form of harassment due to capture. The trapping at ‘Uko‘a Pond is anticipated to last five years and a total of take of 50 individuals in the form of harassment is also requested. No risk of injury or mortality is anticipated from this harassment and the conservation strategy to implement wetland management including a predator control program will result in an overall increase in the baseline number of individuals of the endangered Hawaiian moorhen. Therefore, the implementation of live trapping will have beneficial effects through the control of nonnative predators and increased productivity of Hawaiian moorhen. As a beneficial effect no further mitigation would be required for the potential capture of Hawaiian moorhen.

However, if the implementation of mitigation measures causes a waterbird capture that does result in mortality or injury, the take will be assessed as part of the Kawailoa Wind Power project.

4.6.1.3 (f) Hawaiian Hoary Bat

Hawaiian hoary bats have been known to use both native and non-native habitats for feeding and roosting (Mitchell et al. 2005). The vegetated areas within the project area for the wind farm site consist mostly of agricultural land, alien grassland and forest. The forest habitat is fairly homogenous and comprised of non-native species, including stands of albizia, ironwood and eucalyptus trees; these trees may provide roosting habitat for bats. Bat activity has been detected in essentially all habitats, including in clearings, along roads, along the edges of treelines, in gulches, and at irrigation ponds; monitoring to date indicates that bats use all of these features for travelling and foraging.

Construction of the project would result in the loss of about 6.4 acres of land to permanent structures such as turbines, meteorological towers, buildings, and riser poles. An additional 15.3 acres of land is expected to be altered by road widening or creation of access roads to turbine pads. These changes are not expected to adversely affect the Hawaiian hoary bat, as they are likely to continue to use the clearings and edges of the new or widened roads for traveling and foraging much as they do now. A total of approximately 251.0 acres of land will be cleared to establish search plots for the monitoring of downed wildlife around each turbine. These search plots will be maintained as short stature shrubs and grasses to maximize the probability of finding downed wildlife and will result in the conversion of approximately 44 acres of agricultural land, 62 acres of shrubland, 124 acres of alien forest, and 21 acres of grassland to mowed or otherwise maintained clearings.

Although patterns of use may change, modifications to the habitat mosaic are not expected to adversely affect the Hawaiian hoary bat provided that clearing occurs outside the pup-rearing season when non-volant young may be present. Bat activity has been detected in similar types of clearings around the current temporary meteorological towers. Although bats may use the alien forest trees on the site for roosting, the loss of 124 acres of alien forest constitutes only 0.9% of the total lowland forest (alien and native) available in the project area and vicinity. The project area and vicinity encompasses the vegetation bounded by Waimea Valley to the north, Kawailoa Gluch to the south, the coastline to the west, and lowland forest that extends to an elevation of 1,600 feet, to the east. Clearing this small percentage of available forest is not expected to measurably decrease the amount of forest available to the local population of bats for roosting. In addition, as the total population of bats on O‘ahu is believed to be small (USFWS 1998), and trees are plentiful, roost trees in alien forests are probably not a limiting factor for the species on O‘ahu. The alien forest habitat in the vicinity of the wind farm site is fairly homogenous, and does not vary significantly in composition or structure between adjacent patches (L. Ong/SWCA, personal observation 2011). For these reasons, it is expected that any bats displaced by the clearing would readily find alternate roost sites in surrounding undisturbed forest.

The potential for bats to collide with met towers onsite and offsite communication towers and overhead cables, utility poles, other associated structures, or cranes is considered to be negligible because they would be immobile and should be readily detectable by the bats through echo-location. While the guy wires on the temporary meteorological towers may pose a somewhat greater threat to bats, bats present at KWP on Maui have not been found to have collided with the guyed met towers after three years of operation nor with any cranes during the construction phase of that project. Similarly, no downed bats have been found during the weekly searches of the four guyed temporary meteorological tower within the Kawailoa wind farm site. Weekly searches began in October 2009 and are ongoing. These search plots have been regularly mowed since the plots were established. In addition, of 64 wind turbines studied at Mountaineer Wind Energy Center in the Appalachian plateau in West Virginia, bat fatalities were recorded at operating turbines, but not at a turbine that remained non-operational during the study period (Kerns et al. 2005). This supports the expectation that presence of the stationary structures such as met towers and cranes should not result in bat fatalities.

The estimated average rate of take for the Proposed Action is 0.075 bats/turbine/year. This equates to a total average take of 2.25 bats/year for 30 turbines on the site. However, as previously described, in an effort to minimize this risk, low wind speed curtailment would be implemented from the start of project operations for peak months of March through November. The expected fatality at the Kawailoa wind farm site with low wind speed curtailment assumes a conservative 70% reduction in fatalities. This leads to an overall take of 0.67 bats/year for the entire project and approximately 13.5 bats for the life of the project.

The expected rates of take for the Hawaiian hoary bat, based on the information provided in the HCP (SWCA 2011) are as follows:

Annual average	=	0.7 adults/immatures and 1.2 juveniles (1.9 bats per year)
20-year project life	=	14 adults/immatures and 7 juveniles

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian hoary bat is 72 individuals (adults or juveniles).

Impacts of Avoidance and Minimization Measures

Low wind speed curtailment will be implemented at night by raising the cut-in speed of the project's wind turbines to 5 m/s. Based on data collected to date, the curtailment will initially occur during months of March to November, which is when bat activity has been relatively higher. This is expected to reduce the risk of bat take by approximately 70%. Recent studies on the mainland indicate that most bat fatalities occur at relatively low wind speeds, and consequently the risk of fatalities may be significantly reduced by curtailing operations on nights when winds are light and variable. Research suggests this may best be accomplished by increasing the cut-in speed of wind turbines from their normal levels (usually 3.5 or 4 m/s, depending on the model) to 5 m/s. Two years of research conducted by Arnett et al. (2009, 2010) found that bat fatalities were reduced by an average of 82% (95% CI: 52 to 93 percent) in 2008 and by 72% (95% CI: 44 to 86 percent) in 2009 when cut-in speed was increased to 5 m/s. Therefore, based on best available science, low wind speed curtailment would be implemented at night by raising the cut-in speed of the project's wind turbines to 5 m/s.

Clearing of trees above 15 feet in height for construction would not be conducted between June 1 to September 15, to avoid take of non-volant Hawaiian hoary bat juveniles that may occur in the project area.

The use of barbless wire on the top strand of any ungulate fence erected as part of the mitigation measures will prevent take of the Hawaiian hoary bat due to entanglement with the barbed wire.

Impacts of Mitigation

Proposed mitigation for Kawailoa Wind Power at Tier 1 consists of restoring wetland habitat or native forest to improve foraging resources available to bats and to provide additional roost trees, along with a complimentary research project that supports the efficacy of the mitigation method selected. Research will also be conducted to identify bat habitat utilization patterns and bat interactions at Kawailoa Wind Power.

The wetland or forest habitat restoration is expected to increase and improve bat foraging and roosting habitat which will lead to increased adult and juvenile survival and increased productivity to mitigate for the impacts to the population at Tier 1. The research conducted at the either the wetland or forest restoration site will demonstrate if the restoration successfully increased bat survival productivity. If after five years it is determined that the wetland restoration is insufficient to meet Tier 1 obligations, then additional wetland restoration or forest restoration or other newer management measures will be conducted to offset the deficit.

The on-site research at Kawailoa Wind Power will be to document bat occurrence, habitat use and habitat preferences on site, as well as identify any seasonal and temporal changes in Hawaiian hoary bat abundance. These on-site surveys are also expected to advance avoidance and minimization strategies that wind facilities in Hawaiʻi and elsewhere can employ in the future to reduce bat fatalities.

Tier 2 and Tier 3 mitigation consist of additional wetland or forest restoration. The restoration may be modified depending on the outcome of the research that was conducted in Tier 1. Further research will be conducted to investigate the reasons for the increased rate of take, and additional measures to reduce the take will be implemented if possible. The wetland or forest habitat restoration is expected to increase and improve bat foraging and roosting habitat which will lead to increased adult and juvenile survival and increased productivity to mitigate for the impacts to the population at Tier 2 or 3. The research will further advance avoidance and minimization strategies that wind facilities in Hawaiʻi and elsewhere can employ in the future to reduce bat fatalities.

4.6.1.4 State Listed Covered Species

4.6.1.4 (a) Hawaiian Short-Eared Owl

Given that no Hawaiian short-eared owls have been observed on site, it is possible that no Hawaiian short-eared owl fatalities would be realized during the life of the Kawailoa Wind Power project. However, as suitable habitat for hunting does seem to be present, the risk of collision cannot therefore be considered zero. Given the onsite survey results and monitoring results from First Wind's Kaheawa wind farm project on Maui, it seems reasonable to assume that the chance of the Proposed Action causing a short-eared owl fatality in any given year is well less than 1.0. For the purposes of this HCP, it is assumed that the Proposed Action would on average result in the loss of 0.2 Hawaiian short-eared owl/year. This equates to one owl every five years. This mortality rate includes loss because of interaction with turbines, met towers, onsite and offsite communication towers and overhead cables, utility poles and other associated structures, as well as mortality because of construction-related fatalities and vehicular strikes.

The expected rates of take for the Hawaiian short-eared owl, based on the information provided in the HCP (SWCA 2011) are as follows:

Annual average	=	0.2 adults/immatures and 0.2 owlets (0.4 birds per year)
20-year project life	=	4 adults/immatures and 4 owlets

The requested take for Tier 1 and Tier 2 are listed in Table 4-2 and the total requested authorized take for the Hawaiian short-eared owl is 12 individuals (adults or fledglings).

<u>Impacts of Avoidance and Minimization Measures</u>

Vegetation clearing will be avoided around nesting Hawaiian short-eared owls and will only recommence when the young have fledged or nesting is no longer occurring. These measures will ensure that any owls breeding on the project site will not be affected by the construction activities. The spacing of the overhead lines is also tailored to prevent the electrocution of owls if they perch on the lines. The implementation of a 15mph speed limit will also reduce the risk of vehicular collisions with the owl if it should be hunting along or flying low across the road. Thus the avoidance and minimization measures are expected to minimize the impact any Hawaiian short-eared owls utilizing or breeding on site.

<u>Impacts of Mitigation Measures</u>

Mitigation for possible take of the Hawaiian short-eared owl at the Tier 1 level would consist of two parts: funding research or rehabilitation of injured owls and subsequently implementing management actions on Oʻahu as they are identified and as needed to bring mitigation ahead of take (that is, providing a net benefit).

The rehabilitation efforts of injured owls are anticipated to offset any impact that the wind facility may have on the local population in the area. If research is funded, it is anticipated that the research conducted would result in an increased understanding of the habitat requirements and life history characteristics of Hawaiian short-eared owl populations, leading to the development practicable management strategies and possibly help with the recovery of the Hawaiian short-eared owl on Oʻahu.

Management measures when implemented at the respective tier are expected to improve adult or juvenile survival which should mitigate for impacts at Tier 1 or Tier 2 and provide a net benefit to the species.

4.6.2 Alternative 2 (Alternative Communications Site Layout)

Under this alternative, a new tower would be installed in the areas adjacent to the existing Hawaiian Telcom structures, and communications equipment would be mounted on each tower. Approximately 144 square feet of vegetation would be cleared at each site, resulting in a small loss of habitat for avian, mammalian, and mollusk species. However, the disturbed area would constitute a only a sliver of the range of the species identified within this site and, as such, would not be expected to significantly affect any of the faunal resources at the population level. To minimize direct impacts of clearing on native mollusk species, additional mollusk surveys will be conducted, in coordination with USFWS and DOFAW staff, before any vegetation clearing or trimming at either site. No vegetation will be cleared if *Achatinella* species are detected. Leaf litter will be collected before the area is graded and distributed to the surrounding area to allow any native snails in the leaf litter to move on to undisturbed ground. In addition, measures to minimize the potential for introduction of non-native invasive ant species would be implemented, as described above. No direct impacts to avian or mammalian species would be expected to occur.

The construction of the towers is not expected to increase the requested take for any of the Covered Species. Studies have shown that only 1% of Newell's shearwaters (n = 688 birds; B. Cooper/ABR, pers. comm.) fly below 60 ft and of these individuals, the estimated collision avoidance rate is 97% (Day et al., in prep). Given that the seabird traffic rate on O'ahu is extremely low, and that the towers are substantially less than 60 ft tall, the likelihood of a seabird flying at such low altitudes and colliding with the microwave towers is considered to be remote.

There are no open water features near the proposed location of the microwave towers, and waterbirds have not been historically documented at Mt. Ka'ala (DLNR 1990). In addition, none of the listed waterbird species have been observed at the site (Hobdy 2010c; Steve Mosher pers. comm.). Therefore, the erection of additional microwave towers is not expected to increase the risk of waterbird fatality for the project.

Potential for short-eared owls to collide with the microwave towers is also considered negligible because these structures will be immobile and stationed in cleared sites. The towers should be readily visible to, and avoidable by, owls. Likewise, the potential for bats to collide with the microwave towers is considered to be negligible because they will be immobile and should be readily detectable by the bats through echolocation.

4.6.3 Alternative 3 (No Action Alternative)

No impacts to non-listed wildlife would be expected under the No Action Alternative because there would be no construction or development within the project area and no loss of potential habitat for non-listed wildlife.

This no-build scenario would not cause any adverse impacts to the four Covered Species because no potential for collision with wind turbines or project infrastructure would be created. However, this scenario also would not provide the benefits to the Covered Species expected under the Proposed Action because proposed beneficial measures outlined in the HCP would not be implemented. This scenario would not contribute to recovery efforts, research, or habitat protection for listed species.

4.7 Historical, Archaeological, and Cultural Resources

4.7.1 Alternative 1 (Proposed Action)

The sites recorded to date were assessed for their significance based on criteria established and promoted by the DLNR-SHPD and contained in HAR §13-284-6. This significance evaluation should be considered as preliminary until DLNR-SHPD provides concurrence. For a resource to be considered significant it must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria: A) be associated with events that have made an important contribution to the broad patterns of our history; B) be associated with the lives of persons important in our past; C) embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value; D) have yielded, or is likely to yield, information important for research on prehistory or history; E) have an important traditional cultural value to the native Hawaiian people or to another ethnic group of the state because of associations with traditional cultural practices once carried out, or still carried out, at the property or because of associations with traditional beliefs, events or oral accounts—these associations being important to the group’s history and cultural identity.

The preliminary evaluation of significance and recommended treatment for the 17 recorded archaeological sites within the project area (in the context of the National Historic Preservation Act) of the recorded sites indicated that three sites meet two significance criteria. These sites are likely interrelated elements of a WWII military cable-communication and signaling network that was established as a warning system in the event of a foreign invasion. Although the integrity of the overall system no longer exists, the locational and contextual integrity of these elements are intact, and as such these sites are considered significant under Criteria A and D. The remaining sites retain sufficient integrity to be considered significant under Criterion D for the historical information they have yielded relative to the development of the plantation industry on the north shore of Oʻahu.

Many of the participants in the interviews for the Cultural Impact Assessment supported the proposed project, while others articulated concerns that the project may impact the area’s cultural sites, and beliefs and practices. Several of the participants voiced the importance of the project being done in the correct way. As previously described, the project was deliberately sited to avoid known cultural sites, as well as gulches and steep slopes where burials could be found. The archaeological inventory survey did not identify any burial features, or other cultural sites within the areas that would be disturbed by the project (Rechtman et al. 2011). Sensitive cultural sites in adjacent areas that have been avoided would be fenced before construction. In addition, as described above, archaeological monitoring would be conducted within the project area during construction.

A few of the participants also expressed that the turbines would impact the visual landscape and the integrity of the cultural landscape of Kawailoa. Although the participants did not describe visual impacts from any specific cultural sites, it is expected that some of the turbines would be visible from cultural sites (such as Puʻu o Mahuka) and culturally significant locations (including Waimea Valley, which has been nominated as a Traditional Cultural Property, and Haleʻiwa town, which is a State Historic, Cultural, and Scenic District).

At the Mt. Kaʻala communication sites, no additional archaeological or cultural resources are expected to be affected because of the negative findings of the field investigation coupled with the fact that the proposed communication equipment would be installed on existing structures. Given the negative findings of the field investigation coupled with the fact that the proposed communication equipment would be installed on existing structures, no archaeological resources are expected to be affected at the Mt. Kaʻala communication sites.

Minimization Measures:

To the extent possible, impacts to these features would be avoided as part of construction and operation of the project. However, in the event that impacts are unavoidable, it is expected that a reasonable and adequate amount of information has been collected about all of these potentially significant historic properties as part of the archaeological assessment to warrant a no further work recommendation, and thus a no historic properties affected determination for these sites. However, archaeological monitoring would be conducted during construction to help ensure that any inadvertently discovered resources would receive immediate attention and protection, while their ultimate disposition is determined by SHPD. In compliance with HAR 13§13-279, a monitoring plan would be prepared and submitted to SHPD for review and approval.

Although the project cannot be implemented in a way that entirely avoids all potential cultural impacts, particularly those related to cultural beliefs, the goal is to develop and operate the project in a way that is respectful to Hawaiʻi’s unique cultural and natural resources while also contributing to the local community where the project is located, so as to balance any perceived adverse impacts.

Following is a list of cultural and environmental mitigation and community outreach that has been conducted on other First Wind projects; similar mitigation and outreach is ongoing or is planned for the Kawailoa wind farm project:

- Community Consultation. Throughout the project development, First Wind meets with community members and organizations to share information and seek input about the project. For the Kahuku project, the community asked for the project to be sited in a way to minimize project-related sound in Kahuku town; the project was adjusted accordingly. Similarly, residents in Mokulēʽia were concerned about a planned communications tower in their neighborhood, so an alternate location for the antennas was found on an existing facility at Mt. Kaʽala. In both cases, community feedback helped to improve the final project. First Wind also seeks input from residents about community priorities and local efforts which the project can help support. For the Kahuku project, residents identified education, flood mitigation and agriculture as the most important priorities for their local community. In response, First Wind is working with schools, community associations and local ranchers to contribute to these priorities over the life of the Kahuku project. For the Kawailoa project, a wide range of community members has been engaged to share information and seek input on the project; the community will continue to be consulted as the project design and construction progresses.
- Support for Native Hawaiian Organizations. Since beginning operations in Hawaii, First Wind has been a strong supporter of Native Hawaiian organizations and cultural events, including Aha Punana Leo, Maui Cultural Lands, Hawaiian Homestead Associations on Molokaʽi, Na Pua Noeau, Waimea Valley Music Festival, Waimea Valley Makahiki Festival, and the Council for Native Hawaiian Advancement's annual convention. For the Kawailoa project, First Wind intends to form a long-term partnership with Waimea Valley to support their efforts to promote Hawaiian culture and environmental awareness.
- Continued Access for Traditional Activities. In parallel with the wind farm project, Kamehameha Schools is planning to expand its access opportunities to allow for safe, legal and controlled access to and around the mauka portions of the Kawailoa property for hiking, hunting, gathering and cultural practices. As part of this effort, First Wind is coordinating with Kamehameha Schools to facilitate safe access in and around the wind farm site.
- Continued Agricultural Use of Land. Implementation of the proposed wind farm project would allow Kamehameha Schools to maintain the existing agricultural uses of the Kawailoa property, which is consistent with their North Shore Master Plan and Strategic Agricultural Plan. The turbines would be located on unirrigated land on the mauka sections of the Kawailoa property, which is currently being fenced for pasture by Kamehameha Schools. Lease revenues generated by the project can be used by Kamehameha Schools to improve the irrigation system and other infrastructure that directly benefits local farmers on the makai sections of the property. Not unlike the traditional concept of an ahupuaʽa, this arrangement would provide for productive, sustainable use of the land while not depleting resources.
- Conservation of Native Species. For each wind farm project, First Wind develops a habitat conservation plan to address endangered native wildlife species that may be impacted as a result of the project. Similar efforts are also made to conserve native plant species. First Wind is working with Kamehameha Schools to identify native trees that should be avoided (for example, koa and sandalwood); any native trees that are removed would be replanted on a one-to-one basis.

The intent of these measures is to balance the beliefs and traditions of the past with the need for clean, renewable energy to sustain future generations.

Impacts of Avoidance and Minimization Measures

No historical, archaeological or cultural resources are expected to be impacted due to the implementation of avoidance and minimization measures as prescribed in the HCP.

Impacts of Mitigation Measures

Historical, archaeological and cultural surveys will be conducted prior to the implementation of mitigation measures for all species, and any identified sensitive site will be avoided during the implementation of any mitigation measure.

All historical, archaeological or cultural resources will be avoided during the implementation of management measures therefore no impacts are expected.

4.7.2 Alternative 2 (Alternative Communications Site Layout)

Impacts as a result of Alternative 2 are expected to be to the same as those described for the Proposed Action (Alternative 1), except that this alternative includes ground-disturbing activity at the Mt. Ka'ala communications site. The new communication towers would be installed adjacent to the existing Hawaiian Telcom facilities, resulting in a small amount of disturbance. However, no archaeological resources were identified within these sites, and as such, no significant archaeological impacts are expected. Impacts to historical, archaeological or cultural impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.7.3 Alternative 3 (No Action Alternative)

No impacts to cultural resources or traditional cultural practices are expected under the No Action Alternative because there would be no construction or development within the project area and no resources potentially present in the project area would be impacted. No impacts to historical, archaeological or cultural resources due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.8 Visual Resources

4.8.1 Alternative 1 (Proposed Action)

Two analyses were conducted to determine the impacts of the wind farm project. First, a zone of visual influence (ZVI) analysis was conducted in June of 2011 to identify locations on the island from which the turbines would be visible, and to assess the extent to which they might be potentially visible. Second, visual simulation were produced which illustrate the appearance of the wind farm site from key observation points (KOPs), both with and without the project. Following is a discussion of these two analyses and the results of each. Full descriptions and figures are available in the accepted EIS (CH2M Hill 2011).

The ZVI analysis was conducted based on digital elevation model (DEM) information from the State of Hawai'i, specifications of the Siemens SWT-2.3-101 wind turbine model and the 30-turbine layout. Project features were plotted on topographic maps and overlaid with the locations of communities, roads, preservation areas, historic landmarks, and recreation areas (that is, parks, hiking trails, and beaches). A viewshed analysis was subsequently conducted to determine the areas from which project features could be visible.

Visual simulations were prepared for each key observation point (KOP) using computer modeling techniques to depict the view as it would appear with the project constructed. In general, KOPs that may be of concern to local residents, businesses and visitors were selected for the visual simulations. The KOPs are: 1) the entrance to Waimea Valley Park, 2) within Waimea Valley Park, 3) Kamehameha Highway above Waimea Bay, 4) Puu O Mahuka Heiau, 5) Kamehameha Highway near Turtle Beach, 6) Mokulē'ia Beach Park, 7) Waialua District Park, 8) Matsumoto's Shave Ice Shop, 9) Dole Plantation Visitor's Center in Wahiawa, 10) Pūpūkea Residence on Holike Road, and 11) Pūpūkea Private Property on Maulukua Road. Each of the KOP simulations is briefly described below according to distance zone.

Near foreground: No KOP locations within the near foreground were selected because these areas are not readily accessible to the public.

Foreground: The existing topography and vegetation heavily influence the views at the Waimea Valley KOPs. In some locations, the turbines are potentially obstructed by the existing vegetation, but this is not necessarily the case for all potential viewing locations throughout Waimea Valley.

Given the difficulty of identifying a KOP that captures the full extent of the turbines unobstructed by existing vegetation cover, a line-of-sight analysis was conducted from three viewing locations within Waimea Valley to determine the potential line-of-sight for turbines without potential obstructions from vegetation cover. The line-of-sight analysis indicated that portions of four towers and blades (Turbines 10, 11, 13, 14) would be potentially visible.

Near middle ground: Existing vegetation and topographical features potentially obstruct views of the turbines, particularly the mauka views from the coastline, from the entrance to Waimea Valley, Kamehameha Highway above Waimea Bay, Puʽu o Mahuka Heiau, and Pūpūkea residence on Holike Street, Pūpūkea private property on Maulukua Road, and Kamehameha Highway at Turtle Beach, and Kamehameha Highway approaching Haleiwa town. Analysis indicates that visual obstruction by vegetation and topographic features would potentially extend north along the coastline, including Pūpūkea Beach Park and Waialee Beach Park, with limited views consisting of the blades of only a few turbines.

Far middle ground: The views from Kamehameha Highway at Matsumoto's Shave Ice Shop, Waialua District Park, and Haleʽiwa Alii Beach Park are potentially obstructed by existing vegetation and structures such as buildings, utility poles, and lines. Where not obstructed, views of the project from this distance can be relatively expansive. For views in which the turbines are seen against a land backdrop, the turbines have the potential, at least under some lighting conditions, to be visually absorbed into the landscape's background.

Near background: While turbines are potentially visible from the Mokulēʽia Beach Park and Waialua District Park, turbines are potentially obstructed by vegetation, existing structures, and topographical features from the Dole Plantation Visitor's Center. Similar to views from the Far Middleground zone, unobstructed views from these distances can be relatively expansive, but under at least some lighting conditions, the turbines may be visually absorbed into the background.

At the Mt. Kaʽala communications site, the equipment installation would not be readily visible from any public vantage points, given the distance of the site and the small size of the structures. They would be visible from the Mt. Kaʽala summit access road and the nearby hiking trails; however, the equipment is visually consistent with the existing communication facilities. As such, visual impacts associated with the additional antennae are expected to be insignificant.

Impacts of Avoidance and Minimization Measures

The marking of guy wires for the temporary met towers and overhead lines to reduce bird collisions may make these structures more visible, but these structures are not adjacent to populated areas and the visual impact of these structures is likely to be insignificant. No other avoidance and minimization activities are expected to have a visual impact.

Impacts of Mitigation Measures

Only the construction of fences and fence corridors for waterbird and possibly bat mitigation have the potential to have visual impacts. Most of the fences and fenceline corridors will be constructed away from populated areas and will likely not be visible to the public. If visible at all, the visual impact would be temporary until regrowth of the understory.

However, a portion of ʽUkoʽa Pond, the mitigation site for waterbirds and possibly bats, is along Kamehameha highway, and the fenceline could be visible from the highway. However, an existing fence is already present and the construction of the new fence (while removing the old one) will not add to the existing visual landscape. No other mitigation measures are expected to have a visual impact.

4.8.2 Alternative 2 (Alternative Communications Site Layout)

As in the Proposed Action, installation of two communications towers at the Mt. Ka'ala site would not be readily visible from any public vantage points, given the distance of the site and the small size of the structures. They would be visible from the Mt. Ka'ala summit access road and the nearby hiking trails; however, these features are visually consistent with the existing communication facilities. As such, visual impacts associated with this alternative are expected to be insignificant. Visual impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.8.3 Alternative 3 (No Action Alternative)

No impacts to existing visual resources would occur under the No Action Alternative because the wind facility would not be constructed or operated in the project area. Visual impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.9 Noise

4.9.1 Alternative 1 (Proposed Action)

Construction of the Proposed Action would produce short-term construction-related noise. Site grading, vegetative clearing, and construction of the various facility related structures would involve the short-term use of graders, excavators, bulldozers, cranes, cement trucks, haul trucks, and other heavy equipment. Construction noise would be expected to exceed DOH's "maximum permissible" property line noise levels and, as such, Kawailoa Wind Power would obtain a permit from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit sound levels in excess of the "maximum permissible" levels. The DOH noise permit does not limit the sound level generated at the construction site, but rather the times at which noisy construction can take place. The HDOH may also require the incorporation of noise mitigation into the construction plan and/or community meetings to discuss construction noise with the neighboring residents and business owners. As discussed in the minimization and mitigation measures section, BMPs would be implemented to mitigate construction noise, as needed.

During operation, the only project components expected to create sound on a regular basis would be the WTGs. Wind turbines produce four types of sound: broadband, tonal, low frequency, and impulsive. Sound emission from modern wind turbines is dominated by the aerodynamic broadband type. Broadband noise occurs as the revolving rotor blades encounter atmospheric turbulence, creating a rhythmical "swishing" sound. Tonal sound occurs at discrete frequencies, such as turbine meshing gears. Low frequency sound is the portion of broadband sound at the low end of the frequency spectrum, near the lower limit of human hearing. Low frequency sound can also include infrasound, which is defined as sound below the limit of human hearing (i.e., vibration). Impulsive sound (short acoustic impulses) can be caused by the interaction of WTG blades with disturbed air flowing around the tower of a downwind machine (Rogers and Manwell 2004; Pedersen and Waye 2007). As wind speed varies throughout the day, lower or higher rotational speed of the turbines would result in lower or higher sound levels (van den Berg 2004).

The wind turbines are considered stationary sources and would be subject to the State of Hawai'i Community Noise Control standards. The maximum permissible noise levels would be enforced by the HDOH for any location at or beyond the property line and should not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits that apply are a function of the zoning and time of day; with respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible noise level. For enforcement purposes, noise levels are typically measured at the property line or on the property of the complainant; the maximum permissible noise level corresponds with the zoning of the complainant's property. HDOH also takes the ambient noise environment into account when enforcing the noise limits and typically allows for a 3 dB increase in noise level over the ambient noise when the ambient noise is combined with the noise source of interest.

Based on the zoning surrounding the proposed project site, the following Community Noise Control standards:

A) Class C sound level limits apply to the areas surrounding the project site that are zoned as agriculture. Therefore, sound levels from the wind turbines cannot exceed 70 dBA at the site property lines. Ambient noise levels in these areas are expected to be below 70 dBA and are not expected to change this requirement.

B) The project site is also situated adjacent to areas zoned as preservation. Therefore, Class A sound level limits may apply, where sound levels from the wind turbines cannot exceed 55 dBA during the day or 45 dBA during the night at the property lines. However, ambient sound at these sampling locations along the preservation boundary north of the project site are close to or exceed these limits and may be taken into account by the HDOH in determining the maximum permissible sound level.

To evaluate the potential sound-related impacts associated with the project, a sound propagation model was developed to predict wind turbine sound in the areas throughout the project site and surrounding areas. The model is a 3-D representation of the propagation of wind turbine sound and includes the effect of ground cover and terrain and also considers environmental parameters, such as temperature, humidity, and wind direction. These model results were then compared to the ambient sound levels that were measured in the community surrounding the project site to assess the potential community reaction to project-related sound. The results were also compared to the HDOH maximum permissible noise limits to assess potential noise impacts and regulatory compliance.

Based on the results of the sound propagation model and comparisons to the measured ambient sound levels, the predicted wind turbine sounds are expected to increase the ambient sound level by less than 3 dB at the nearest sensitive receptor, Waimea Valley. The predicted sound levels would be 30 to 35 dBA over approximately 20% of the valley, 35 to 40 dBA over approximately 11% of the valley, 40 to 45 dBA over approximately 3% of the valley, and greater than 45 dBA over less than 1% of the valley. During daytime hours, model results indicate that wind turbine sounds would be completely masked by ambient noise sources such as birds and wind. At night, wind turbine sounds would be just barely perceptible at Waimea Valley. Other residential areas surrounding the project site are a sufficient distance away from the site that wind turbine sounds are predicted to be below ambient noise levels, and therefore not perceptible. These results indicate that the wind farm project is unlikely to create a noise impact at nearby sensitive receptors or generate complaints from the surrounding residential communities.

The predicted wind turbine sounds are not expected to exceed the HDOH maximum permissible noise limit in the areas to the west of the project site that are zoned for agriculture. However, sounds from the wind turbines are expected to exceed the HDOH nighttime maximum permissible noise limit where the project borders preservation land (that is, to the north, east, and south). Because these areas are not easily accessible and are not inhabited, it is unlikely that there would be noise complaints from these areas. In addition, ambient noise measured along the preservation land boundaries to the north and south of the site indicate that average ambient noise levels are close to or exceed 45 dBA. However, to comply with the Community Noise Rule, the need for a variance will be coordinated with HDOH.

The proposed communication equipment near Mt. Ka‘ala would be installed on existing Hawaiian Telcom structures; no excavation or ground-disturbing activities would be required. Installation would involve trucks and a helicopter to transport the components and necessary tools to the site. Noise generated by these activities would be intermittent and very short in duration (occurring over the course of approximately 15 days). Operation of the communications equipment would not be expected to result in any significant noise impacts.

Minimization and/or Mitigation Measures During Construction:

The State DOH may require Kawailoa Wind Power to incorporate noise mitigation into the construction plan and/or it may require Kawailoa Wind Power to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. However, because of the isolated location of the proposed work, the State DOH may deem this unnecessary. If a construction noise permit is granted, Kawailoa Wind Power would be required to use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. If construction noise in excess of the standards is allowed, it would be limited to between 7:00 a.m. and 6:00 p.m., Monday through Friday and to between 9:00 a.m. and 6:00 p.m. on Saturday.

Impacts of Avoidance and Minimization Measures

The implementation of avoidance and minimization measures as prescribed by the HCP will not have significant noise impacts.

Impacts of Mitigation Measures

Vehicles will be used to conduct regular site visits to mitigation sites during the monitoring or implementation of mitigation measures. Regular visits to the mitigation site will occur (weekly or monthly) and the noise due to transportation is anticipated to be of short duration and of low intensity and is not anticipated to significantly increase the noise levels at the site.

Minor increases in noise is expected during fence construction and vegetation removal (may apply to seabird, waterbird and bat mitigation) due to the possible use of machinery to accomplish the required work. However, the noise is expected to be during normal work hours and the mitigation sites are not near populated areas and will likely have insignificant impact on the affected area.

The transportation of antennae to the off-site microwave tower by helicopter will temporarily increase noise levels along the flight path. The flights will be few in number and will occur during normal work hours and is not expected to substantially change the sound levels in the affected areas.

No other mitigation measures are anticipated to have significant noise impacts.

4.9.2 Alternative 2 (Alternative Communications Site Layout)

Under this alternative, a new tower would be constructed in the areas adjacent to the existing Hawaiian Telcom structures, and communications equipment would be mounted on each tower. Construction of the towers would involve the use of heavy equipment to transport the materials to the site and to excavate footings for the tower. Although this equipment would generate moderate levels of noise, the activities are expected to be very short in duration (occurring over the course of approximately 15 days). Operation of the communications equipment would not be expected to generate any significant noise. Noise impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.9.3 Alternative 3 (No Action Alternative)

Under the No Action Alternative, no change in existing noise conditions would occur in the project area because the wind facility would not be constructed and WTGs would not operate. No noise impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.10 Land Use

4.10.1 Alternative 1 (Proposed Action)

4.10.1.1 Existing Land Use

The project would be located almost entirely on unirrigated, fallow fields that were previously used for cultivation of sugarcane; these areas are not currently used for agricultural purposes. However, the eastern portion of the wind farm site overlaps with an area that is actively used by the military as an aviation training area. To minimize the potential impact of the proposed project on agricultural uses, the project components were sited to avoid areas that are currently being cultivated, which generally include the irrigated fields at the lower elevations of the Kawailoa Plantation. The existing onsite roads that would be used to access the wind farm site traverse these active agricultural fields, but use of the roads (including the proposed road improvements) are not expected to adversely affect these operations.

The permanent footprint of the project would occupy approximately 21.7 acres. These areas would be located almost entirely on prime agricultural lands as classified under the ALISH system, but would only constitute less than 1% of the more than 3,600 acres of prime agricultural lands available for cultivation within the general project location. Relative to agricultural productivity classification, the project components would span areas with soil ratings of A, B, C, D, and E.

As previously noted, the turbines and potential meteorological tower locations would be distributed as follows: 15 of the turbines and 2 potential meteorological tower locations would be located in B soils, 8 turbines and 1 potential meteorological tower location would be located in C soils, and 7 turbines and 1 potential meteorological tower location would be located in D soils. Other appurtenant facilities essential to the operation of the wind farm would generally be located in soils classified as Categories B.

Although the areas within the project footprint would no longer be available for agricultural purposes, implementation of the proposed wind farm project would allow Kamehameha Schools to maintain the existing agricultural uses of the Kawailoa property, which is consistent with their North Shore Master Plan and Strategic Agricultural Plan. Lease revenues generated by the project can be used by Kamehameha Schools to improve the irrigation system and other infrastructure that directly benefits local farmers on the *makai* sections of the property.

The unused areas surrounding the wind farm components are currently being fenced for pasture by Kamehameha Schools, and would be actively grazed. As indicated by other wind farm projects in the U.S. and worldwide, wind turbines are highly compatible with grazing activities; the animals routinely graze right up to the base of the towers, which they often use as rubbing posts or for shade (New Zealand Wind Energy Association [NZWEA] 2011; DOE 2005).

Given that the permanent project footprint would comprise only approximately 21.7 acres and the remainder of the Kawailoa plantation lands would be maintained for agricultural uses, the proposed project is not expected to have more than a minimal adverse impact on agricultural production and, in fact, would allow for productive, sustainable use of the land.

4.10.1.2 Existing Policies and Land Use Plans

The proposed Kawailoa Wind Power facility is compatible and comparable to existing land uses in the vicinity and is consistent with all federal, state, and local land use plans and controls described in Section 1.3.

National Environmental Policy Act

The Proposed Action is compatible with this Act. See Sections 1.2 and 1.3.1.1.

Federal Endangered Species Act

The Proposed Action is compatible with this Act. See Sections 1.2, 1.3.1.2, and 4.11.

Federal Migratory Bird Treaty Act

The Proposed Action is compatible with this Act. See Sections 1.3.1.3 and 4.11.

Federal National Historic Preservation Act

The Proposed Action is compatible with this Act. See Sections 1.3.1.4 and 4.13.

Executive Order 12898 - Environmental Justice

The Proposed Action is compatible with this Executive Order. See Sections 1.3.1.5 and 4.12.1.1.

Hawai'i State Plan

The sections of the Hawai'i State Plan that are most relevant to the Proposed Action are Sections 226-18(a) and (b), which establish objectives and policies for energy facility systems. These sections are reproduced and discussed below.

§226-18 *(a) Planning for the state's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all:*

> *(1) Dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people;*
>
> *(2) Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased;*
>
> *(3) Greater energy security in the face of threats to Hawaii's energy supplies and systems.*
>
> *(4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and use.*

§226-18 *(b) To achieve the energy objectives, it shall be the policy of this state to ensure the provision of adequate, reasonably priced, and dependable energy services to accommodate demand.*

The Proposed Action would produce clean, renewable energy, thus contributing to energy self-sufficiency by increasing the ratio of domestic to imported energy use. The Proposed Action would generate up to 70MW energy, contributing to the array of renewable energy projects in Hawai'i, and thus increasing energy security for the state. The Proposed Action would also help to reduce greenhouse gas emissions associated with state's energy supply because of the very low or no emissions associated with wind energy.

Hawaii Revised Statutes, Chapter 195D

Kawailoa Wind Power is currently seeking a state ITL. A HCP will be submitted to the State DLNR in 2011. Acquisition of a state ITL is expected. Therefore, the project is compliant with this statute.

Hawaii Revised Statutes, Chapter 343

As stated in Section 1.3.2.3, the permitting process pursuant to the State's HRS Chapter 201N Energy Facility Siting Process requires compliance with HRS Chapter 343.

An EIS Preparation Notice (EISPN) was released for public comment on September 23, 2010. Following the end of the 30-day public review period for the EISPN, Kawailoa Wind Power addressed comments on the EISPN, and prepared a DEIS which discussed the likely direct, indirect, and cumulative impacts of the Proposed Action, as well as mitigation measures. The public comment period for the DEIS lasted for 45-days as provided by law. A EIS which incorporated and responded to all comments on the DEIS was then submitted to DBEDT for review and acceptance.

The Final EIS was accepted by DBEDT on June 27, 2011 (CH2M Hill 2011). In addition to the EIS, Kawailoa Wind Power also complies with Chapter 343 for any actions conducted under the Habitat Conservation Plan, including this EA, as required by law.

Hawaii Revised Statutes, Chapter 205

The project area is located within an Agricultural District. Per HRS Chapter 205-4.5, wind energy facilities are a permissible use in State Agricultural Districts. The statute states that these facilities are permitted "provided that the wind energy facilities and appurtenances are compatible with agriculture uses and cause minimal adverse impact on agricultural land. "The proposed facility meets these requirements as it would result in disturbance of only a small percentage of the project area and it is compatible with agricultural land uses. Kawailoa Wind Power is in the process of evaluating the possibility of complementary agricultural uses in the project area.

HAR Chapter 13-5-22 lists the types of uses permissible in a Conservation District. This includes: "transportation systems, transmission facilities for public utilities, water systems, energy generation facilities utilizing the renewable resource of the area (e.g., hydroelectric or wind farms) and communications systems and other such land uses which are undertaken by non-governmental entities which benefit the public and are consistent with the purpose of the conservation district." Thus, the offsite communication towers are compatible with the land use designation. However, construction of these facilities may require Kawailoa Wind Power to obtain a CDUP.

Hawaii's Coastal Zone Management Program

Hawai'i's Coastal Zone Management (CZM) Program (HRS 205A) is a broad management framework designed to protect valuable and vulnerable coastal resources by reducing coastal hazards and improving the review process for activities proposed within the coastal zone. The entire State of Hawai'i is within the coastal zone boundary. The CZM Program focuses on 10 objectives and associated policies. Federal actions occurring in, or affecting, the state's coastal zone must be in agreement with the CZM Program's objectives and policies.

City and County of Honolulu General Plan

The following section lists the objectives and policies outlined in the City and County of Honolulu Plan that are most relevant to the Proposed Action followed by a discussion of the Proposed Action's consistency with these topics.

Natural Environment

> *Objective A – To protect and preserve the natural environment*
>
> > *Policy 1 – Protect O'ahu's natural environment, especially the shoreline, valleys, and ridges from incompatible development.*
>
> *Objective B – To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.*
>
> > *Policy 1 – Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.*
> > *Policy 2 – Protect O'ahu's scenic views, especially those seen from highly developed and heavily traveled areas.*
> > *Policy 3 – Locate roads, highways, and other public facilities and utilities in areas where they will least obstruct important views of the mountains and the sea*

Environmental due diligence conducted for the Proposed Action included extensive biological surveys of the site to identify existing habitats, native ecosystems, and threatened and endangered species. The project would be designed to minimize and mitigate impacts to ecologically sensitive habitats and species. The associated Habitat Conservation Plan addresses mitigation associated with the incidental take of six federally listed threatened or endangered species. The project is being designed to minimize disturbance to ecologically sensitive habitats and species, and also to minimize encroachment into the City and County of Honolulu's Preservation Districts.

In addition, natural gulches, streams, and drainages were identified and their avoidance would be taken into consideration in the final design of the Kawailoa wind farm project. A views analysis was also conducted to assess the potential impacts of the Proposed Action's effect on the North Shore's scenic resources. Consideration was taken with regard to maximizing the distance of associated wind farm components (i.e., substation, O&M building, and BESS) from Kamehameha Highway and placement of collector lines underground where feasible.

Energy

Objective A – To maintain an adequate, dependable, and economical supply of energy for O'ahu residents

Policy 1 – Develop and maintain a comprehensive plan to guide and coordinate energy conservation and alternative energy development and utilization programs on O'ahu.

Objective D – To develop and apply new, locally available energy resources.

Policy 1 – Support and participate in research, development, demonstration, and commercialization programs aimed at producing new, economical, and environmentally sound energy supplies from:

a. Solar insolation;
b. Biomass energy conversion;
c. Wind energy conversion;
d. Geothermal energy; and
e. Ocean thermal energy conversion.

The Proposed Action meets the City and County General Plan's energy objectives and policies by providing new, dependable, and economical supplies of wind energy to O'ahu.

Community Plans

Several of the opportunities, objectives, and policies identified in the North Shore Sustainable Communities Plan area are relevant to the Proposed Action. The following objectives and policies in the plan are compatible with the Proposed Action:

3.1.1 Open Space and Natural Environment General Policies

- *Protect significant natural features*
- *Protect ecologically sensitive lands*
- *Protect scenic views*

Environmental due diligence conducted for the Proposed Action included extensive biological surveys of the site to identify existing habitats, native ecosystems, and threatened and endangered species. The project would be designed to minimize and mitigate impacts to ecologically sensitive habitats and species. The associated Habitat Conservation Plan addresses mitigation associated with the incidental take of six federally listed threatened or endangered species. The project would also minimize encroachment into the State Conservation District and North Shore SCP preservation districts and avoid, to the extent possible, natural gulches, streams, and drainages.

A views analysis was also conducted to assess the potential impacts of the Proposed Action's effect on the North Shore's scenic resources. Consideration was taken with regard to maximizing the distance of associated wind farm components (i.e., substation, O&M building, and BESS) from Kamehameha Highway and placement of collector lines underground where feasible.

3.2.1 Agriculture General Policies

- *Protect all important agricultural lands, regardless of current crop production capabilities, from uses that would undermine or otherwise irreversibly compromise their agricultural potential and crop production capabilities.*

Road access improvements on Kamehameha School property formerly used for agriculture would be required for the construction and operation of the Proposed Action. These improvements would once again provide access to agricultural lands formerly used to produce sugarcane but has since become inaccessible. Furthermore, the operation and maintenance of the wind turbines allow the lands on which they are located to be concurrently used for agriculture.

3.4.1 Historic and Cultural Resources General Policies

- *Preserve significant historic features from earlier periods*
- *Respect significant historic resources by applying appropriate management policies and practices. Such practices may range from total preservation to integration with contemporary uses.*
- *Restore or keep intact sites with cultural and/or religious significance out of respect for their inherent cultural and religious values.*

Archaeological and cultural surveys were conducted as part of the Proposed Action's environmental due diligence and design process to identify plantation-era and historic resources. Such features are to be avoided or managed accordingly as part of the final design and construction of the wind farm facility.

The implementation of the North Shore SCP also includes the integration of general policies and principles for public facilities and infrastructure. As such, the following public facilities and infrastructure policy is applicable to the Kawailoa project:

4.4.1 Electrical Power Development General Policies

- *Additions to utility systems and other public facilities should be located in areas where they will least obstruct important views. Locate and design system elements such as renewable electrical power facilities, substations, communication sites, and transmission lines to avoid or mitigate any potential adverse impacts on scenic and natural resources. Locating powerlines underground or away from Kamehameha Highway is desired.*

The location of wind farm components such as turbines, substations, BESS, O&M building, collector lines, onsite access roads, were determined based on the location of suitable wind resources and existing facilities (i.e., former agriculture roads and existing transmission lines). Consideration was also taken with regard to maximizing the distance of these components from Kamehameha Highway and placement of collector lines underground where feasible.

<u>Impacts of Avoidance and Minimization Measures</u>

The avoidance and minimization measures prescribed in the HCP will not have any effect on land use.

<u>Impacts of Mitigation Measures</u>

For mitigation occurring at ʻUkoʻa Pond, former ranching that occurred in the area will no longer be allowed if restoration and fencing of the wetland occurs (for waterbird and as an alternative for bat mitigation) may be restored. Ranching will no longer be allowed at the entire 150 acres of wetland and possibly up to 80 acres of forest in the periphery of the pond may also be fenced off and restored.

No mitigation measures are anticipated to have any effect on land use as the areas identified for mitigation are on state conservation land or not part of any plans for any development or agricultural projects during the project permit term.

<u>4.10.2 Alternative 2 (Alternative Communications Site Layout)</u>

Alternative 2 is compatible and comparable to existing land uses in the vicinity and is consistent with federal, state, and local land use plans and controls. Land use impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

<u>4.10.3 Alternative 3 (No Action Alternative)</u>

No change in existing land use would occur under the No Action Alternative because the project would not be constructed or operated. It is possible that land in the project area could ultimately be used for some other purpose if the Kawailoa Wind Power facility is not constructed; however, there are no planned land uses identified in any state or local plans for the project area and uses would be limited to those permitted. No land use impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.11 Transportation and Traffic

4.11.1 Alternative 1 (Proposed Action)

Roadways

Delivery of the turbine components and other project equipment would require the use of existing state and county roadways by oversized vehicles. The number of oversized equipment delivery trips is estimated to average five trips per day, with a total of 270 trips during the 12-month construction period. The proposed routes (described above) have been evaluated and the existing infrastructure and adjacent utility lines are expected to be of sufficient capacity and dimension to accommodate the oversized loads. Potential impacts associated with oversized equipment transport include traffic delays and delays in emergency services caused by periods where traffic flow must be stopped to allow oversized trailers to navigate turns. To mitigate these impacts, the following measures would be implemented:

- All tower and blade components would have a minimum of four police escorts per load. Police escorts would direct traffic at intersections along each proposed route where necessary to allow oversized trailers to navigate turns.

- Police escorts and/or flagmen would provide traffic direction at the entrance to the wind farm site during construction.

- Hours of transport would be restricted to periods of the day when vehicular traffic is typically light, as follows:

  - Monday through Saturday from 9:00 p.m. to 5:00 a.m.; loaded equipment must be off of the roadways between the hours of 5:00 a.m. and 9:00 p.m.
  - No oversized loads would be transported on Sundays or holidays.

Transport of oversized and/or overweight equipment is being coordinated with both the DOT Highways Division and the City and County of Honolulu Department of Transportation Services (DTS). Permits have been issued by DOT for transport of each of the turbine components; permitting through DTS is underway.

Other project-related traffic would vary over the course of construction. On average, delivery of other equipment for the wind farm (such as materials for the substation and BESS facilities) would require approximately five trips between Honolulu Harbor and the wind farm site per day. Select material (such as cement and aggregate) would also be brought from the plant to the project area for construction of the turbine pads, roadways and other purposes. Approximately 45 cement truck trips and 25 dump trucks of aggregate would be needed per day. During the 12-month construction period, an average of 75 employees would be traveling to the site each day, with an anticipated maximum of 129 employees.

Of these trips, the turbine and cement deliveries would all occur at nighttime (between 9 p.m. and 5 a.m.) and the remainder of the construction materials would generally be delivered during the day (7 a.m. to 6 p.m.), resulting in an average of 50 nighttime trips and 30 daytime trips per day. At the peak of construction, a total of approximately 163 daytime truck and construction worker commute trips (including light delivery vehicles) would be expected to occur each day. It is assumed that approximately 10% of these trips would occur during peak hours (6 to 9 a.m. and 3 to 6 p.m.), with the remaining trips occurring during non-peak hours. Based on a 2009 traffic count of 1,329 vehicles on Kamehameha Highway during the highest peak-hour period (3:45 to 4:45 p.m.) (DOT 2009), the anticipated construction traffic would represent an approximately 1.4% increase in traffic levels.

An approximately 1.4% increase in the highest peak-hour traffic levels, which would be short-term and localized in nature, would not be expected to have a measurable impact on traffic conditions. All truck trips with oversize and/or overweight loads would comply with specified permit conditions, and any road damages that might be incurred would be reported and repaired, such that no significant impacts would occur to state and county roadways. Improvements to the existing onsite roadways may periodically inconvenience others who use those roadways to access farm plots or other permitted uses in the project area. However, the amount of local onsite vehicle movement is negligible and prior coordination with other users of the roadways would be expected to mitigate any impacts to other roadway users.

During operation, the majority of the vehicular traffic associated with the proposed wind farm would be employees reporting to or leaving the facility and service trips by HECO maintenance personnel. Typically, the maximum number of vehicle trips during operation would be eight trips per day. The amount of vehicular traffic associated with the proposed facilities during operation would be minimal and the proposed project would not be anticipated to noticeably increase traffic volumes on Kamehameha Highway or roadways in the area over the long term. Operation of the wind farm would not impact access for other users who use or transit through Kamehameha School's Kawailoa properties.

Use of the existing single-lane access road at Mt. Kaʻala would be coordinated with the Kaʻala JUCC to avoid or minimize disruptions to the use of the access road by the proposed project's construction and operations activities. Impacts to the roadway are not anticipated.

Airports and Airfields

With respect to the impact of the Proposed Action on airspace, Part 77 of the FAA Federal Aviation Regulations (CFR Title 14 Part 77.13) applies to objects that may obstruct navigable airspace. Proposed projects more than 200 feet above ground level must file FAA Form 7460-1, Notice of Proposed Construction or Alteration with the FAA before construction. A Notice of Proposed Construction or Alteration-Off Airport was filed with the FAA in December 2010 for the wind turbines, as well as for the temporary and permanent meteorological towers.

On March 9, 2011, the FAA issued its Determination of No Hazard to Air Navigation for each of the structures as well as an approved marking and lighting plan. The determination for each structure stated that the structure "*would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities*."

The determination for the structures proximate to the TFTA received additional information:

> *This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation.*

Revisions have been filed with the FAA for one wind turbine and one meteorological tower within the project site because of micro-siting considerations. In both cases, the movement of both structures is toward the west, either out of, or closer to the edge of, the TFTA. An additional request will be filed to the FAA for the installation of lighting on all turbines in the TFTA.

Impacts to aviation training within the TFTA as a result of construction and operation of the proposed project are also being addressed through a working group, referred to as the Regional Mission Compatibility Review Team (RMCRT), which is composed of the affected Department of Defense services, First Wind, and the site's landowner, Kamehameha Schools. The RMCRT has been meeting on an ongoing basis to identify potential impacts, alternative solutions and mitigation measures. These meetings have resulted in changes to the initial wind farm layout, including the relocation of wind turbines away from the training areas and the undergrounding of proposed electrical lines to avoid and minimize potential conflicts with flight lines. Project-related impacts have, and will continue to be resolved through the RMCRT, such that project-related impacts to the TFTA would be mitigated to a less than significant level.

Harbors

The major components of the wind farm, such as the blades, towers, and nacelles, would be transported by sea and offloaded at Kalaeloa Harbor. Temporary storage of these components would require the use of vacant areas at Kalaeloa Harbor for a minimal amount of time to conduct inspections of the equipment and to prepare them for transport to the Kawailoa Site. To minimize disruption to harbor operations, all activities related to the shipment, unloading, storage and transport of these components would be coordinated directly with the DOT Harbors Division Oʻahu District Office and/or engineering maintenance section.

It is anticipated that the smaller turbine components and other equipment required for the project would be offloaded and transported from Honolulu Harbor. In general, the individual pieces of equipment are of a size and nature that allows them to be handled as general containerized cargo; therefore, import of equipment for the project is not expected to place an unusual demand on the harbor facilities.

Minimization Measures During Construction:

The following measures would be implemented to mitigation transportation impacts:

- All tower and blade components would have a minimum of four police escorts per load. Police escorts would direct traffic at intersections along each proposed route where necessary to allow oversized trailers to navigate turns.
- Police escorts and/or flagmen would provide traffic direction at the entrance to the wind farm site during construction.
- Hours of transport would be restricted to periods of the day when vehicular traffic is typically light, as follows: Monday through Saturday from 9:00 p.m. to 5:00 a.m. (and loaded equipment must be off of the roadways between the hours of 5:00 a.m. and 9:00 p.m.) and no oversized loads would be transported on Sundays or holidays.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures prescribed in the HCP will not have any effect on transportation and traffic.

Impacts of Mitigation Measures

The vehicles and vehicular trips required for monitoring and implementation of mitigation measures will involve too few vehicle trips (weekly to monthly trips) to significantly affect transportation and traffic.

4.11.2 Alternative 2 (Alternative Communications Site Layout)

Use of the existing single-lane access road at Mt. Kaʻala would be coordinated with the Kaʻala JUCC to avoid or minimize disruptions to the use of the access road by the proposed project's construction and operations activities. Impacts to the roadway are not anticipated. Transportation and traffic impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.11.3 Alternative 3 (No Action Alternative)

If the proposed project were not built, there would be no change from existing conditions. No transportation and traffic impacts due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.12 Military Operations

4.12.1 Alternative 1 (Proposed Action)

To address concerns of the wind farm's impacts on military training and to explore alternatives that could resolve those concerns while still allowing for a wind farm development at Kawailoa, the Department of Defense services formed a working group composed of the affected Department of Defense services, First Wind, and the site's landowner, Kamehameha Schools. The working group has met on five occasions (November 10, 2010, December 15, 2010, January 24, 2011, March 4, 2011, and June 2, 2011) to discuss potential impacts, alternative solutions and mitigation measures. These meetings have resulted in changes to the initial wind farm layout, such as the relocation of wind turbines away from the training areas and the undergrounding of proposed electrical lines to avoid and minimize potential conflicts with flight and ground training.

At the January 24 meeting, the group's named was changed to the Regional Mission Compatibility Review Team (RMCRT) to reflect recent federal legislation (Section 358 of the 2011 National Defense Authorization Act). The Department of Defense is developing an interim policy to enable a central clearinghouse, the Energy Siting Clearinghouse, in the Office of the Secretary of Defense, to evaluate whether proposed renewable energy projects would interfere with mission capabilities across the Department of Defense. Final determination of the project's impacts will be made by the Department of Defense Renewable Energy Clearinghouse in accordance with Section 358. Topics that have been discussed by the local RMCRT as related to the proposed Kawailoa wind farm project are as follows:

- Effect on day and night aviation training
- Effect on day and night ground training
- Copter NDB 152 and use of airspace over the wind farm
- Lighting on the wind turbine towers
- Markings on the towers and blades to alert pilots during the day, night, and during night-vision device training
- Radar interference
- Electromagnetic interference
- Overhead electrical lines

Based on these discussions, potential conflicts and associated mitigation measures that were identified by the RMCRT are as follows (based on the notes from the March 4, 2011 meeting of the RMCRT):

- Alert Area-311:The proposed Kawailoa wind farm would impact Alert Area-311. The proximity of the turbines poses a high safety risk to helicopters operating in the low level training area. The proximity of the turbines would also require the closure of one of only four authorized nap of the earth (NOE) training routes on O‘ahu. To mitigate for impacts to the Alert Area-311, Kawailoa Wind Power removed the 4 turbines that were closest to the yellow flight line. The 25th CAB would create a new flight route for day, night, and NVD NOE flight training.

- NVD Entry Control Point: The proposed turbines would bound the NVD Entry Control Point C12 on both the east and west sides. To mitigate this impact, the 25th CAB would move or discontinue use of the NVD Control Point.

- Landing Zones: Puu Kapu is a high density LZ used for air assault, sling loading and helicopter landing zone operations. The turbines would be located approximately 5,900 feet from this LZ and would increase risk to flight operations in and around the LZ. To mitigate for impacts to the Puu Kapu LZ, Kamehameha Schools has agreed to identify a new area for training.

- Copter NDB 152:Wind turbines would overlap with the Copter NDB 152 instrument approach to Wheeler Army Airfield, which is used primarily for recovery to the airfield from the TFTA and Kahuku Training Area. The FAA determination indicated that the turbines in the NDB 152 area would not pose a hazard to air navigation. While the FAA did not identify a significant impact, if other stakeholders identify this as a potential concern, the RMCRT can identify an appropriate solution in future meetings.

- Turbine Marking or Lighting: Not all turbines in the TFTA are marked. Unmarked turbines pose a flight hazard for pilots during day, night, and NVD flight operations. To mitigate for these impacts, Kawailoa Wind Power has agreed to put FAA-compliant red strobes on each turbine in the TFTA and to implement NVD-compatible blade marking or lighting.

- Overhead Electrical Lines: Overhead electrical lines pose a flight hazard for pilots during day, night, and NVD flight operations. To mitigate for these impacts, overhead electrical lines have been removed from the TFTA.

- Construction Activities: The crane used to install the turbines could pose a safety risk to helicopters operating in the low-level training area, particularly when left in a fully-extended, upright position. To mitigate this potential impact, Kawailoa Wind Power would notify the affected Department of Defense services of the anticipated plans for crane position and transit across the site.

In general, the RMCRT has determined that the proposed mitigation for each of these potential conflicts would reduce the impact to a less-than-significant level. For several of the topics discussed by the RMCRT, it was determined that impacts would not be likely to occur; these include radar interference, electromagnetic interference and ground training. Radar interference was not identified as a concern by the FAA in their determination and information from the turbine manufacturer indicated that electromagnetic interference generated by the project would not be significant.

The RMCRT has been an important forum to identify and address potential impacts of the Kawailoa Wind Power project on military activities. Going forward, the RMCRT will continue to serve as a communication mechanism between Kawailoa Wind and Department of Defense stakeholders to continue to develop mitigation measures for impacts.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures prescribed in the HCP will not have any effect on military operations.

Impacts of Mitigation Measures

The monitoring and implementation of mitigation measures will not significantly affect military operations as the military will not be using the land at or airspace above the proposed mitigation sites.

4.12.2 Alternative 2 (Alternative Communications Site Layout)

Impacts associated with this alternative would be the same as those described for installation of the Mt. Kaʻala communication facilities under the Proposed Action. Impacts to military operations due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.12.3 Alternative 3 (No Action Alternative)

Under the No Action alternative, the wind farm facility and Mt. Ka‘ala communications facilities would not be constructed, and therefore, no impacts relative to military training would occur. No impacts to military operations due to avoidance and minimization measures or mitigation measures are expected as these measures will not be implemented under Alternative 3.

4.13 Hazardous Substances and Materials

4.13.1 Alternative 1 (Proposed Action)

Other than the potential that chemicals related to former agricultural use of the property are present, no hazardous material or hazardous wastes are known to be present within the proposed wind farm project site. With the exception that chemicals related to former agricultural practices may be encountered, construction of the project is not expected to uncover or result in the release of an existing contaminant into the environment. An evaluation would be conducted before construction to evaluate for the presence of agricultural-related chemicals in site soils. If chemicals of potential concern are detected, mitigation measures would be implemented based on the nature and extent of contamination. Mitigation measures would include BMPs to minimize exposure of workers to contaminants during construction, and measures to store excavated materials using methods that would prevent release of potentially hazardous chemicals to the environment. Mitigation measures may include onsite monitoring and use of exclusion zones during construction, use of proper personal protective equipment by personnel at the site, placing stockpiled soils on bermed liners, covering stockpiled materials with impermeable liners, and proper characterization and disposal of contaminated materials.

Construction, operation, and decommissioning activities associated with the proposed project would require the use of some hazardous materials. Types of hazardous materials to be used would include fuels (for example, gasoline, and diesel fuel), lubricants, cleaning solvents, and paints. Facility construction personnel would follow BMPs to prevent spills or releases of hazardous materials during construction activities.

Construction activities (which include soil disturbing activities such as clearing, grading, excavating, stockpiling, etc.) that disturb one or more acres, or smaller sites that are part of a larger common plan of development or sale, are regulated under the NPDES stormwater program. Operators of regulated construction sites are required to develop stormwater pollution prevention plans; to implement sediment, erosion, and pollution prevention control measures; and to obtain coverage under a state or EPA NPDES permit. Kawailoa Wind Power will obtain a NPDES permit for construction activities. Incorporated in the NPDES permit for the wind farm construction will be effluent limitations guidelines (ELGs) and new source performance standards (NSPS) to control the discharge of pollutants from the construction site.

Operation of the proposed project would require the use of a possible BESS, an emergency back-up generator, electrical transformers, and the potential need for heavy equipment for maintenance and replacement activities. These activities would involve the use of hazardous materials, including oil, diesel fuel, propane, mineral oil, petroleum-based lubricants and/or solvents, and coolants, as well as the contents of the battery system.

SPCC plans are required by EPA’s SPCC regulations for regulated facilities to avoid oil spills and minimize impacts of spills on public health and the environment. Regulated facilities are non-transportation-related facilities with an aboveground oil storage capacity greater than 1,320 gallons or underground tanks with an oil storage capacity greater than 42,000 gallons that can be reasonably expected to discharge oil into navigable U.S. waters or shorelines.

Because the wind farm would have aboveground oil storage (mineral oil in electrical transformers), and smaller quantities of other oils and hazardous materials, the wind farm facility will be designed in accordance with good engineering practices including applicable industry standards and applicable federal regulations.

In addition, Kawailoa Wind Power would prepare and implement an SPCC Plan for the facility to prevent oil spills from occurring, and to perform safe, efficient and timely response in the event of a spill or leak. The SPCC Plan would identify the following:

- Where hazardous materials and wastes are stored or located onsite
- Volume of each type of hazardous material stored or located onsite
- Spill prevention measures to be implemented, training requirements during routine operations
- Periodic training requirements for facility operations personnel, and records of training completed
- Appropriate spill response actions for each material or waste
- Locations of spill response kits onsite
- A procedure for ensuring that the spill response kits are adequately stocked at all times
- Procedures for making timely notifications to authorities.

The plan would identify and address storage, use, transportation, and disposal of each hazardous material anticipated to be used at the facility. It would establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials, and would include material safety data sheets of hazardous materials. The SPCC plan would also identify key Kawailoa Wind Power management, state and federal regulatory contacts, and appropriate spill reporting requirements. The plan would provide instructions for notification of local emergency response authorities (Fire and Police) and include emergency response plans. Facility operations personnel would receive periodic training, to include the following:

- An introduction to pollution control laws
- Rules and regulations pertaining to the use and storage of petroleum products
- BMPs during routine operations and maintenance procedures in order to prevent spills
- Periodic inspection of spill control or containment equipment to ensure it is adequately maintained and functional
- Periodic inspection and maintenance of spill response kits
- Spill response and cleanup
- Spill notification and recordkeeping

In addition, in the event of a spill, Kawailoa Wind Power would provide the manpower, equipment and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful to the environment. If waste management is required, Kawailoa Wind Power would hire licensed contractors to characterize, transport, and properly dispose of contaminated materials.

There are no known existing environmental conditions at the two communications facilities sites at Mt. Kaʻala; however, a UST release was previously reported at the existing Hawaiian Telcom facility. Because the new antennae would be mounted on existing structure, no ground disturbance would occur under the Proposed Action. Therefore, no hazardous materials that could be associated with the UST release are expected to be encountered during construction.

Operation and maintenance of the equipment would require the use of some hazardous materials. Types of hazardous materials to be used would include lubricants, cleaning solvents, and paints. It is anticipated that these types of materials would be transported to the site during maintenance and replacement activities.

If hazardous materials are stored at the site that are of a nature or at volumes that trigger SPCC regulations, Kawailoa Wind Power would prepare and implement a SPCC Plan for the facility.

The SPCC Plan will identify the following:

- Where hazardous materials and wastes are stored or located onsite
- Volume of each type of hazardous material stored or located onsite
- Spill prevention measures to be implemented during routine operations
- Periodic training requirements for facility operations personnel, and records of training completed
- Appropriate spill response actions for each material or waste
- Locations of spill response kits onsite
- A procedure for ensuring that the spill response kits are adequately stocked at all times
- Procedures for making timely notifications to authorities

The plan will identify and address storage, use, transportation, and disposal of each hazardous material anticipated to be used at the facility. It would establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials, and would include material safety data sheets of hazardous materials. The SPCC plan would also identify key Kawailoa Wind Power management, state and federal regulatory contacts, and appropriate spill reporting requirements. The plan would provide instructions for notification of local emergency response authorities (Fire and Police) and include emergency response plans.

Facility operations personnel would receive periodic training including:

- An introduction to pollution control laws
- Rules and regulations pertaining to the use and storage of petroleum products
- Best management practices during routine operations and maintenance procedures in order to prevent spills
- Periodic inspection of spill control or containment equipment to ensure it is adequately maintained and functional
- Periodic inspection and maintenance of spill response kits
- Spill response and cleanup
- Spill notification and record keeping

In addition, in the event of a spill, Kawailoa Wind Power would provide the manpower, equipment and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful to the environment. If waste management is required, Kawailoa Wind Power would hire licensed contractors to characterize, transport, and properly dispose of contaminated materials.

<u>Impacts of Avoidance and Minimization Measures</u>

The avoidance and minimization measures prescribed in the HCP will not have any effect on hazardous materials.

<u>Impacts of Mitigation Measures</u>

Fuel (diesel or gasoline) will be used to operate vehicles to transport staff and equipment to the mitigation sites and fuel may be used to run equipment to carry out mitigation measures. Herbicides may be used as part of vegetation control. Proper precautions will be taken when driving and operating equipment and the herbicide will only be applied according the labeled instructions. Therefore, monitoring and implementation of mitigation measures will not result in any significant impacts due to hazardous materials.

4.13.2 Alternative 2 (Alternative Communications Site Layout)

Because there are no known existing environmental conditions at the two communications facilities sites at Mt. Kaʻala, it is not expected that installation of the new microwave dishes would uncover or result in the release of an existing contaminant into the environment. However, because a UST release was reported at the existing Hawaiian Telcom facility, measures would be taken to identify and mitigate potential issues that could arise during construction if residual contamination is encountered. Mitigation measures could include BMPs to minimize exposure of workers to contaminants during construction, and measures to store excavated materials using methods that would prevent release of potentially hazardous chemicals to the environment. Mitigation measures may include onsite monitoring and use of exclusion zones during construction, use of proper personal protective equipment by personnel at the site, placing stockpiled soils on bermed liners, covering stockpiled materials with impermeable liners, and proper characterization and disposal of contaminated materials.

Impacts associated with operation and maintenance of this alternative would be similar to those described for operation of the Mt. Kaʻala communication facilities under the Proposed Action.

Impacts of hazardous materials due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.13.3 Alternative 3 (No Action Alternative)

Under the No Action Alternative, there would be no change from existing conditions because the wind facility would not be constructed or operated in the project area. No impacts due to hazardous materials are expected as avoidance and minimization measures or mitigation measures will not be implemented under Alternative 3.

4.14 Socioeconomic Characteristics

4.14.1 Alternative 1 (Proposed Action)

Potential direct socioeconomic effects of the proposed facilities would include (1) construction employment and business activity; (2) lease revenue for use of the project sites; (3) revenues for the state in the form of excise taxes and property taxes; (4) substantial fuel cost savings to HECO, which potentially translate into ratepayer savings; (5) ongoing employment of facility operation and maintenance staff (which would be relatively limited); and (6) ongoing expenditures for materials and outside services. During the construction phase, Kawailoa Wind Power may employ an average of 75 people per day, with an anticipated maximum level of 129 employees. The work would include general construction and more specialized installation of electrical equipment and wind turbine components, potentially providing employment opportunities for those trained in renewable energy industries. Local residents of the North Shore or Oʻahu may be employed during the general construction of the project. Following construction, the operation of the wind facility would be staffed by four to eight full-time, regular employees working onsite Monday through Friday. These employees would include biologists, road maintenance workers, engineers, and technicians. Local residents of the North Shore or Oʻahu may be employed during operation of Kawailoa Wind Power; however, because the operations staff would be small, the project is not expected to result in a substantial long- term employment increase for the area. Collectively, these effects would be expected to provide socioeconomic benefits at both the regional and state-wide scale.

Adverse short-term or long-term impacts to the social or economic condition of the area are not expected to occur as a result of the Proposed Action. The Proposed Action would not result in a large number of new residents moving to the North Shore or the island of Oʻahu. Energy generated from the facility would provide power "as available" and would be used to substitute other energy sources. The population of the area is not expected to increase because of increase energy availability; therefore, the project would not be considered growth inducing. The Proposed Action is not anticipated to impact housing costs or availability.

4.14.1.1 Environmental Justice

Executive Order 12898 requires federal agencies to take appropriate steps to identify and avoid disproportionately high and adverse effects of federal actions on the health and surrounding environment of minority and low-income persons and populations. The USEPA, working with the Enforcement Subcommittee of the National Environmental Justice Advisory Council, has developed technical guidance to ensure that environmental justice concerns are effectively identified and addressed throughout the NEPA process. Suggested measures include identifying areas as low-income if more than 20% of the affected area is below the poverty level (as defined by the U.S. Census Bureau) or identifying areas as minority areas if minority populations represent more than 15.7% of the total population. Typically, minorities are defined as individuals who are members of the following population groups: African Americans, American Indians, Alaskan Natives, Asians, Hispanics, Native Hawaiians, or other Pacific Islanders.

As recognized in the Hawaii Environmental Justice Initiative Report (Kahihikolo 2008), the minority population distribution of Hawaiʽi differs greatly from that of the continental U.S. In contrast to the continental U.S., where Whites account for the majority of the population, no racial group in Hawaiʽi comprises even as much as half of the state population (OMPO and DPP 2004). The state is also unique in that 21.4% of the population reported multiple races; only 2.4% did so in the continental U.S. Thus, the minority definitions developed to determine environmental justice impacts on the mainland U.S. may not be applicable or appropriate for Hawaiʽi (OMPO and DPP 2004). For this reason, the State of Hawaiʽi has also developed its own legislation and guidance related to environmental justice. Act 294 was signed by Governor Lingle in July 2006 to define environmental justice in the unique context of Hawaiʽi and to develop and adopt environmental justice guidance document that addresses environmental justice in all phases of the environmental review process (Kahihikolo 2008).

The Haleʽiwa and Pūpūkea CDPs are more predominately White than Asian in comparison to Hawaiʽi as a whole. The percentage of Native Hawaiian and other Pacific Islanders and those listing two or more races in the CDPs was comparable to Hawaiʽi as a whole. Approximately 13% of families and 16% of individuals had incomes below the poverty level, which is somewhat a higher percent than Hawaiʽi as a whole but less than the 20% considered by the U.S. Census Bureau to be considered low income (U.S. Census Bureau 2000). Thus, there are no concentrations of minority or low income populations in the vicinity of the project area.

The Proposed Action is not expected to result in significant environmental, human health, or economic impacts on surrounding populations. No persons or populations would be displaced as a result of this project. Furthermore, the Proposed Action would benefit the local economy, including low-income and minority persons, including those associated with Kamehameha Schools. These individuals would also not experience a disproportionate share of the impacts of the project. Therefore, the Proposed Action complies with Executive Order 12898.

<u>Impacts of Avoidance and Minimization Measures</u>

The avoidance and minimization measures prescribed in the HCP will not have any effect on the socioeconomic characteristics of the area.

<u>Impacts of Mitigation Measures</u>

The implementation of mitigation measures will likely result in the hiring of local contractors or subcontractors. These may be long-term or short-term employments. Overall, mitigation measures may have a small positive effect on the socioeconomics of Oʽahu. No effect (positive or negative) is expected for minorities or low-income persons.

<u>4.14.2 Alternative 2 (Alternative Communications Site Layout)</u>

Similar to the installation of the Mt. Kaʽala communication facilities under the Proposed Action, this alternative would not be expected to result in either short-term or long-term adverse impacts to the social or economic condition of the area surrounding Mt. Kaʽala. Socioeconomic impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.14.3 Alternative 3 (No Action Alternative)

No changes in existing social or economic conditions are expected under the No Action Alternative because the wind facility would not be constructed or operated. This alternative would result in continued reliance on petroleum-based energy generation and would not provide the social and economic benefits expected under the Proposed Action (i.e., construction and maintenance employment, expenditures for materials and outside services, and state revenues). There would be no changes or adverse impacts to low-income or minority populations under the No Action Alternative because the facility would not be constructed or operated. No socioeconomic impacts are expected due avoidance and minimization measures or mitigation measures as these measures will not be implemented under Alternative 3.

4.15 Natural Hazards

4.15.1 Alternative 1 (Proposed Action)

Neither construction nor operation of the proposed project is expected to affect the incidence rate of a natural hazard, with the exception of an increased potential for wildfires associated with use of vehicles and electrical equipment in the project area. Construction and operation of the project could be adversely affected by a natural hazard, such as a hurricane or earthquake, should one occur; however, the occurrence rate is expected to be very low.

Wind turbines are not generally susceptible to wildfires, and grass and other flammable materials are kept well back from the base of the tower as a matter of regular maintenance. However, consistent with the requirements of the Honolulu Fire Department, an appropriate access road for fire apparatus would provide access to within 150 feet of all onsite facilities and buildings. In addition, the O&M Building and BESS would be supported by an exterior fire hydrant, supplied from water tanks with a total capacity of approximately 60,000 gallons. Interior areas would include accessible fire extinguishers.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures prescribed in the HCP will not have any effect on the incidence of natural hazards in the area.

Impacts of Mitigation Measures

The implementation of mitigation measures will not have any effect on the incidence of natural hazards in the area.

4.15.2 Alternative 2 (Alternative Communications Site Layout)

Similar to the discussion of construction and operations of the Mt. Kaʻala communication facilities under the Proposed Action, implementation of this alternative would not be expected to result in impacts related to natural hazards.

Incidences of natural hazards due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.15.3 Alternative 3 (No Action Alternative)

Under the No Action alternative, the wind farm facility and Mt. Kaʻala communications facilities would not be constructed, and therefore, there would be no change in the existing condition relative to natural hazards. No effect on the incidences of natural hazards is expected due avoidance and minimization measures or mitigation measures as these measures will not be implemented under Alternative 3.

4.16Public Safety

4.16.1 Alternative 1 (Proposed Action)

In general, the wind farm facilities are greater than 1 mile away from the nearest residence, and are not publicly accessible. As such, the unlikely event of a tower collapse, blade throw or stray voltage significantly impacting public safety is minimal.

During the construction phase of the project, ignition sources for accidental fires include errant sparks from a variety of vehicles, equipment and tools, and improperly discarded matches and cigarette butts. These are of limited intensity, and under most conditions are unlikely to spark a grass or other fire. Fire-fighting equipment would be maintained in work vehicles and staging areas of the project site and would be available if needed.

During operation of the project petroleum-fueled mobile equipment (such as trucks and cranes), petroleum-based lubricants, and other flammable materials means would be present at the site. If a fire does occur, there is potential for equipment damage, but it is not expected to be significant. The towers supporting the turbines are of 3/4-inch plate steel, mounted on concrete foundations; the interconnecting electrical systems are below ground; and the operations and maintenance facilities would be constructed of noncombustible construction and exterior finishes. Damage from fire could occur to the onsite substation and would potentially disrupt the facility's provision of electricity to HECO, though it would not jeopardize HECO’s ability to provide electricity services to its customers. Basic onsite fire-fighting resources would include fire extinguishers in the maintenance facility, at the substation, and in all project vehicles, as well as shovels and backpack pumps in the maintenance facility and maintenance vehicles.

During construction, firefighting resources would include the provision of fire extinguishers in all construction vehicles and trailers. In addition, during some periods of construction, earthmoving equipment would be present onsite and able to assist in creating fire breaks. Lastly, water that is stored in water tanks during construction can also be used for firefighting.

The results of a shadow flicker analysis for the project indicated that areas of potential shadow flicker effect extend 4,577 feet from each turbine. Because the project is located in an agricultural area, no residences are located within the areas within which detectable shadow flicker would be created. The closest residences lie in the corridor along the Kamehameha Highway south of Waimea Bay. These and the other residential areas in this part of the island are more than 4,577 feet from the nearest turbine locations, and outside of the areas within which detectable levels of shadow flicker effect would occur. Shadow flicker could potentially occur along the edges of Waimea Valley: approximately 5% of Waimea Valley Park could experience 0 to 10 hours of shadow flicker on an annual basis, approximately 4% of the park could experience 10 to 30 hours on an annual basis, and approximately 2% of the park could experience 30 to 100 hours on an annual basis. The potential for shadow flicker within these areas may be further diminished by the vegetation canopy within the valley. In general, these results indicate that the potential for shadow flicker would be almost entirely contained within the wind farm site, and the amount of potential flicker extending onto adjacent areas would be relatively short in duration.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures prescribed in the HCP will not have any negative effects on public safety in the area. The speed limit of 15 mph on site will likely reduce the risk of vehicular accidents.

Impacts of Mitigation Measures

The implementation of mitigation measures will not have any negative effects on public safety in the area. In fact, mitigation measures such as fencing, eradication/control of ungulates and introduced mammals are likely to improve the safety of the mitigation site when accessed by people.

4.16.2 Alternative 2 (Alternative Communications Site Layout)

Similar to the discussion of construction and operations of the Mt. Kaʻala communication facilities under the Proposed Action, implementation of this alternative would not be expected to affect public safety. Public safety impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.16.3 Alternative 3 (No Action Alternative)

Under the No Action alternative, the wind farm facility and Mt. Kaʻala communications facilities would not be constructed, and therefore, there would be no change in the existing levels of public safety. No effects on public safety are expected due avoidance and minimization measures or mitigation measures as these measures will not be implemented under Alternative 3.

4.17Public Infrastructure and Services

4.17.1 Alternative 1 (Proposed Action)

Activities associated with wind energy generation may generate small amounts of solid waste, wastewater and hazardous waste, which would be transported by truck to the appropriate local disposal facility for reclamation or landfill, as described below. The potential for electromagnetic interference as a result of the project is also addressed below. Public services including fire and police, health care, education, and recreation would not be significantly affected, and will not be discussed further.

Energy

With the 70 MW of power potentially generated by the proposed facility, HECO would be able to eliminate the use of approximately 304,200 barrels of oil annually that would otherwise be used to produce conventional power. Reducing the proportion of its energy that comes from fossil fuel would decrease the amount of money that HECO spends on imported fuel and buffer the system from the energy cost fluctuations that accompany volatile oil prices.

The proposed project would contribute to the goals outlined in the Hawaiʻi's RPS and the HCEI by increasing the percentage of the state's energy that is derived from clean, renewable sources. The exact percentage is unknown; however, Kawailoa Wind Power is expected to generate enough clean energy to power up to approximately 14,500 of the 337,152 homes on Oʻahu (DBEDT 2008b). It also would support recently passed state statutes designed to promote energy efficiency and renewable energy sources.

The proposed project would consume only small amounts of electrical power, which would be either generated by the facility or back-fed through utility's sub-transmission lines.

Solid Waste

Construction and operation of the proposed project is not anticipated to generate a significant amount of solid waste. Although the exact amount is unknown, for other facilities of this kind, waste typically does not exceed one small dumpster per week (Planning Solutions 2010). During construction, all waste would be transported to and stored within the temporary use area and periodically carried out and properly disposed of in a permitted landfill. During operation, waste would be collected by a private solid waste management company once a week and disposed of in an approved landfill. Some solid waste may be recycled. These materials would be stored and hauled separately to the appropriate recycling company. An onsite septic tank system would be constructed in the project area to handle sewage.

The vast majority of waste created during construction and operation of wind energy facilities is nonhazardous solid waste, such as shipping crates, boxes, and packing material. No hazardous solid waste is expected to be generated as a result of construction or operation of the proposed project. Because only a small amount of solid waste is expected to be generated during construction and operation, and appropriate management practices would be implemented, impacts to solid waste disposal or processing are expected to be minor.

Water and Wastewater

Wastewater generated by employees of the proposed facility can easily be accommodated in existing treatment and disposal facilities. Therefore, no significant impact to wastewater treatment facilities is expected from the proposed project.

Telecommunication Services

Voltage and elevation are the primary factors in the amount of corona produced by a transmission line. The electric field gradient that causes corona is the rate at which the strength of the electric field changes with distance and is directly related to the line voltage. Corona typically becomes a design concern for transmission lines at voltages of 345 kV and above. Corona increases at higher elevations where the density of the atmosphere is less than at sea level. Given the low voltage (46 kV) and the elevation near sea level, the power lines for the proposed project would produce very low levels of corona.

Corona-generated radio interference could potentially affect the amplitude modulation (AM) radio broadcast band (535 to 1,605 kilohertz); frequency modulation (FM) radio is rarely affected. Even at higher voltages and elevations, only AM receivers located very near to transmission lines that are tuned to a weak station have the potential to be affected. Moderate corona-generated television interference may occur during wet weather; however, interference should not occur for televisions located more than 200 feet from the lines, or for televisions receiving signals from a satellite dish. Given that the distance of the transmission lines from the adjacent community is more than 200 feet, the project is not expected to significantly affect telecommunication services.

Mt. Kaʽala Communication Facility Sites

The communication facilities proposed for installation on Mt. Kaʽala are similar in type and function to the existing on-site facilities, and would not require any public services or affect any public infrastructure.

Impacts of Avoidance and Minimization Measures

The avoidance and minimization measures prescribed in the HCP will not have any negative effects public service and infrastructure in the area.

Impacts of Mitigation Measures

The implementation of mitigation measures will not have any negative effects on public service and infrastructure in the area.

4.14.2 Alternative 2 (Alternative Communications Site Layout)

Overall, impacts to public infrastructure and services as a result of Alternative 2 would be expected to be the same as those described for the Proposed Action (Alternative 1). Public service and infrastructure impacts due to avoidance and minimization measures or mitigation measures are expected to be the same at Alternative 1.

4.14.3 Alternative 3 (No Action Alternative)

Under the No Action Alternative, the facility would not be built and operated so there were be no impacts to public infrastructure and services in the area. The benefits of reducing imported fossil fuel use would not occur. This no build scenario would not contribute to the goals outlined in the Hawai'i's Renewable Portfolio Standards or the Hawaii Clean Energy Initiative. This alternative would result in the continued reliance on petroleum-based energy generation on the Island of O'ahu, with the exception of the Kahuku Wind Power facility. No effects on public service and infrastructure are expected due avoidance and minimization measures or mitigation measures as these measures will not be implemented under Alternative 3.

4.18 Cumulative Impacts

This section considers projects in the past, present, and reasonably foreseeable future, authorized or under review, that are considered to contribute to the cumulative impacts not only on endangered, threatened, and other rare species, but also on society and the human environment in the Kawailoa area and the Island of O'ahu. "Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This discussion is limited to those past, present, and reasonably foreseeable future actions that involve impacts on a resource that overlaps with the Proposed Action impacts on that same resource.

The Kawailoa project area encompasses a predominantly rural area. It is situated on agricultural land; and comparatively few large-scale projects occur in the area. For this reason, cumulative impacts of the Proposed Action are evaluated for the regional area, defined as the Island of O'ahu. However, for impacts to resources that are essentially confined to the site (e.g., geology and soils), cumulative impacts are evaluated with respect to the Kawailoa region only.

Past and future development in the Kawailoa project area is generally limited to diversified agriculture. Agricultural activities may result in on-going impacts to soils, vegetation, and wildlife, including the Covered Species. Other projects planned in Kawailoa region include a Kamehameha Schools outdoor education program. The only other wind project is the Kahuku wind farm, located approximately seven miles northeast of the Kawailoa wind farm site. A second wind farm project, Na Pua Makani has also been identified in the vicinity of the Kahuku wind farm site. Table 4-4 lists all existing and potential wind farms in Hawaii.

Table 4-4. Existing and Potential Wind Energy Facilities throughout the State.

Facility Name	Operator	Energy Generated	Island
Lalamilo Wind Farm replacement (P)	Hawaii Electric Light Company	N/A	Hawai'i
Pakini Nui	Tawhiri Power, LLC	20.5 MW	Hawai'i
'Upolu Point	Hawi Renewable Development	10.5 MW	Hawai'i
Auwahi Wind Project (P)	Auwahi Wind Energy LLC	21 MW	Maui
Kaheawa Wind Power (KWP)	First Wind	30 MW	Maui
Kaheawa Wind Power (KWP) II (P)	First Wind	22 MW	Maui
Kahuku Wind Power	First Wind	30 MW	O'ahu
Kawailoa Wind Power(P)	First Wind	70 MW	O'ahu
Na Pua Makani (P)	Oahu Wind Partners LLC	25 MW	O'ahu
Unknown (P)	Castle & Cooke	300 MW	Lāna'i
Kauai Wind Power (P)	UPC Kauai Wind Power	10.5 – 15 MW	Kaua'i
(P) = Potential wind facility DBEDT (2011)			

4.18.1 Alternative 1 (Proposed Action)

To assess cumulative impacts, other projects in the vicinity of the project area that occurred in the recent past, present and reasonably foreseeable future and involved impacts to resources for which the Proposed Action could contribute incrementally were considered. To date, the only relevant action that has been identified is the Kahuku wind farm project, located approximately seven miles northeast of the Kawailoa wind farm site. A second wind farm project, Na Pua Makani has also been identified in the vicinity of the Kahuku wind farm site; however, the project is not believed to be proceeding at this time. As part of their master planning effort, Kamehameha Schools identified several potential projects to be implemented on their property, including diversified agriculture and outdoor education programs; these projects are all believed to be in the early stages of development.

Analyses of potential cumulative impacts associated with the Kahuku wind farm project focused on the resource areas most relevant to potential cumulative impacts: climate change, military operations, and wildlife. Because Kahuku is located more than seven miles away from the Kawailoa wind farm site, and is separated by steep topography, cumulative impacts to sound and visual resources are not anticipated.

4.18.1.1 Climate

The release of anthropogenic greenhouse gases and their potential contribution to global warming are inherently cumulative phenomena. Greenhouse gas emissions resulting from the Proposed Action would be relatively small compared to the 54 billion tons of CO_2-equivalent anthropogenic greenhouse gases emitted globally in 2004 (IPCC 2007a, b). However, emissions from the Proposed Action in combination with past and future emissions from other sources would contribute incrementally to climate change impacts. At present there is no methodology that allows quantification of the specific impacts (if any) this increment of climate change would produce in the vicinity of the facility or elsewhere.

Greenhouse gas emissions caused by construction and operation of the proposed project and the Kahuku wind farm project would be more than offset by the reduction of emissions resulting from the decrease in the amount of fossil fuels currently burned on Oʽahu to generate electricity. The energy potentially generated by the Proposed Action would eliminate the use of approximately 304,200 barrels of oil, which in turn would reduce emissions of CO_2 by more than 134,400 tons. The 30 MW of power generated by the Kahuku Wind Power facility is expected to eliminate the use of approximately 154,550 barrels of oil annually, and thereby reduce emission of approximately 79,800 million pounds of CO_2. These amounts far exceed those which would be produced by construction and operation of the wind facilities. Given this, the projects are expected to result in beneficial cumulative effects on local and statewide levels of greenhouse gas emissions.

4.18.1.2 Air Quality

The Proposed Action would contribute very low levels of air emissions to the air in the region during construction, operation, and monitoring of the project (though considerably less emissions than carbon-based forms of energy generation). The cumulative effect of emissions resulting from this and other projects occurring on the island is not expected to cause a significant change in regional air quality because impacts are minor and localized. Prevailing northeasterly trade winds help to maintain healthy air quality on the island.

Any potential change in electric rates resulting from the addition of new electrical power generation would not markedly promote or discourage economic activity or population growth. Consequently, it would not lead to increased residents or changes in the character of economic activity (e.g., opening of new industries not previously practical) that might have secondary air quality impacts.

4.18.1.3 Geology, Topography and Soils

No significant impacts to geologic features or soils are expected from the Proposed Action. Because the soil on-site has largely been disturbed by agricultural and other activities, any disturbance of the soil would not contribute to loss of native soils or add to impacts resulting from other development activities on the regional area.

4.18.1.4 Hydrology and Water Resources

The Proposed Action would result in only slight increases in impervious surfaces and alterations to drainage patterns and stormwater runoff pathways. The proposed project has the potential to degrade the quality of surface water runoff leaving the project area. BMPs and general construction management techniques designed to minimize erosion will be implemented to ensure no significant impacts to the water quality of receiving waters as a result of the proposed project. The project area would represent only a small percentage of the watershed that drains the area. However, when considered in combination with the adjacent wind energy facility, the proposed project has the potential to cumulatively impact the water quality of receiving waters. Therefore, it is important to emphasize the design features that have been incorporated into Kawailoa, in addition to the revegetation plan in place for the facility, to ensure that the potential for erosion is minimized during construction and operation of the proposed facility.

4.18.1.5 Biological Resources

The Proposed Action would contribute to a cumulative reduction of alien habitat for some non-federally listed wildlife species when added to impacts resulting from other development and road construction projects on O‘ahu. However, a large amount of similar habitat is available at other locations on the island. In general, non-federally listed wildlife species occurring at Kawailoa are non-native species that common and widespread in the region and are adapted to disturbed habitats. Therefore, cumulative effects to non-federally listed wildlife are not considered to be significant.

Take for the Covered Species has been authorized for O‘ahu, Maui and Kaua‘i (where take and mitigation for Kawailoa Wind Power are occurring) through HCPs and Safe Harbor Agreements (SHAs) (Table 4-5). Under the Federal Endangered Species Act (16 U.S.C. 1531-1544) HCPs are required to minimize and mitigate the effects of the incidental take. In addition to the above requirements, the State of Hawai‘i requires that all HCPs and their actions authorized under the plan should be designed to result in an overall net benefit to the threatened and endangered species in Hawai‘i (Section 195D-30). Under a SHA, property owners voluntarily undertake management activities on their property to enhance, restore, or maintain habitat benefiting species listed under the ESA. These agreements assure property owners they will not be subjected to increased property use restrictions if their efforts attract listed species to their property or increase the numbers or distribution of listed species already on their property. The USFWS issues the applicant an "enhancement of survival" permit, which authorizes any necessary future incidental take through Section 10 (a)(1)(A) of the ESA. Accordingly, all impacts associated with these take authorizations have been mitigated.

In addition to the take that has already been authorized (Table 4-5), the proposed Na Pua Makani wind facility project on O‘ahu, the Kaheawa Wind Power II and Auwahi wind Project on Maui and Kaua‘i Wind Power project on Kaua‘i (Table 4-4) also have the potential to result in incidental take of the Covered Species. Thus, there is a possibility of cumulative impacts to these species. However, it is expected that if the HCPs for the potential projects are approved, the impacts and mitigation measures will resemble those discussed for Kawailoa Wind Power, where the proposed mitigation measures for Kawailoa Wind Power are expected to more than offset the anticipated take and provide a net benefit to the species.

Table 4-5. Current and Pending Take Authorizations for Covered Species on O'ahu, Maui, and Kauai through HCPs and SHA.

Applicant	Permit Duration	Location	Species and permit duration take authorization
Kahuku Wind Power	05/27/2010-05/27/2030	Kahuku, O'ahu	Newell's shearwater (12 adults, 6 chicks) Hawaiian duck (12 adults, 12 ducklings) Hawaiian stilt (12 adults, 6 chicks) Hawaiian coot (12 adults, 6 chicks) Hawaiian moorhen (12 adults, 8 chicks) Hawaiian short-eared owl (12 adults, 12 owlets) Hawaiian hoary bat (18 adults, 14 juveniles)
Kaheawa Wind Power	01/30/2006-01/30/2026	Mā'alaea, Maui	Newell's shearwater (40 individuals) Hawaiian hoary bat (20 individuals)
Kaheawa Wind Power II	Pending	Mā'alaea, Maui	Newell's shearwater (6 adults,4 chicks)[11] Hawaiian hoary bat (9 adults,6 juveniles)[12]
Kauai Island Utility Cooperative (KIUC)	2011-2015	Kaua'i	Newell's shearwater (625 individual mortalities, 275 non-lethal injuries)
Chevron SHA	09/23/2005-9/23/2011	Kapolei, O'ahu	Hawaiian stilt Hawaiian coot

At a broader scale, Kawailoa Wind Power represents one of many projects that can be expected to occur on the Island of O'ahu, Maui and Kauai. O'ahu, Maui and Kaua'i have experienced increasing human population growth and real estate development, and will likely continue increasing in the future. Some of the causes of decline of the Covered Species (such as mammal predation, light disorientation, pesticide use, and loss of nesting or roosting habitats) may be on the increase due to this growth. Through mitigation, projects like Kawailoa Wind Power are among the few that are implementing measures to provide a net benefit to the affected species. In general, it is assumed that future development projects will be conducted in compliance with all applicable local, state, and federal environmental regulations.

6.4.1 Seabirds (Newell's Shearwater)

Currently, take for Newell's shearwater has been authorized on O'ahu, Maui and Kaua'i (Table 4-5). Mitigation for Kahuku Wind Power on O'ahu consists of colony-based management on Maui or Kaua'i. The colony based management is expected to consist of erecting a cat and mongoose-proof fence around an identified colony, eradicating the cats and mongoose within and trapping for rats to protect the nesting seabirds within. Social attraction and artificial burrows could also be used to enhance the colony numbers by attracting seabirds to a managed site, safe from predation. The predator exclusion and trapping is expected to increase adult and juvenile survival and also increase the overall productivity of the colony within the protected area. The mitigation is expected to offset the requested take and provide a net benefit to the species by contributing knowledge to new management techniques for the species such as social attraction. Mitigation for Newell's shearwater at Kaheawa Wind Power and the pending project Kaheawa Wind Power II also consists of colony-based management on Maui and is very similar to the measures described for Kahuku Wind Power.

Mitigation by KIUC for their Short-term Seabird HCP is comprehensive. It consists of rehabilitating downed seabirds, colony-based management and research and additional take monitoring. The Save our Shearwaters (SOS) Program rescues and rehabilitates downed seabirds that would otherwise have died due to powerline collisions and light attraction. It provides a significant conservation benefit to these seabirds, which supplements KIUC's main mitigation effort which is implementing colony based management. Seabird colony management will occur at Limahuli Valley and Hono o Na Pali Natural Area Reserve. The measures that will be implemented at Limahuli Valley include ungulate proof

[11] Anticipated revised take estimate after public comment
[12] Anticipated revised take estimate after public comment

fencing, ungulate removal, feral cat removal, rodent control, alien plant control, and monitoring the breeding success of the seabirds. Measures to be implemented at Hono o Na Pali Natural Area Reserve include cat-trapping, rodent control, owl removal and monitoring of breeding success of the seabirds. Research initiatives include a two-year auditory survey to locate additional breeding colonies and updating at-sea seabird population estimates. Funds will also be provided to implement an appropriate underline monitoring program.

Take authorization for this species may also be requested for by Na Pua Makani on O'ahu and Kauai Wind Power on Kaua'i (Table 4-4).

The proposed mitigation measures described for Newell's shearwater from the various HCPs are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by state law. The proposed mitigation measures are expected to produce a measurable net benefit in the form of an increase in the species' population by increasing productivity and survival rates of birds through predator control and other management measures such as fencing and ungulate control and supplementary programs such as SOS. The research and development of new management techniques proposed by the different projects (such as the development of the self-resetting cat trap by Kawailoa Wind Power) will also improve effectiveness of the management of the seabird colonies. The research and development will also have far reaching effects beyond the mitigation measures implemented by any of the Applicants. All the improved management measures will be available to be utilized by most parties involved in the management of Newell's shearwater colonies once developed. This is expected to result in better protection and greater reproductive success and adult survival for many colonies, including those that are currently unmanaged. For these reason, no significant adverse impacts to the species' overall population, and no significant cumulative impacts to the species, are anticipated.

6.4.2 Waterbirds (Hawaiian Duck, Hawaiian Stilt, Hawaiian Coot, Hawaiian Moorhen)

Currently, only the Kahuku Wind Power facility has been authorized to take the Hawaiian duck, Hawaiian stilt, Hawaiian coot, or Hawaiian moorhen on O'ahu. Take authorizations of this project are shown in Table 4-5. No observed take of waterbirds has been recorded at Kahuku since the project began in May 2010. Take authorization for these federally listed waterbirds is assumed for Na Pua Makani on O'ahu and Kauai Wind Power on Kaua'i (Table 4-4).

The most important causes of decline of Hawaiian waterbirds are the loss of wetland habitat and predation by introduced animals. Other factors that have contributed to population declines include altered hydrology, alteration of habitat by invasive nonnative plants, disease, and possibly environmental contaminants (USFWS 2005a). Development of the Kawailoa Wind Power project will not increase losses due to these other causes. However, some of these causes (loss of wetlands and pesticide use) may be on the increase due to continued real estate development on O'ahu, and will likely continue increasing in the future. Thus, the possibility of cumulative impacts in addition to the anticipated take at Kawailoa Wind Power exists.

However, the proposed mitigation measures described for the federally listed waterbirds are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by state law. With the low expected rate of take, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the species' population by increasing productivity and survival rates of birds through predator control and other management measures such as fencing and ungulate control. Similar mitigation measures are being implemented for Kahuku Wind Power and are assumed for Na Pua Makani and Kauai Wind Power on Kaua'i (if constructed). For this reason, no significant adverse impacts to the species' overall population, and no significant cumulative impacts to the federally listed waterbirds, are anticipated.

6.4.3 Hawaiian Short-eared Owl

Currently, the only authorized take of Hawaiian short-eared owls is at Kahuku Wind Power. Over the 20-year project life, Kahuku Wind Power is authorized to take eight owls and four owlets (Table 4-5). No observed take of Hawaiian short-eared owls has been recorded at Kahuku since construction of the project began in May 2010. Take authorizations of this species are also assumed for Na Pua Makani on O'ahu (Table 4-4).

Loss and degradation of habitat, predation by introduced mammals, and disease threaten Hawaiian short-eared owl. Hawaiian short-eared owls appear particularly sensitive to habitat loss and fragmentation, as they require relatively large tracts of grassland and are ground nesters. Ground nesters are more susceptible to the increased predation pressure that is typical within fragmented habitats and near rural developments (Wiggins et al. 2006). These nesting habits make them vulnerable to predation by rats, cats, and the small Indian mongoose (Mostello 1996; Mitchell et al. 2005). Trauma (apparently from vehicular collisions), emaciation and infectious disease (pasteurellosis) (Thierry and Hale 1996) also causes death of Hawaiian short-eared owls throughout the state. Thus, the possibility of cumulative impacts from these threats, in addition to the anticipated take at Kawailoa Wind Power exists.

However, Kawailoa Wind Power has proposed mitigation measures for the species which will contribute to the rehabilitation of injured owls and/or a greater understanding of the species' occurrence and status as well as management measures to aid in the recovery of the species. These measures should result in an overall net conservation benefit for the species by rehabilitating owls that would otherwise have died or by increasing adult survival or productivity due to the management measures. Similar mitigation measures are being implemented for Kahuku Wind Power and are assumed for Na Pua Makani. For this reason, no significant adverse impacts to the species' overall population are expected, and no significant cumulative impacts to the species, are anticipated.

6.4.4 Hawaiian Hoary Bat

Currently, only the Kahuku Wind Power facility has been authorized to take Hawaiian hoary bats on O'ahu (Table 4-5). Take authorizations for this species are assumed for Na Pua Makani on O'ahu. Kaheawa Wind Power is authorized for Hawaiian hoary bat take on Maui. Take authorizations for Kaheawa Wind Power II and Auwahi Wind Power on Maui are assumed (Table 4-4).

Because the population of this species is not known, it is difficult to gauge whether the take of Hawaiian hoary bat will result in a significant impact on the overall population. Research was the main component of Kaheawa Wind Power mitigation due to the need for research to help determine some basic life history parameters and identify effective management measures. Kahuku Wind Power and Kaheawa Wind Power will mitigate for bats by restoring forest habitat to increase or improve bat foraging and roosting habitat. This is expected to increase survival and reproductive success commensurate with take and provide a net benefit to the species. Kawailoa Wind Power's proposed mitigation for the anticipated take of Hawaiian hoary bat will also contribute to restoration of native bat habitat (either wetland or forest) with a research component and are anticipated to have the same benefits. Similar mitigation measures are assumed Na Pua Makani on O'ahu, Auwahi Wind Project on Maui and Kauai Wind Power on Kaua'i. Therefore, there is no anticipated cumulative impact to the Hawaiian hoary bat.

4.18.1.6 Historical, Archaeological, and Cultural Resources

The Proposed Action would not have a significant adverse effect on archaeological, historic, or cultural resources during construction or operation. Thus, cumulative impacts to these resources are not anticipated.

4.18.1.7 Visual Resource

Construction of the Proposed Action would add to the amount of structural development within the visual landscape of the North Shore and specifically in the Kawailoa area, adding additional wind energy visual features into the viewshed. The only other major development under consideration in the project area is the Na Pua Makani wind farm, though significant cumulative impacts to visual resources are not expected.

4.18.1.8 Noise

Cumulative noise impacts from the Proposed Action and other sources are not expected due to the distance between the project and potential receptors. The nearest potential receptors are residents of Waimea Valley; however, predicted sound levels during the day are lower than the Community Noise Control Rule limits and would be completely masked by ambient noise sources such as birds and wind. At night, wind turbine sounds would be just barely perceptible at Waimea Valley. Other potential receptors are much farther away, at distances of over one mile to several miles, and thus well beyond the limit of potential adverse or cumulative impact.

4.18.1.9 Land Use

The Proposed Action is comparable and compatible with other long-standing land uses in the area. Therefore, the cumulative effect of the Proposed Action on land use is not considered to be significant

4.18.1.10 Transportation and Traffic

Transportation and traffic impacts of the project under the Proposed Action would be short-term and restricted to the construction period. Long-term traffic during operations would be minimal, with little or no potential for cumulative effects. There are no other developments currently under review for the project area; consequently there are no cumulative impacts associated with roadways.

4.18.1.11 Military Operations

The Kawailoa Training Area and Kahuku Training Area comprise the TFTA, an FAA-designated alert area of high-density air traffic from the ground surface to 500 feet above ground level, known as the A-311 alert area. These areas are used by several branches, or services, of the Department of Defense including the U.S. Army, Marine Corps, Navy, and Air Force. The eastern portion of the proposed Kawailoa wind farm site overlaps with the TFTA. First Wind's already constructed Kahuku wind farm site is located near the Kahuku Training Area, and is proximate to flight lines within the TFTA.

Several potential conflicts have been identified relative to the Kawailoa wind farm project and activities in the TFTA. A local RMCRT, comprised of the affected Department of Defense services, First Wind and Kamehameha Schools, has been formed to help identify actions to avoid, minimize, or mitigate the potential conflicts.

The subject of cumulative impacts of the Kawailoa and Kahuku wind farms on military training was generally discussed by the RMCRT, but the mitigation that has been identified addresses the impacts of each wind farm site individually. The overall concern relative to cumulative impacts is that the total aviation training areas not decrease in size as a result of the existing, proposed or future wind farms. Mitigation for Kawailoa includes identification of a new training area, implementation of NVD-compatible marking or lighting for turbine blades, and installation of strobe lighting. For the Kahuku wind farm project, mitigation includes installation of an additional strobe light on one of the turbines to improve visibility for military aviators.

Cumulative impacts were also considered as part of the FAA review process and were addressed in their Determination of No Hazard to Air Navigation, issued on March 9, 2011. Specifically, the determination for the structures that are proximate to the TFTA stated:

> *"This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect on air navigation."*

4.18.1.12 Hazardous Substances and Materials

No other known developments are under review for the area; thus, there are no anticipated cumulative impacts of hazardous substances and materials.

4.18.1.13 Socioeconomic Characteristics

The Proposed Action would not result in new residents moving to the region or O‘ahu. Energy generated from the facility would provide power "as available" and would be used to substitute other energy sources. The population of the area is not growth inducing and would not impact housing costs or availability. When combined with past, present, and future projects, the Proposed Action would not result in adverse cumulative impacts to social or economic conditions in the area, including adverse or disproportionate impacts to minority or low income persons or populations.

Beneficial social and economic impacts include: increased employment opportunities during construction (short-term) and operation (long-term); generation of tax and lease revenues; production of ongoing expenditures for materials and outside services; and stabilization of imported fuel costs.

4.18.1.14 Natural Hazards

The wind farm is not expected to contribute to any natural hazards; thus, there are no anticipated cumulative impacts.

4.18.1.15 Public Safety

Public safety issues associated with the Proposed Action are expected to be minimal given the project location; thus, there are no anticipated cumulative impacts.

4.18.1.16 Public Infrastructure and Services

Wind energy is a critical component of the state's renewable energy portfolio, and clearly fulfills the government mandate to increase renewable energy as a percentage of generation capability. The cumulative impact of these standards will be to considerably reduce Hawaii's dependence on oil imports. Other recent renewable energy projects that are planned or have been constructed in Hawai‘i are listed in Table 4-4. These wind farms also contribute to the state's renewable energy portfolio. Thus, the Proposed Action would provide beneficial cumulative impacts to public infrastructure and services on the islands by increasing the share of wind energy in the state's renewable energy portfolio.

4.18.2 Alternative 2 (Alternative Communications Site Layout)

Cumulative impacts are expected to be the same as Alternative 1.

4.18.3 Alternative 3 (No Action Alternative)

The No Action Alternative would not cause any change to the existing environment (because a wind energy project would not be constructed or operated) and therefore would not cumulatively contribute to a change in the status of any of the natural or human factors addressed in this EA. Under this scenario, Kawailoa Wind Power would not provide mitigation for potential impacts to the Covered Species, and there would be no cumulative contribution toward regional conservation and recovery of threatened and endangered species.

CHAPTER 5: LIST OF PREPARERS

SWCA Environmental Consultants (SWCA)

- James Feldmann, Environmental Planner
- Ling Ong, Wildlife Scientist
- Paul Sunby, Senior Project Manager
- Tiffany Thair, Environmental Planner
- Jaap Eijzenga, Wildlife Biologist
- Jason Balmut, GIS and Cartography
- John Ford, Project Manager

First Wind

- David Cowan, Vice President of Environmental Affairs
- Greg Spencer, Wildlife Biologist
- Wren Wescoatt, Development Manager
- Steve Jiran, Construction Project Manager

CH2M Hill

- Paul Luersen, Senior Planner
- Marc Dexter, Project Manager
- Lisa Kettley, Environmental Planner
- John Padre, Environmental Planner
- Curt Bagnall, Senior Reviewer
- Kathleen Chu, Civil Engineering
- Rebecca King, Air Quality
- Tom Priestley, Visual Resources
- Michael Stephan, Visual Resources

U.S. Fish and Wildlife Service

- James Kwon, Botanist
- Megan Laut,Biologist
- Jeff Newman, Assistant Field Supervisor
- John Nuss, Division of Endangered Species
- Aaron Nadig,Waterbird and Wetlands Biologist

Hawaiʻi Division of Forestry and Wildlife

- Scott Fretz, Wildlife Program Manager
- Sandee Hufana,Conservation Initiative Coordinator

CHAPTER 6: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS CONTACTED

This list includes agencies, organizations, and persons contact during preparation of the state EISPN, state EIS, Draft HCP, and EA, as well as agencies, organizations, and persons on the state EISPN distribution list.

Federal Agencies
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (EPA)
- National Marine Fisheries Service (NMFS)
- U.S. Army Corps of Engineers (USACE)
- U.S. Federal Aviation Administration (FAA)
- U.S. Geological Survey (USGS)

State Agencies
- Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW)
- Department of Land and Natural Resources (DLNR), Historic Preservation Division (SHPD)
- Department of Land and Natural Resources (DLNR), Land Division
- Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL)
- Department of Land and Natural Resources (DLNR), Division of Conservation and Resource Enforcement
- Commission on Water Resource Management (CWRM)
- Department of Defense (DoD)
- Department of Hawaiian Homelands (DHHL)
- Hawaii State Civil Defense
- Office of Environmental Quality Control (OEQC)
- Office of Hawaiian Affairs (OHA)
- Department of Accounting and General Services
- Department of Agriculture (DOA)
- Department of Transportation (DOT)
- Department of Health (DOH), Environmental Planning Office
- Department of Health (DOH), Environmental Health Service Division (EHSD)
- Department of Business, Economic Development and Tourism (DBEDT), Office of Planning
- Department of Business, Economic Development and Tourism (DBEDT), Energy Resources, and Technology Division
- University of Hawai‘i Environmental Center

County Agencies
- Department of Planning and Permitting (DPP)
- Department of Public Works
- Department of Environmental Management
- Department of Water Supply (DWS)
- Department of Parks and Recreation
- Department of Transportation Services
- Department of Fire Control
- Police Department

Organizations
- Hawaiian Electric Company, Inc. (HECO)
- Honolulu Advertiser
- Honolulu Star-Bulletin

CHAPTER 7: LITERATURE CITED

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APPENDIX A: Archaeological Inventory Survey of the Kawailoa Wind Farm Project Area

RC-0660

Archaeological Inventory Survey of the Kawailoa Wind Farm Project Area

(TMKs: 1-6-1-05:001, 003, 007, 014, 015, 016, 019, 020, 021, 022; 1-6-1-06:001; 1-6-1-07:001; 1-6-1-08:025; 1-6-2-02:001, 002, 025; 1-6-2-09:001; and 1-6-2-11:001)

Kawailoa Ahupua'a
Waialua District
Island of O'ahu

DRAFT VERSION

PREPARED BY:

Robert B. Rechtman, Ph.D.,
Matthew R. Clark, B.A.,
and
Johannes H. N. Loubser, Ph.D.

PREPARED FOR:

CH2M Hill, Inc
1132 Bishop Street, Suite 1100
Honolulu, HI 96813

May 2011

RECHTMAN CONSULTING, LLC
507-A E. Lanikaula St. Hilo, Hawaii 96720
phone: (808) 969-6066 fax: (808) 443-0065
e-mail: bob@rechtmanconsulting.com
ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL STUDIES

Archaeological Inventory Survey of the Kawailoa Wind Farm Project Area

(TMKs: 1-6-1-05:001, 003, 007, 014, 015, 016, 019, 020, 021, 022; 1-6-1-06:001; 1-6-1-07:001; 1-6-1-08:025; 1-6-2-02:001, 002, 025; 1-6-2-09:001; and 1-6-2-11:001)

Kawailoa Ahupuaʻa
Waialua District
Island of Oʻahu

Rechtman Consulting

EXECUTIVE SUMMARY

At the request of CH2M Hill, Inc. Rechtman Consulting, LLC has prepared this archaeological inventory survey for the proposed development of a wind power generation facility (Kawailoa Wind Farm Project) within portions of TMKs: 1-6-1-05:001, 003, 007, 014, 015, 016, 019, 020, 021, 022; 1-6-1-06:001; 1-6-1-07:001; 1-6-1-08:025; 1-6-2-02:001, 002, 025; 1-6-2-09:001; and 1-6-2-11:001) in Kawailoa Ahupuaʻa, Waialua District, Island of Oʻahu. The proposed wind power generating facility will occupy land that is owned by Kamehameha Schools and leased to First Wind for the specific purpose of the development of alternative energy. This land has for decades been used for agricultural and grazing purpose and already has much of the needed baseline infrastructure (i.e., roads and HECO subtransmission lines) in place. The wind power project requires microwave communication connectivity with the HECO power grid, thus existing off-site facilities on Mount Kaʻala were also examined as the location for the placement of microwave dishes and repeater antennae. CH2M Hill, Inc. is preparing an Environmental Impact Statement for the proposed development and the current report is intended to accompany the environmental documentation in compliance with Chapter 343 HRS, as well as fulfilling the requirements of the City and County of Honolulu Planning Department and the Department of Land and Natural Resources with respect to permit approvals for land-altering and development activities. The current study was undertaken in accordance with the Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports as contained in Hawaiʻi Administrative Rules 13§13-284.

Located northeast of Haleʻiwa Town and *mauka* of Kamehameha Highway (Hwy 83), the current study area includes a series of tableland formations arranged in two separate arrays (Western Tableland Array and Eastern Tableland Array) on which the proposed wind turbine towers and appurtenant facilities will be constructed. A new overhead electrical collector line will connect the Eastern and Western Tableland Arrays (Overhead Collector Line Corridor). For construction, operation, and maintenance purposes these tableland locations will be accessed using four existing plantation roads that may need to be improved to support the construction activities. Existing cane field roads will also be used to access a *makai* interconnection facility located in a former sugarcane field (Makai Interconnection Facility Corridor). Given the potential need to improve these roads, the current project area not only includes the tableland formations but also corridors along each roadway extending 20 feet on either side of the roadway. The only wind farm associated development (actually demolition) activities planned for any portions of the involved parcels outside of the defined project area might involve the dismantling of currently abandoned overhead electrical infrastructure. Any such activity will be subject to archaeological monitoring.

The fieldwork for the current project was carried out during two major sessions–between April 12 and May 14, 2010, and between February 15 and February 25, 2011; with follow-up field days on March 30, 2011, April 14, 2011, and April 27, 2011. The field effort was supervised by Robert Rechtman, Ph.D., directed by Johannes Loubser, Ph.D. and Matthew Clark, B.A., and the field crew included Ashton Dircks Ah Sam, B.A., Owen Moore, M.A., Morgan Schmidt, Ph.D., and Mark Winburn, B.A. During the first fieldwork session the areas studied included the Eastern Tableland Array, the Kawailoa Road Corridor, the southern end of the Cane Haul Road Corridor, and the Ashley Road Corridor. The second session of fieldwork focused on the Western Tableland Array, the Mid-Line Road Corridor, and the bulk of Cane Haul Road Corridor. Follow-up fieldwork days were spent surveying the Makai Interconnection Facility Corridor and the Overhead Collector Line Corridor. An estimated total of 1088 labor hours were expended in the field.

As a result of the current study, seventeen archaeological sites were identified within the study area. All of these sites date from the Historic Period and were likely associated with either former military operations (Site 7155, 7156, 7158), or former plantation activities (Sites 7157, 7159, 7160, 7161, 7162, 7163, 7164, 7165, 7166, 7167, 7168, 7169, 7170, 7171). No subsurface testing was deemed necessary at any of these sites to assess age and function. In addition to the sites identified within the study area, six previously identified archaeological sites and nineteen newly identified sites were inspected during the current study nearby, but outside of, the study area. These sites represent both Precontact and Historic use of the general study area.

Sites 7155, 7156, and 7158 are likely interrelated elements associated with a WWII (or slightly older) military communication and fire control network that was established as a warning and response system in the event of a foreign invasion. Although the integrity of the overall system no longer exists, the locational and contextual integrity of these elements are intact, and as such these sites are considered significant under Criteria A and D. Sites 7157, 7159, 7160, 7161, 7162, 7163, 7164, 7165, 7166, 7167, 7168, 7169, 7170, and 7171, although either non-functional (7161, 7162, 7164, 7169, 7171) partly functional (7157, 7159, 7170) or fully functional (7160, 7163, 7165, 7166, 7167, 7168), do retain sufficient integrity to be considered significant under Criterion D for the historical information they have yielded relative to the development of the plantation industry on the north shore of O‘ahu.

It is suggested however, that a reasonable and adequate amount of information has been collected from and about all of these sites as a result of the current study to warrant a no further work recommendation; and thus, a no historic properties affecting determination for these sites with respect to the proposed Kawailoa Wind Power project. It is further recommended that a program of archaeological monitoring be maintained during the construction activities associated with the Kawailoa Wind Power project. Such a program will help to ensure that any inadvertently discovered resources would receive immediate attention and protection, while their ultimate disposition is being determined by DLNR-SHPD. A monitoring plan in compliance with HAR 13§13-279 should be prepared and submitted to DLNR-SHPD for review and approval.

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FIGURES

TABLES

INTRODUCTION

At the request of CH2M Hill, Inc. Rechtman Consulting, LLC has prepared this archaeological inventory survey for the proposed development of a wind power generation facility (Kawailoa Wind Farm Project) within portions of TMKs: 1-6-1-05:001, 003, 007, 014, 015, 016, 019, 020, 021, 022; 1-6-1-06:001; 1-6-1-07:001; 1-6-1-08:025; 1-6-2-02:001, 002, 025; 1-6-2-09:001; and 1-6-2-11:001) in Kawailoa Ahupua‘a, Waialua District, Island of O‘ahu (Figures 1 and 2). The proposed wind power generating facility will occupy land that is owned by Kamehameha Schools and leased to First Wind for the specific purpose of the development of alternative energy. This land has for decades been used for agricultural and grazing purposes and already has much of the needed baseline infrastructure (i.e., roads and HECO subtransmission lines) in place. The wind power project requires microwave communication connectivity with the HECO power grid, thus existing off-site facilities on Mount Ka‘ala were also examined as the location for the placement of microwave dishes and repeater antennae (Appendix A). CH2M Hill, Inc. is preparing an Environmental Impact Statement (EIS) for the proposed development and the current report is intended to accompany the environmental documentation in compliance with Chapter 343 HRS, as well as fulfilling the requirements of the City and County of Honolulu Planning Department and the Department of Land and Natural Resources with respect to permit approvals for land-altering and development activities. The current study was undertaken in accordance with the Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports as contained in Hawai‘i Administrative Rules 13§13-284.

An appropriate study area was discussed and agreed upon with DLNR-SHPD Archaeologist Michael Vitousek and Historian Ross Stephenson prior to the completion of this report. It was agreed that for the purposes of a Chapter 6E archaeological study only the areas of direct impact would be surveyed for archaeological sites, and that existing archival information combined with any new oral information (obtained during the Cultural Impact Assessment being prepared for the current project) would be used to identify potential archaeological resources nearby, but outside of, the actual development area. It was also agreed that any future Section 106 compliance (to be undertaken as part of the USFW habitat conservation planning) would also have to take into consideration an Area of Potential Effects (APE) that would include visual impacts (currently discussed in the Chapter 343 EIS being prepared for the current project) to potential historic properties that are situated distant from the current project area.

This report contains a physical description of the project area, a discussion of the regional culture-historical context, and a presentation of prior archaeological studies. This background information is used to develop a set of archaeological expectations for the study area as well as provide the contextual information with which to assess the significance of historic properties identified within the project area.

PROJECT AREA DESCRIPTION

Located northeast of Hale‘iwa Town and *mauka* of Kamehameha Highway (Hwy 83), the current study area (see Figures 1 and 2) includes a series of tableland formations arranged in two separate arrays (Western Tableland Array and Eastern Tableland Array) on which the proposed wind turbine towers and appurtenant facilities will be constructed. A new overhead electrical collector line will connect the Eastern and Western Tableland Arrays (Overhead Collector Line Corridor). For construction, operation, and maintenance purposes these tableland locations will be accessed using four existing plantation roads (Kawailoa Road, Mid-Line Road, Ashley Road, and Cane Haul Road) portions of which may need to be improved (widened and reinforced) to support the construction activities. Existing cane field roads will also be used (widened and improved) to access a *makai* interconnection facility located in a former sugarcane field inland and south of Ashley Road (Makai Interconnection Facility Corridor). Given the potential need to improve these roads, the current project area not only includes the tableland formations but also corridors along each roadway extending 20 feet on either side of the roadway. The only wind farm associated development (actually demolition) activities planned for any portions of the involved parcels outside of the defined study area might involve the dismantling of currently abandoned overhead electrical infrastructure. Any such activity will be subject to archaeological monitoring. For the purposes of this report “study area” is defined as that area that was subject to inventory survey (roughly 350 acres), which is distinct from terms used in the EIS that refer to the development area as the area of maximum potential disturbance associated with the construction of the wind farm project (roughly 335 acres), and the final project footprint (roughly 21 acres) that the wind turbines and appurtenant facilities will eventually occupy.

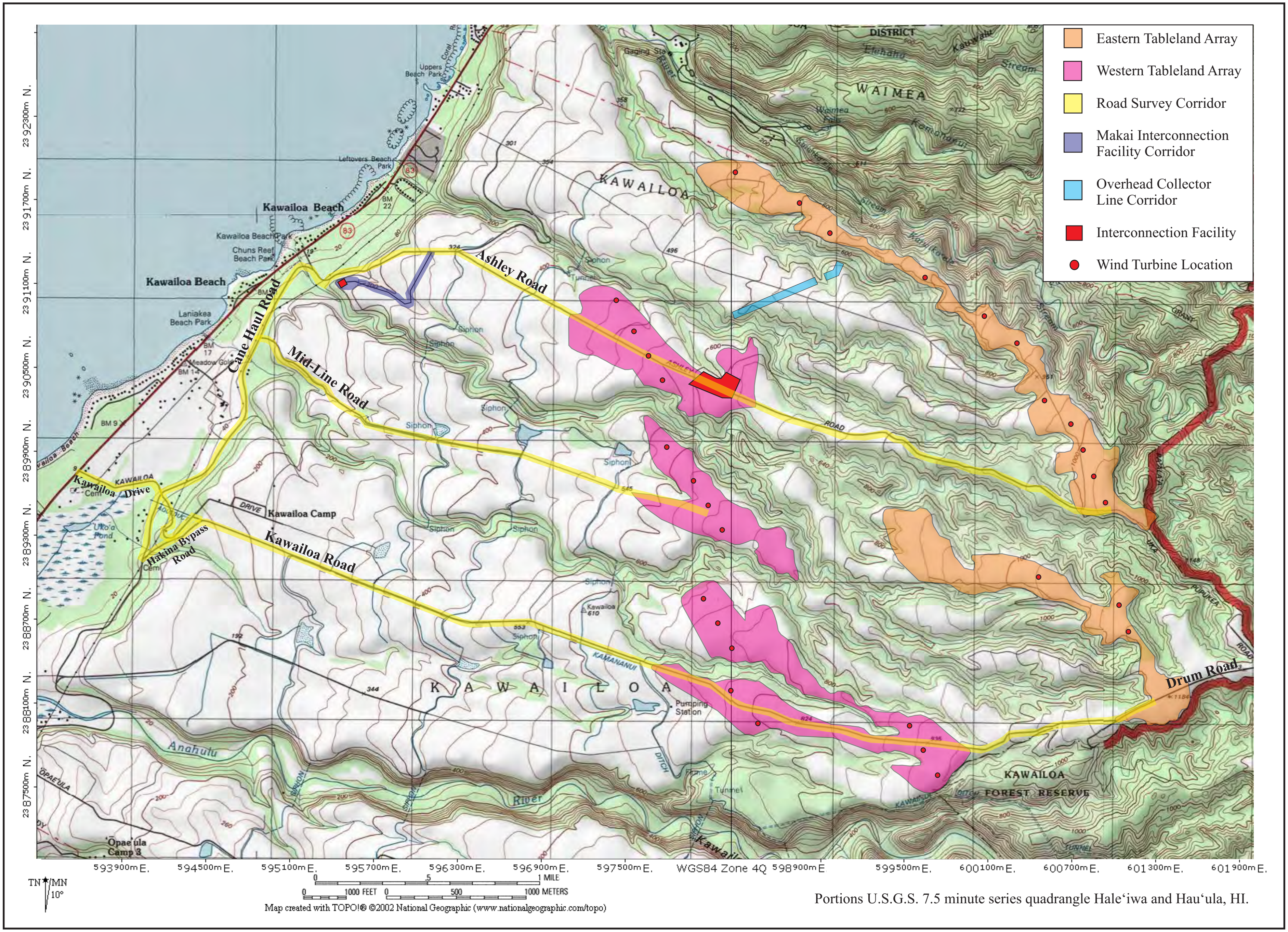

Figure 1. Study area location.

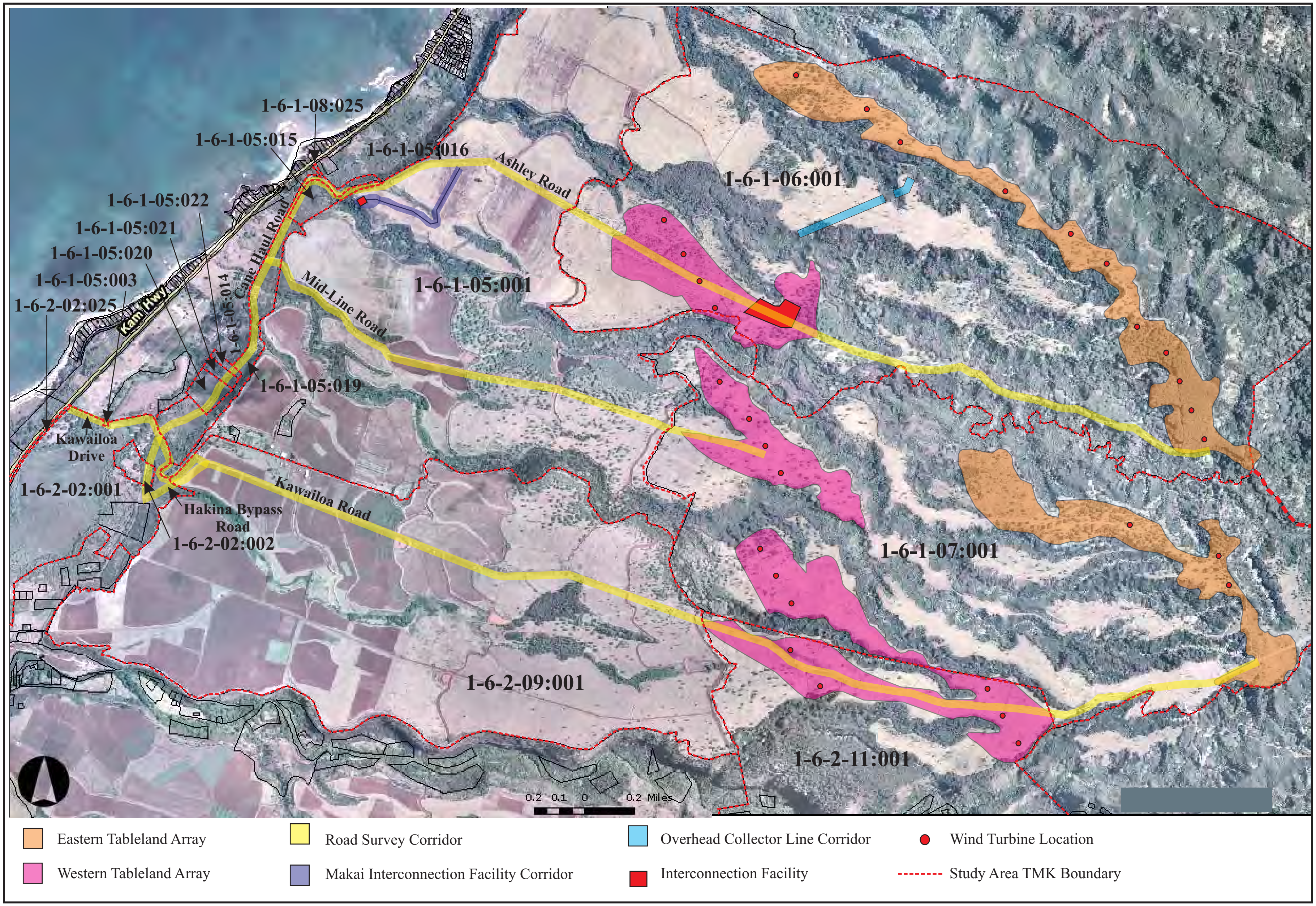

Figure 2. Tax Map parcels and study area.

RC-0660

Natural Environment

The project area is located within the coastal lowlands of the *ahupua'a* of Kawailoa in the District of Waialua on the northwest shore of the Island of O'ahu. It is situated along the western edge of the Ko'olau Mountains at the shoreward end of a saddle-like plateau that stretches west to the Wai'anae Mountains (Figure 3). The Wai'anae Mountains are slightly younger than the Ko'olau Mountains, which were formed by the Ko'olau volcanic series roughly 2.2 million years ago (Stearns and Vaksvik 1935). This area receives a median annual rainfall of approximately 1,000 millimeters, mostly falling during the winter months (Foote et al. 1972), and it has an annual temperature range of 65 to 85 degrees Fahrenheit. Elevation within the project area varies from 20 feet above sea level near the coast to 1,200 feet above sea level at the upper ends of the tableland arrays.

At the coast Kawailoa Ahupua'a has a flat littoral plain fronted by coral reefs and a long narrow sandy beach interspersed with rocky outcrops. The plain is widest at the southern end of the *ahupua'a*, but quickly narrows to the north as it approaches Waimea Bay. Inland of Kamehameha Highway brackish ponds and swampy areas are present on the plain between the project area and Hale'iwa Town. The largest pond, 'Uko'a Pond, is situated below the project area just south of the Kawailoa Drive access road. Inland of 'Uko'a Pond a low, but steep, escarpment rises above the littoral plain. The escarpment increases in height as it progresses northwards and the littoral plain narrows, becoming a coastal cliff by the time it reaches Waimea Bay. Inland of the escarpment Kawailoa Ahupua'a gives way to dissected tablelands that rise gently toward the Ko'olau mountain range. The tablelands are flat lands separated from one another by deeply eroded gulches and valleys that were formed by rivers and streams flowing to the ocean. The current project area lies between Kaiwiko'ele Stream (to the east) and Anahulu River (to the west) (see Figure 3). Several smaller drainages, with intermittently flowing streams that parallel the permanently flowing streams, dissect the project area, generally running in a northwesterly/southeasterly direction (Figure 3).

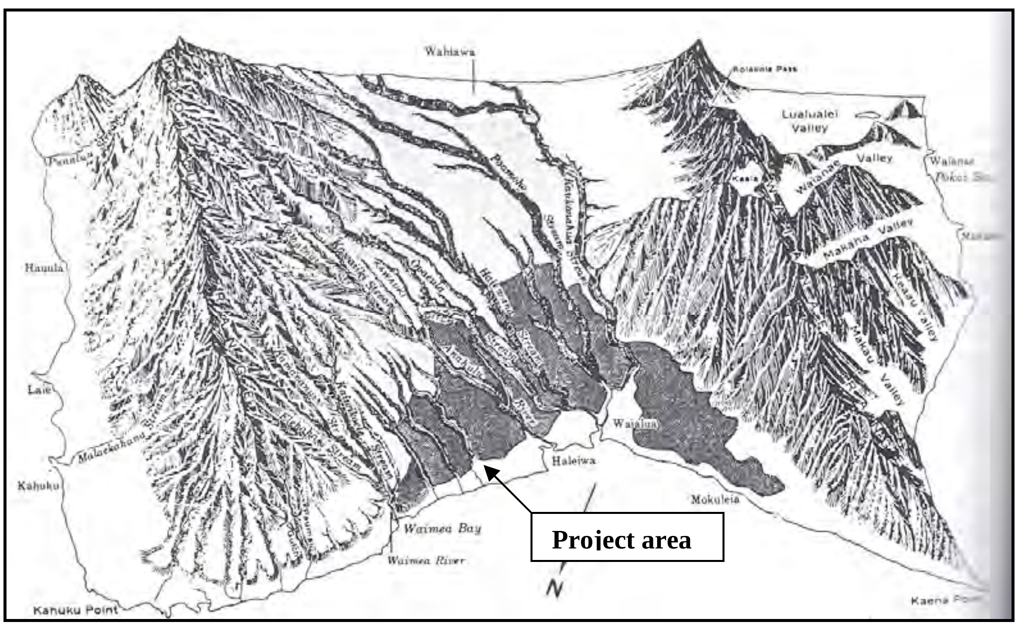

Figure 3. Oblique view of Waialua District (from Kirch 1992:6).

Most of the tablelands consist of deep and well-drained, but acidic, red soils with fine-textured subsoil (Foote et al. 1972). These silty clays are a product of weathered igneous bedrock. Within the current project area silty clays of the Paaloa (PaC) and Leileihua Series (LeB, LeC) occur in the broad upper reaches of the tablelands, while the middle elevations are dominated by of the Wahiawa silty clays (WaB, WaC), and the lower elevations are comprised, above the coastal escarpment, primarily of Lahaina silty clays (LaB, LaC) and, on the littoral plain, of Waialua silty clay (WkA, WkB), Ewa stony slity clay (EwC), and Waialua stony silty clay (WlB). The steep sided gulches adjacent to the survey areas contain predominantly rough mountainous land (rRT) and Helemano silty clay on 30 to 90 percent slopes (HLMG) (Foote et al. 1972).

Vegetation across the project area consists primarily of a thick growth of Guinea grass (*Panicum maximum*) and Albizia trees (*Acacia lebbek*) interspersed with *koa-haole* (*Leucaena glauca*), Christmas-berry (*Schinus teribinthifolius*), guava (*Psidium guajava*), *waiawī* (*Psidium cattleianum*), stands of ironwood trees (*Casuarina equisetifolia*), and various other non-native shrubs, vines, ferns, and grasses. The perennial Guinea grass (*Panicum maximum*), which covers virtually all of the former sugarcane lands within the study area, was introduced from Africa to counteract erosion. Dense tussocks of this grass conceal the ground surface, and in some areas stand as tall as ten feet. Large Indian Banyan trees (*Ficus benghalensis*) can be found growing against cliff faces in the lower and *makai* portion of the project area as well as on the steeper slopes that border the higher *mauka* tablelands. Also, Kamehameha Schools has re-introduced *koa* trees (*Acacia koa*) in certain sections of the tablelands. These endemic trees, traditionally used for a variety of purposes, including canoe production, are gradually spreading and appear to be thriving. Other endemic plants observed during the field study included *‘ōhia*, *ki*, *alahe‘e*, *pukeawe*, *kukui*, *‘iliahi*, *ulu‘he*, and *hapu‘u*. These plants are mostly confined to isolated areas along the upper edges of the deep gullies and valleys that dissect the tablelands. The predominant vegetation within the gulches is *waiawī* (*Psidium cattleianum*).

Built Environment

Traditionally, in the general vicinity of the project area, Hawaiians lived, practiced aquaculture, and cultivated taro, bananas, and sugarcane on the more *makai* lands, and gathered forest resources from the more *mauka* lands. Historically, the project area was converted into vast plantations of sugarcane and pineapple. Most recently, modern and historic period alteration of the landscape for continued agricultural use has virtually obliterated all material traces left by both traditional Hawaiian and early historical modification and use of the project area lands. Only the gulch areas were left relatively untouched by this last period of mechanized agriculture.

The current project area environment is largely a result of more than a century of use as sugarcane and pineapple fields. The sugar and pineapple companies modified and utilized most of the land within the APE, clearing original vegetation, leveling original landforms, digging ditches, constructing reservoirs, and building roads and railroads. Substantial amounts of foreign laborers (mostly Chinese, Filipino, and Japanese) were imported to work the fields, and labor camps dotted the landscape. The 1929 U.S.G.S. quadrangle maps for Hale‘iwa and Kaipapau (Figure 4) show irrigation ditches, emptying into reservoirs, following contours at roughly every 100-foot change in elevation; railroad tracks running across the plantation lands; numerous roads traversing the length of the tablelands, bounding field edges, and crossing gulches; and workers' camps scattered throughout. A review of aerial photographs taken on June 4, 1951 (Figure 5), December 4, 1962 (Figure 6), February 9, 1977 (Figure 7), and September 22, 1993 (Figure 8) shows the former extent of the plantation fields and how they developed over time. Virtually all of the project area tablelands were formerly cultivated in either sugarcane or pineapple. An undated map of the Waialua Sugar Company fields shows the field numbers that the current project area corresponds to (Figure 9). The eastern fields are within the Waimea section of the plantation, and the western fields are within the Kaiwailoa section of the plantation. When the Waialua Sugar Company closed its doors in 1998 the lands were reclaimed by Kamehameha Schools. As shown in an aerial photograph taken on June 11, 2000 (Figure 10) most of the upper tableland areas (above the 400 foot contour) were allowed to go fallow, although Kamehameha Schools did plant *koa* trees in some areas.

Portions of the project area below the 400-foot elevation contour are currently farmed (Figure 11). These lands are leased to individuals by Kamehameha Schools for diversified agricultural purposes. Crops grown on the leased lands include corn, lettuce, asparagus, plumeria, banana, tuberose, taro, and *noni*. An irrigation system consisting of a series of interconnected ditches, flumes, and reservoirs that was originally created by the Waialua Agricultural Company to water the sugarcane fields (see Figure 4) has been maintained in the vicinity of the current project area, and it continues to supply water to the diversified agricultural fields. Above the 400-foot contour, the project area tablelands are all former fields that currently lie fallow. These lands were extensively modified during the twentieth century to accommodate agricultural use. Many of the gulch edges are lined with push piles created by bulldozers during field clearing activities, and old roads follow nearly all of the gulch edges and cross the tablelands at field boundaries. At the time of the current inventory survey fieldwork extensive fencing (with associated land altering activities) was being placed within the *mauka* sections of the study area along road and gulch edges as part of a Kamehameha Schools cattle lease.

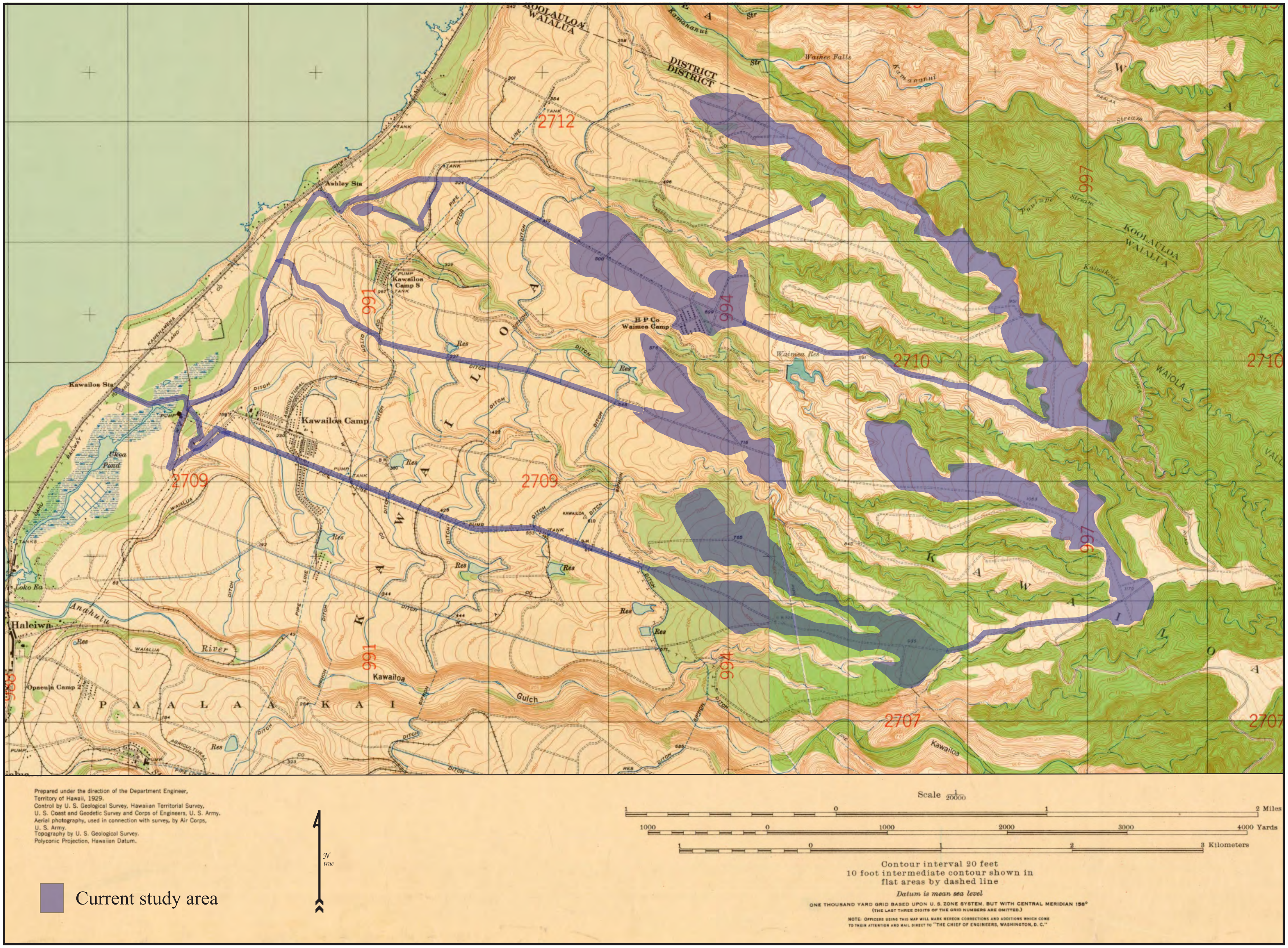

Figure 4. Portion of 1929 U.S.G.S. Hale‘iwa (and Kaipapau) quadrangle showing the current study area.

Figure 5. Oblique aerial photograph of a portion of the study area taken on June 4, 1951.

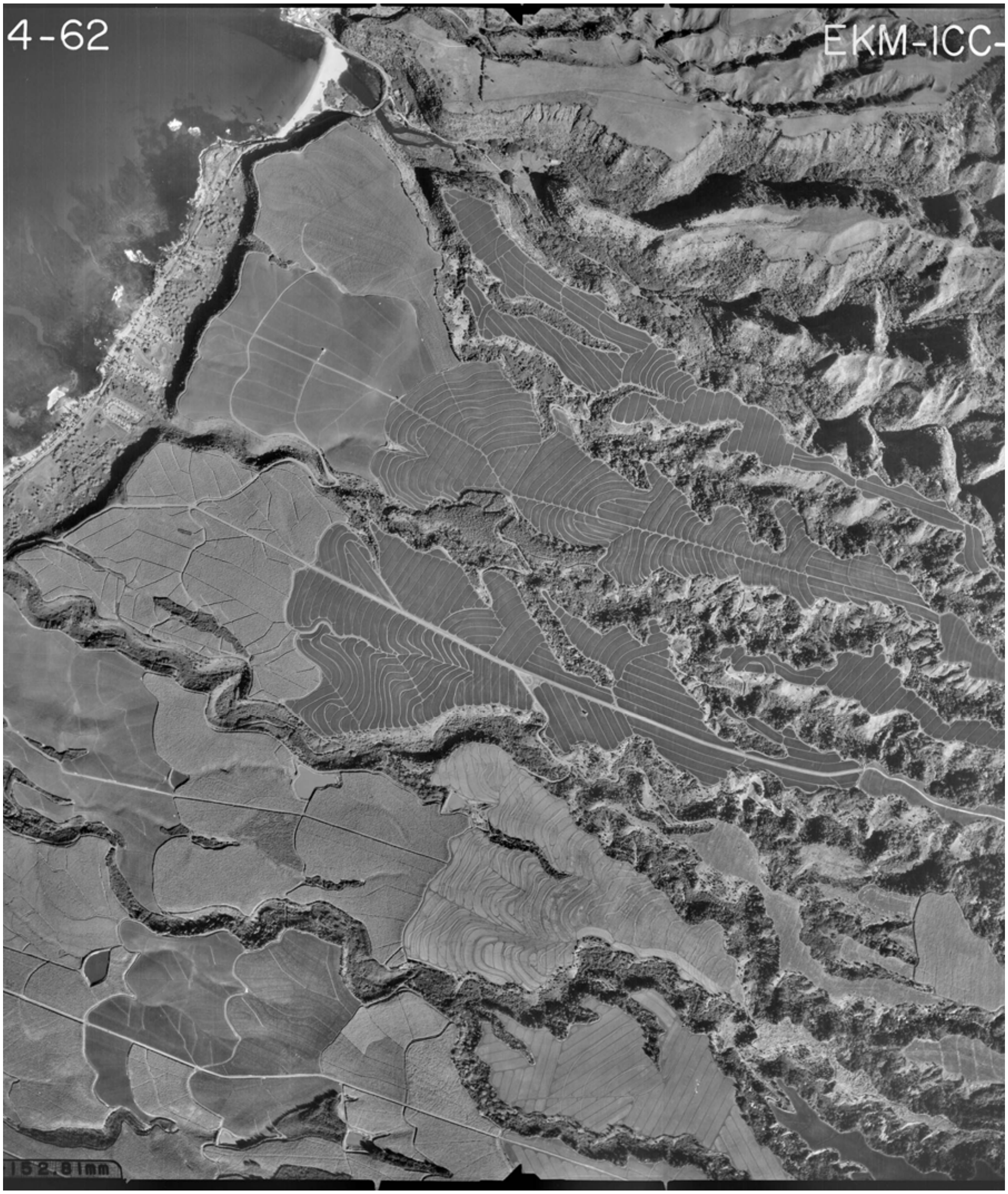

Figure 6. Aerial photograph of a portion of the study area taken on December 4, 1962.

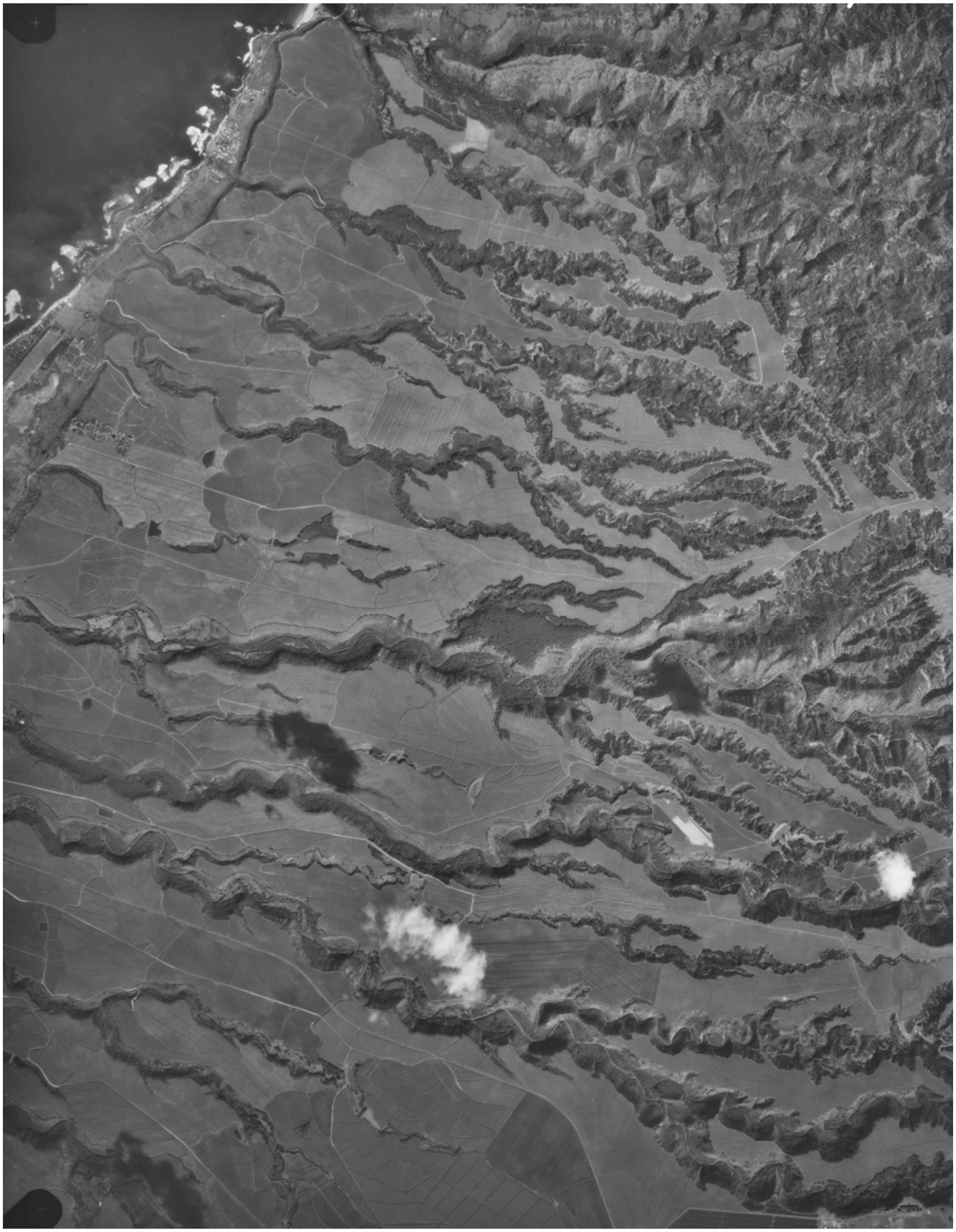
Figure 7. Aerial photograph of a portion of the study area taken on February 9, 1977.

Figure 8. Aerial photograph of a portion of the study area taken on September 22, 1993.

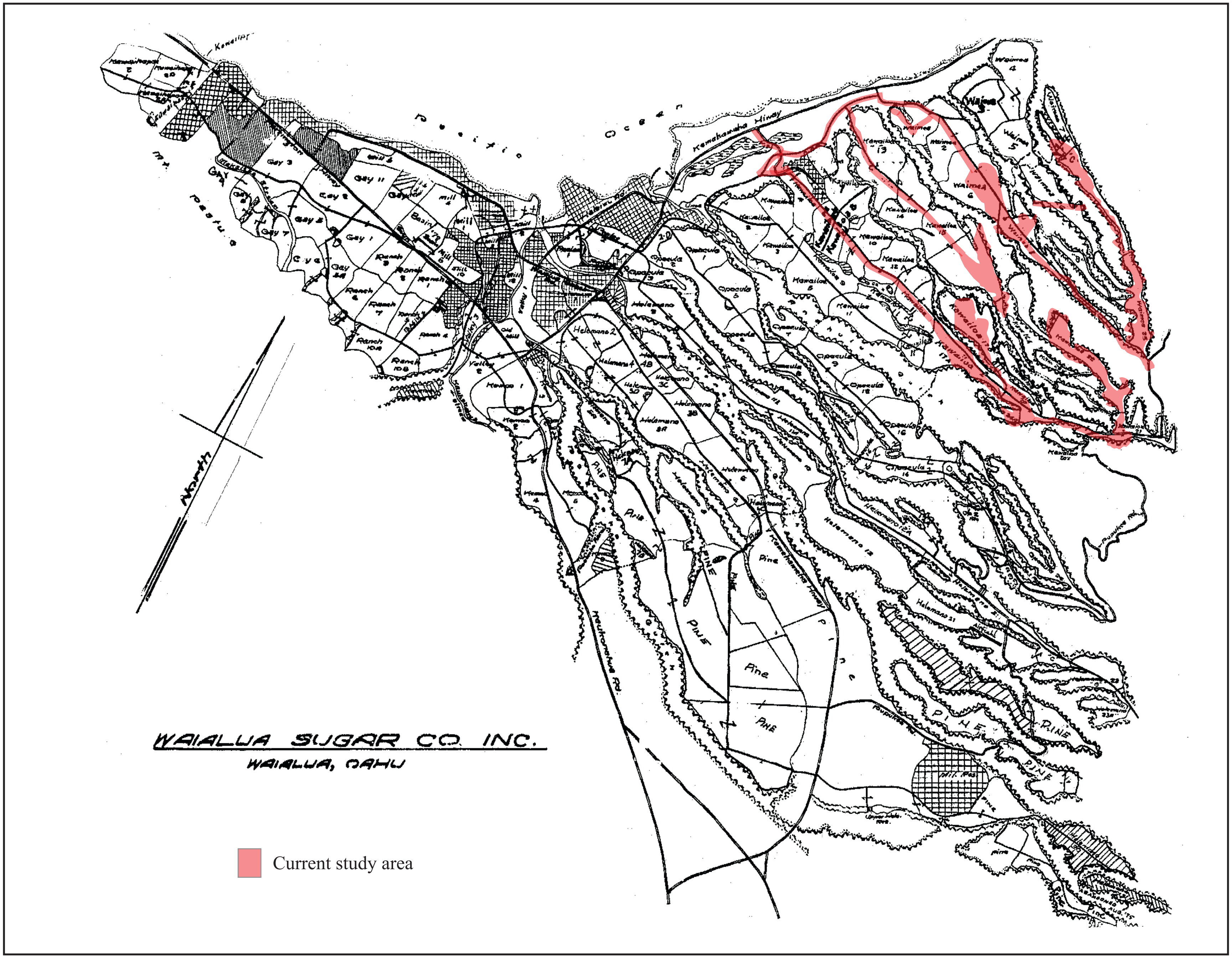

Figure 9. Undated map of the Waialua Sugar Company's fields showing the current study area.

Figure 10. Aerial photograph of a portion of the study area taken on June 11, 2000.

Figure 11. Current aerial view of the project area (from Google earth).

Survey Areas

Given the geomorphology of the project area, the history of past land use, and the proposed scope of the wind farm development an appropriate study area was selected for the current archaeological project with input from DLNR-SHPD. This area, which includes four access road corridors, a *makai* interconnection facility and access road, the tableland arrays, and a new overhead collector line between them, includes portions of TMKs: 1-6-1-05:001, 003, 007, 014, 015, 016, 019, 020, 021, 022; 1-6-1-06:001; 1-6-1-07:001; 1-6-1-08:025; 1-6-2-02:001, 002, 025; 1-6-2-09:001; and 1-6-2-11:001. No development activities will take place outside of the study area. For the purposes of the inventory survey the study area was divided into eight survey areas (Western Tableland Array, Eastern Tableland Array, Kawailoa Road Corridor, Cane-Haul Road Corridor, Mid-Line Road Corridor, Ashley Road Corridor, Makai Interconnection Facility Corridor, and Overhead Collector Line Corridor; see Figures 1 and 2). The Eastern and Western Tableland Array survey areas (and their associated infrastructure) include only the flat tablelands and not the steep sided gulches that they border. All of the proposed tower locations within the tableland arrays were marked in the field with lathe and flagging tape at the time of the inventory survey fieldwork. The roadway study corridors include only the roadway surfaces and an additional 20 feet on either side of the existing road surface. Drum Road, which marks the eastern extent of the current project area and extends for 17 miles through the Kawailoa Training Area between the Halemano Military Reservation and the Kahuku Training Area, has been recently improved by the U.S. Army and is nicely paved. A small section of this road is included in the Western Tableland Array and the Kawailoa Road Corridor survey areas, but no further improvements to the road will be undertaken as part of the wind farm development. Each of the study area survey corridors is discussed below.

The Western Tableland Array consists of three distinct survey areas that are slated for the proposed development of sixteen wind turbines, an O & M (office and maintenance) building, a *mauka* point of interconnection and associated infrastructure (see Figure 1). The proposed array of turbines runs in a northwesterly line from Drum Road at an elevation of roughly 1,000 feet above sea level to a point northwest of Ashley Road at an elevation of roughly 500 feet above sea level. The Western Tableland Array crosses TMKs:1-6-2-11:001, 1-6-1-07:001, and 1-6-1-06:001 (see Figure 2). The survey areas correspond to the former Waialua Sugar Company's fields Kawailoa-15, 17a, 17b, 20, 24a, and Waiamea-6 and 8 (see Figure 9). The proposed O & M building and *mauka* point of interconnection are located near the former Hawaiian Pineapple Company's (H. P. Co.) Waimea Camp (see Figure 4). The tablelands that contain the survey areas are separated from one another by steep sided gulches that do not permit interconnected access. The southeastern most survey area is accessed by Kawailoa Road, the central survey area is accessed by Mid-Line Road, and the northwestern survey area that includes the O & M building and *mauka* point of interconnection is accessed by Ashley Road. All of the survey areas in the Western Tableland Array contain a thick growth of Guinea grass (*Panicum maximum*) interspersed with albizia trees (*Acacia lebbek*) and other less frequently occurring species of trees, shrubs, vines, ferns, and grasses (Figures 12, 13, 14, and 15).

The Eastern Tableland Array consists of two distinct survey areas that are slated for the proposed development of fourteen wind turbines (see Figures 1 and 2). The two survey areas are separated from one another by a deep, unnamed gulch that does not permit interconnected access. The southeastern most survey area of the Eastern Tableland Array runs northwest across TMK:1-6-1-07:001 from the edge of Anahulu Gulch near Drum Road at an elevation of roughly 1,200 feet above sea level to a point along the edge of the unnamed gulch at an elevation of roughly 800 feet above sea level. This survey area, which corresponds to the former Waialua Sugar Company's fields Kawailoa-21 and 22 (see Figure 9), contains three proposed turbine locations. It is accessed via Kawailoa Road. The northwestern survey area of the Eastern Tableland Array runs northwest across TMK:1-6-1-06:001 following a narrow tableland formation between the unnamed gulch and southwestern edge of the Kaiwikoʻele Stream Gulch from an elevation of roughly 1,000 feet above sea level to an elevation of roughly 400 feet above sea level. This survey area, which contains fourteen proposed wind turbine locations, corresponds to the former Waialua Sugar Company's fields Waimea-7 and 25 (see Figure 9). It is accessed by Ashley Road. Both survey areas in the Eastern Tableland Array contain a thick growth of Guinea grass (*Panicum maximum*) interspersed with albizia trees (*Acacia lebbek*) and other less frequently occurring species of trees, shrubs, vines, ferns, and grasses (Figures 16 and 17).

Figure 12. Southeastern survey area of the Western Tableland Array, view to the northwest from Kawailoa Road.

Figure 13. Southeastern survey area of the Western Tableland Array, view to the south from Kawailoa Road.

Figure 14. Central survey area of the Western Tableland Array, view to the southwest from the *makai* most tower location.

Figure 15. Northwestern survey area of the Western Tableland Array, view to the north from Ashley Road.


Figure 16. Southeastern survey area of the Eastern Tableland Array, view to the northwest.


Figure 17. Northwestern survey area of the Eastern Tableland Array, view to the northwest.

The Kawailoa Road Corridor, which will be used to access the southeastern portion of both the Eastern and Western Tableland Arrays, follows an existing paved/gravel roadway from Kamehameha Highway (Hwy 83) to Drum Road (see Figures 1 and 2). Two alternate routes, following existing roads (Alternatives 1 and 2), were surveyed for the portion of the Kawailoa Road Corridor that traverses the steep escarpment (*pali*) inland of ‘Uko‘a Pond. Both routes begin at Kawailoa Drive, a nicely paved road that runs east (*mauka*) from Kamehameha Highway along the northern edge of TMK:1-6-1-02:001, across TMK:1-6-1-05:003, past the Kawailoa Waste Transfer Station (TMK:1-6-1-05:018), to an intersection with Cane Haul Road where a gate blocks public access. This portion of the Kawailoa Road Corridor, between the highway and the gate, will not be improved. From the gate the Alternative 1 survey area follows Kawailoa Drive and the Alternative-2 survey area follows Cane Haul Road. Kawailoa Drive (Alternative-1) continues southeast along the northern edge of TMK:1-6-1-02:001 and then makes a sharp horseshoe turn to the south as it traverses the *pali* and continues up slope to connect with the bottom of Kawailoa Road on TMK:1-6-2-09:001. Cane-Haul Road (Alternative-2) crosses Kawailoa Drive (see Cane-Haul Road Corridor description below) and runs south across TMKs:1-6-1-02:001 and 002 before turning northeast onto Hakina Bypass Road (Figure 18) near the boundary of TMK:1-6-1-02:003 and continuing up the *pali* formation to join with Kawailoa Road on TMK:1-6-2-09:001, slightly *mauka* of the Kawailoa Drive (Alternative-1) intersection. Both options then follow Kawailoa Road as it runs east in a relatively straight line across TMKs:1-6-2-09:001, 1-6-2-11:001, and 1-6-1-07:001. A gate is present across Kawailoa Road at an elevation of roughly 650 feet above sea level. Kawailoa Road accesses the southeastern survey area of the Western Tableland Array, and continues on to the southeastern survey area of the Eastern Tableland Array off Drum Road at an elevation of roughly 1,200 feet above sea level. The Kawailoa Road Corridor passes through the former Waialua Sugar Company’s fields Kawailoa-4, 6, 7, 9, 10, 12, 17a, and 20 (see Figure 9), and passes through the former Kawailoa Camp (see Figure 4). Vegetation along the edges of Kawailoa Road consists primarily of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and cultivated fields (Figures 19 and 20).

Figure 18. Hakina Bypass Road (Alternative-2 of the Kawailoa Road Corridor), view to the southwest.

Figure 19. Kawailoa Road Corridor, middle section, view to the west.

Figure 20. Kawailoa Road Corridor, *mauka* section, view to the west.

The Cane Haul Road Corridor follows the existing gravel/paved alignment of Cane Haul Road north/south between Hakina Bypass Road (Alternative-2 of the Kawailoa Road Corridor) and Ashley Road (see Figure 1). Cane Haul Road, which will be used by First Wind to access Mid-Line Road and Ashley Road from Kawailoa Drive, runs at the base of the steep coastal escarpment and traverses TMKs:1-6-1-05: 014, 019, 020, 021, and 022 (see Figure 2). It has two gates across it within the current project area; one at Ashley Road, and another on the north side of the intersection with Kawailoa Drive (Figure 21). For most of its length, except at its northern end where it joins Ashley Road, Cane Haul Road follows the alignment of an older Waialua Sugar Company railway (see Figure 4). It is lined on either side, by a wire fence lines, and much of the land on both sides of the road was formerly, or is currently, used as pasture. Recently, a section of land on either side of Cane Haul Road (corresponding to TMKs:1-6-1-05:020, 021, and 022 located north of the Kawailoa Road intersection) has been grubbed and graded and lined with walls of stacked boulders to create lots for residential development (Figure 22). With the exception of the recently developed area, vegetation along the edges of Cane Haul Road consists primarily of Guinea grass (*Panicum maximum*) and *koa-haole* (*Leucaena glauca*).

The Mid-Line Road Corridor, which will be used by First Wind to access four turbine locations of the Western Tableland Array, follows the existing gravel/paved alignment of Mid-Line Road (Figure 23) from Cane Haul Road to the middle survey area of the Western Tableland Array at an elevation of roughly 680 feet above sea level (see Figure 1). Mid-Line Road runs in a relatively straight line across portions of TMKs:1-6-1-05:001, 019 and 1-6-1-07:001 (see Figure 2), and it crosses the former Waialua Sugar Company's fields Kawailoa-13,14, and 15 (see Figure 9). Only the western (*makai*) portion of this roadway (below the 440-foot contour), which passes through cultivated agricultural fields and feeds into a cross-road, is currently drivable. Above that elevation Mid-Line Road is completely overgrown and not drivable. Between the 440-foot contour and the 540-foot contour, which is marked by a drivable crossroad, the former road bed is lined by an earthen bank along its southern edge and a series of old power poles that follow its northern edge (Figure 24). Above the 540-foot contour the former route of Mid-Line Road is barely discernable through the thick growth of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and stands of albizia (*Acacia lebbek*).

Figure 21. Cane-Haul Road Corridor, gate at Kawailoa Drive intersection, view to the south.

Figure 22. Recent residential development along Cane Haul Road, view to the north.

Figure 23. Mid-Line Road Corridor, *makai* section, view to the east.

Figure 24. Mid-Line Road Corridor, view to the west from the crossroad at the 540-foot contour.

The Ashley Road Corridor, which will be used by First Wind to access the northwestern most portions of both the Eastern and Western Tableland Arrays, follows the existing gravel/paved alignment of Ashley Road (Figure 25) from the northern end of Cane Haul Road to the Eastern Tableland Array at an elevation of roughly 1,000 feet above sea level (see Figure 1). Beginning at Kamehameha Highway north of the northern end of Cane Haul Road, Ashley Road runs northeast along the boundaries of TMKs:1-6-1-08:025; 1-6-1-05:015, 016, and 019 as it traverses the steep coastal cliff formation. At the top of the cliff Ashley Road turns east and runs in a relatively straight line across TMKs:1-6-1-05:001 and 1-6-1-06:001 as it crosses the northwestern portion of the Western Tableland Array, accesses the proposed location of the O & M building and *mauka* point of interconnection, and continues on to northwestern portion of the Eastern Tableland Array near Drum Road (see Figure 2). The Ashely Road Corridor runs through the former Waialua Sugar Company's fields Waimea-1, 2, 6, 8 and 25 (see Figure 9), and passes by the location of the former Hawaiian Pineapple Company's (H. P. Co.) Waimea Camp (see Figure 4). Vegetation along the existing roadway consists primarily of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), albizia (*Acacia lebbek*), and a thick growth of non-native vines near its upper reaches.

The Makai Interconnection Facility Corridor consists of a proposed switch building (*makai* point of interconnection) and associated infrastructure located on TMK:1-6-1-05:001 at an elevation of roughly 160 feet above sea level with an access road that leads to it from Ashley Road beginning at an elevation of 280 feet above sea level (see Figures 1 and 2). The entire survey area falls within the former Waialua Sugar Company's field Waimea-1 (see Figure 9), and the access road mostly follows a former field road along the edge of a drainage. The entire area is overgrown with Guinea grass (*Panicum maximum*), but was mowed prior to the fieldwork (Figures 26 and 27).

The Overhead Collector Line Corridor consists of a 50-foot wide corridor that stretches across a tableland formation (at an elevation of roughly 600 feet above sea level) between the gulches bordering the Eastern and Western Tableland Arrays (see Figure 1). Within this corridor poles will placed that will hold an overhead power line connecting the Eastern Tableland Array with the *mauka* point of interconnection. The corridor crosses TMK:1-6-1-06:001 (see Figure 2) and passes through the former Waialua Sugar Company's field Waimea-26 (see Figure 9). Aerial photographs indicate that this area was cultivated in pineapple during the second half of the twentieth century. Currently vegetation consists of a thick growth of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and stands of albizia (*Acacia lebbek*).

Figure 25. Ashley Road Corridor, middle section, view to the west.

Figure 26. Makai Interconnection Facility Corridor at Ashley Road, view to the southwest.

Figure 27. Location of the *makai* interconnection facility, view to the southwest.

BACKGROUND

Whereas at least the deeply dissected and flat-bottomed Waimea River valley to the north and the Anahulu River valley to the south contain intact remnants of Prehistoric and Historic Period Hawaiian occupation and use, the archaeological integrity of the interceding tablelands and the coastal plain behind Waialua Bay have for the most part been compromised by Historic Period ranching, cultivation, silviculture, military activities, and modern habitation. To generate a set of expectations regarding the nature of historic properties that might be encountered within the project area, and to establish an environment within which to assess the significance of any such resources, a general historical context for the region and previous archaeological studies conducted in the vicinity of the study area are summarized.

Culture-Historical Context and Ahupuaʻa Settlement Patterns

In an effort to provide a comprehensive and holistic understanding of the current study area and to generate a set of archaeological expectations, *ahupuaʻa* specific archival and historical data along with the general settlement patterns for the Waialua District are presented. The current project area falls within Kawailoa Ahupuaʻa (Figure 28), however Dega (1996:7-10) suggests that prior to the *Māhele* the area comprised by Kawailoa was traditionally identified as six *ahupuaʻa*: Kapaeloa, Punanue, Kuikuiloloa, Lauhulu, Kawailoa, and Paʻalaʻa (Figure 29). Sahlins (1992:18) refers to the other five land units as *ʻili*. The *Māhele* of 1848 was an event marked by complex land transaction that often resulted in changed names and configurations; this report will refer to the single post-*Māhele* Kawailoa Ahupuaʻa. Archaeologically and historically, Kawailoa Ahupuaʻa contained important locations that were occupied both in the long and short-terms, and an outline of Oʻahu's overall prehistory and history highlights the unique characteristics of Kawailoa Ahupuaʻa.

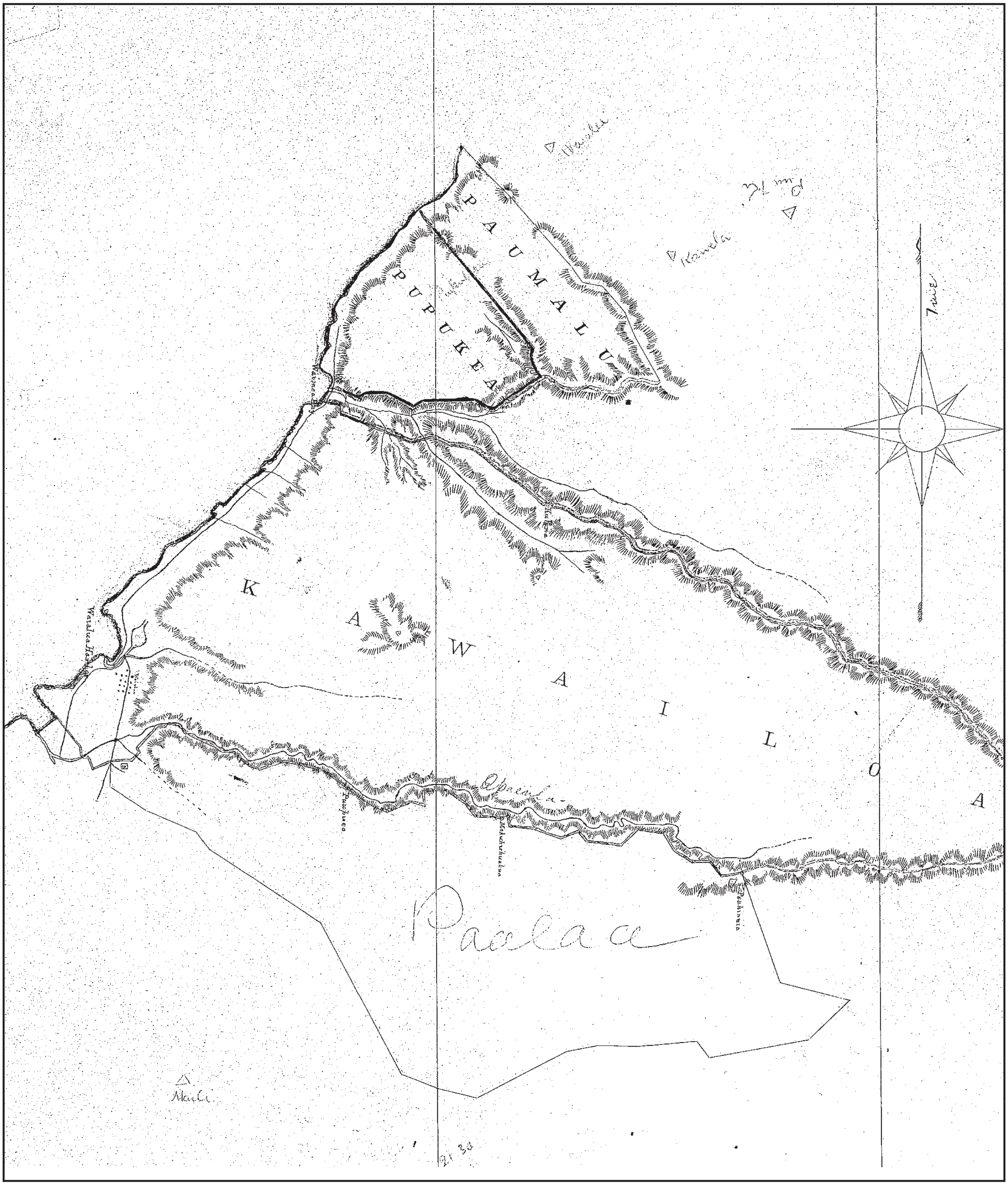

Figure 28. Portion of Hawai‘i Registered Map No. 320 dated 1876.

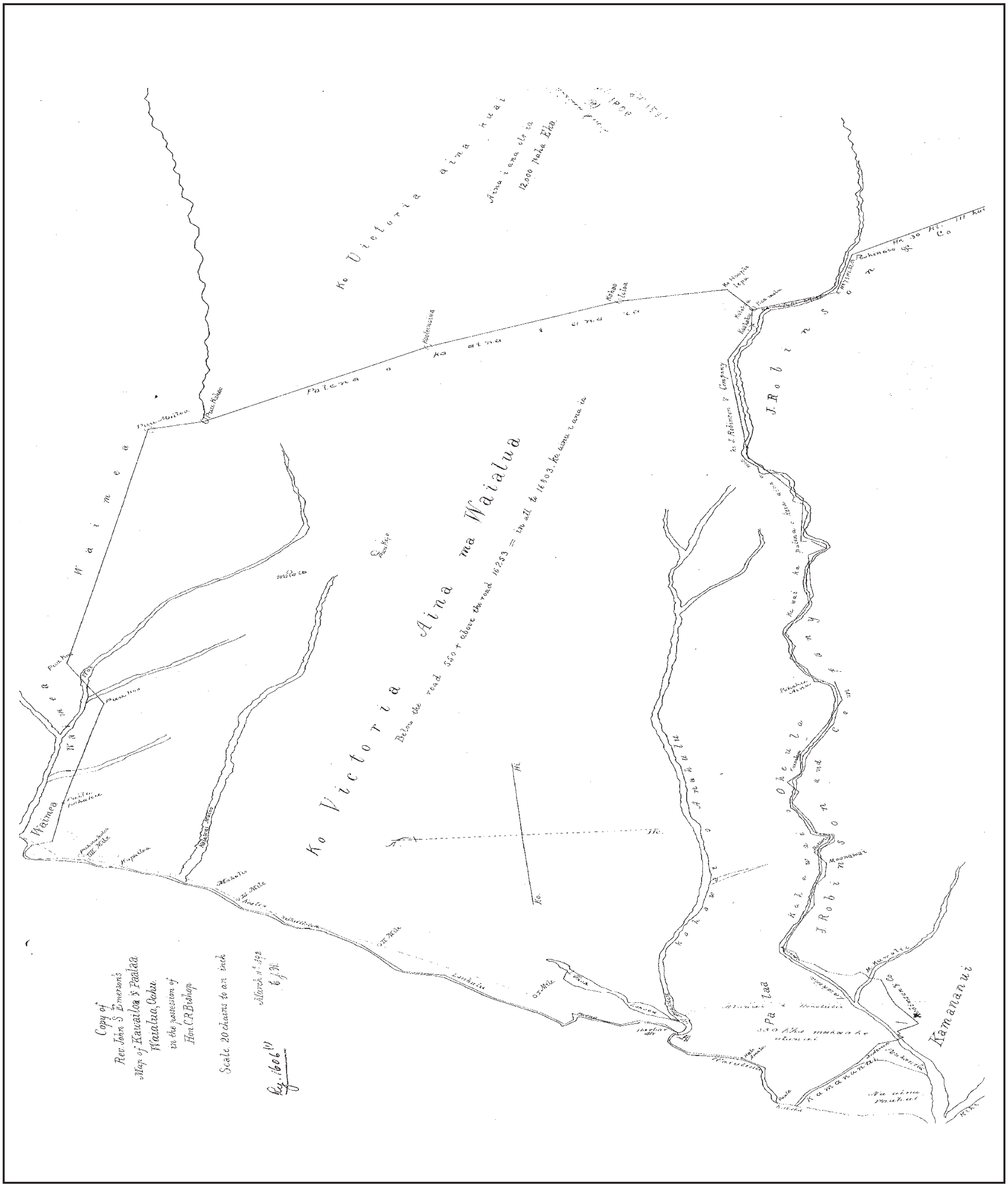

Figure 29. Portion of Hawai‘i Registered Map No. 1606 prepared by J. S. Emerson in 1892.

A Brief Overview of Hawaiian Settlement

A critical review of radiocarbon dates from the windward coast of O'ahu suggest that significant settlement may not have began until A.D. 1000, with a steady and rapid expansion up until the time of Western contact (A.D. 1778) (Kirch 2010; c.f. Stride et al. 2003). Settlement likely occurred from the Marquesas and Society Islands (Emory in Tatar 1982:16-18). In these times, Hawai'i's inhabitants were primarily engaged in subsistence level agriculture and fishing (Handy and Handy 1972:287). The Settlement Period was a time of great exploitation and environmental modification, when early Hawaiian farmers developed new subsistence strategies by adapting their familiar patterns and traditional tools to their new environment (Kirch 1985; Pogue 1978). Their ancient and ingrained philosophy of life tied them to their environment and kept order. Order was further assured by the conical clan principle of genealogical seniority (Kirch 1984). According to Fornander (1969), the Hawaiians brought from their homeland certain universal Polynesian customs: the major gods *Kane, Ku*, and *Lono*; the *kapu* system of law and order; cities of refuge; the '*aumakua* concept; and various beliefs, including the concept of *mana*.

Following initial settlement, communities in O'ahu were clustered along the shores which offered sheltered bays from which deep sea fisheries could be easily accessed. The near shore fisheries and coastal fishponds, which were enriched by nutrients carried in the fresh water, also offered opportunities for resource extraction and stewardship. It was in these coastal areas that clusters of houses were found, and where agricultural production first became established. Over a period of several centuries, these areas became populated and perhaps even crowded, and inland elevations began to be used for agriculture and some habitation. Taro would have been the dominant crop in this area with sweet potatoes planted only as a supplement for it (Handy and Handy 1972:282-283). Other crops would have included *wauke*, *noni*, gourds, sugarcane, *'awa,* breadfruit, bananas, coconuts, and *ti* (Stride et al. 2003).

The period between A.D. 1400–1650 was characterized by increased social stratification, major socioeconomic changes, and intensive land modification (see Kirch 1985). Most of the ecologically favorable zones of the windward and coastal regions of all major islands were settled and the more marginal leeward areas were being developed. The concept of the *ahupua'a* was established during this period (Kirch 1985). This land unit became the equivalent of a local community, with its own social, economic, and political significance. *Ahupua'a* were ruled by *ali'i 'ai ahupua'a* or lesser chiefs; who, for the most part, had complete autonomy over this generally economically self-supporting piece of land, which was managed by a *konohiki*. *Ahupua'a* were usually wedge or pie-shaped, incorporating all of the eco-zones from the mountains to the sea and for several hundred yards beyond the shore, assuring a diverse subsistence resource base (Hommon 1986).

The *ali'i* and the *maka'āinana* (commoners) were not confined to the boundaries of the *ahupua'a*; when there was a perceived need, they also shared with their neighbor *ahupua'a ohana*. The *ahupua'a* was further divided into smaller sections such as the *'ili*, *mo'o'aina*, *pauku'aina*, *kihapai*, *koele*, *hakuone*, and *kuakua* (Hommon 1986, Pogue 1978). The chiefs of these land units gave their allegiance to a territorial chief or *mo'i* (king). *Heiau* building flourished during this period as religion became more embedded in a sociopolitical climate of territorial competition. Monumental architecture, such as *heiau*, "played a key role as visual markers of chiefly dominance" (Kirch 1990:206).

The *ali'i-'ai-ahupua'a* was subject to an *ali'i 'ai moku* (chief who claimed the abundance of the entire district). Accordingly, *ahupua'a* resources supported not only the *maka'āinana* and *'ohana*, who lived on the land, but also contributed to the support of the royalty. This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resources management planning. In this system, the land provided fruits and vegetables and some meat in the diet, and the ocean provided a wealth of protein resources. Also, in communities with long-term royal residents, divisions of labor (with specialists in various occupations on land and in procurement of marine resources) came to be strictly adhered to. It is in the general cultural setting outlined above, that we find the *ahupua'a* of Kawailoa at the time of European contact.

Indigenous Accounts of Kawailoa and Neighboring *Ahupua‘a*

The current study area is located in the *ahupua‘a* of Kawailoa, District of Waialua, Island of O‘ahu. Kawailoa is a large *ahupua‘a* that occupies the northwestern corner of O‘ahu, stretching from the ocean to the Ko‘olau mountains. It includes coastal areas rich in fish, a fertile coastal plain, and prominent river valleys (the coastal plain and river valleys are mostly *mauka* of the present day Kamehameha Highway) with numerous rivers, wetlands, and ponds. ‘Uko‘a and Loko‘ea are two well-known ponds located on the coastal flats *makai* and west of the project area. A low escarpment juts up above the coastal flats *mauka* of the ponds and increases in height northwards in the direction of Waimea Bay, where it becomes a sizeable rock cliff with numerous caves. *Mauka* of this basalt ridge, dissected tablelands rise gently toward the Ko‘olau mountain range, the ridge line of which serves as a border with the neighboring district of Ko‘olau Loa.

Kawailoa Ahupua‘a, and many of the places named within it, have traditional legends and historical accounts associated with them. The Waimea River valley to the north and the ‘Uko‘a Pond *makai* of the project area are particularly associated with legends. The prolific legends most likely relate to this area’s long-standing association with very old lines of prominent priests on O‘ahu. Whereas the story of the Waimea River valley immediately north of the project area is one based mainly on accounts of the royalty and priestly class, that of the Anahulu River valley to the south is one based primarily on archaeological remains and mid-eighteenth century historical documents. This does not imply, however, that no archaeology or historical documentary research has been done in the Waimea area or that no traditional accounts exist for the Anahulu area. The following discussion starts with a broad historical background of the northern portion of the project area before moving to the record that exists for the area farther west and south.

In the legends of the *ali‘i*, the Waimea area is connected originally with the Paao class of *kahuna*. A pig-like deity, known as Kamapua‘a, first gave the Waimea lands to a *kahuna*, known as Lono-a-wohi (Kamakau 1961:230-231). Later on, a certain Kahi-‘ula and the older brothers of a certain Kanaua‘a, gave the land to the Paao *kahuna* of the area in perpetuity. However, with the reign of Chief Kahahana, the lands went to the *kahunanui* who were selected by Kahekili in 1783 and later by Kamehameha in 1795. Following King Kamehameha’s conquest of O‘ahu Island, he gave Waimea to his own high priest, Hewahewa. Hewahewa was the only priest to practice at the Waimea *heiau* who came from outside the area. He was also the last high priest of the Hawaiian kingdom (Mitchell 1986:8).

By the seventeenth century, King Kualii asserted his power over the priests at Waimea as part of his successful campaign to unify the entire Island of O‘ahu. Following unification, Kualii continued to rule with the aid of the *kahunanui*. *Kalaimoku* was a special category of *kahunanui* that advised chiefs concerning secular matters. A well-known *kalaimoku* from Waimea, known as Kaepulupulu, became a prominent adviser to powerful rulers, first to Chief Kamahana and later to Chief Kahahana from the Island of Maui. However, the prophetic abilities the charismatic Kaepulupulu lead to his fall-out with both these corrupt chiefs; by 1773 Chief Kamahana was removed in a bloodless coup, while later on the new Chief Kahahana had Kaepulupulu executed (Fornander, II 1969:129). During all this political intrigue that affected the entire Island of O‘ahu, Kaopulupulu officiated at both of the prominent *heiau* at Waimea; one being Puu‘O‘Mahuka on a high bluff north of where the river enters the ocean and the other being Kupopolo near the beach south of the river mouth (Takemoto 1974:5).

Of the two *heiau*, more orally-transmitted information is available for the massive Puu‘O‘Mahuka than for the smaller Kupopolo. Bingham (McAllister 1933:148) recorded a tradition that huge fires lit on an altar at Puu‘O‘Mahuka can be seen as far as the Island of Kauai. The same tradition also claims that this *heiau* was the birthplace of prominent *ali‘i*. It is said that the much smaller Kupopolo *heiau*, like Puu‘O‘Mahuka, was used for human sacrifices, among other activities (Luter 1938:29-30).

Considering that many stories centered on fishing in the adjacent ocean, numerous mentioning the fishing deity Kaneaukai, it is conceivable that at least some sacrifices at Kupopolo *heiau* related to fishing deities. There are two stones, one on each bluff above Waimea Bay, named after fishing deities known as Ku and Ahuena (McAllister 1933:150). Being variations around a common theme, the stories related to Kaneaukai, Ku, and Ahuena, all mention fishermen either dreaming of or actually netting a stone from the nearby ocean. In exchange for offerings of ‘*awa* and/or pigs to the stones, the stones reciprocated by ensuring that the fishermen, including commoners and priests, will be successful in their acquisition of fish (see selected stories in Takemoto 1974:18, 22-27, 29-32, 41). Whereas fish from the ocean supplied life to those working the land, shrines, or *ko'a*, were constructed on land to increase the number of fish in the ocean. Being located at the transition between fertile agricultural soils within the Waimea Valley and rich fishing waters of Waimea Bay, the *heaiu* and *ko'a* were physical expressions of the reciprocal relationship that land and sea had for the Hawaiians.

Numerous caves within the high cliffs that separate the bluff-sides of Waimea Valley from the ocean below contained human remains and associated burial goods, including canoes and *tapa* cloth (Takemoto 1974:38-40). The sea-side cliffs marked the line of transition between the land of the living and the land of the dead, the latter being the ocean, also known as *Pō*. The fertile soils of the valley and the water of the river could be modified through human action to form cultivatable terraces and irrigation channels. Prior to the arrival of Europeans to the area, the valley was known for its taro, sweet potatoes, '*awa*, and breadfruit. Following his visit to the Waimea River Valley, McAllister (1933:147) reported the remains of agricultural terraces on both sides of the river for up to a distance of two miles inland from the bay. Irrigation ditches and numerous housing enclosures support Historic Period observations that the valley around Waimea Bay was once heavily populated. Based on claims made to the Land Commission in the mid-nineteenth century, most of the *kuleana* were within the level bottomlands, not far from the coast, although a few occurred near the elevated tablelands over a mile inland from Waimea Bay (Handy and Handy 1972:463).

The narrow coastal plain at Waimea Bay, around 250 meters wide, broadens to approximately 1.5 kilometers wide farther south behind Waialua Bay. According to the records of Thrum (1906) and McAllister (1933), the broader and flatter landscape around Waialua Bay was marked by ponds, irrigated pond fields, irrigation ditches, various *heiau*, and *akua* stones (Kirch 1992:18). Indigenous Hawaiian accounts mention a lizard-like female deity, known as Laniwahine, that used to live in the 'Uko'a pond. The pond was her "long house," connected to the ocean via a narrow tunnel.

Farther south, on Kaiaka Bay, a prominent legendary *heiau*, known as Kapukapuakea, was reputedly the place where high priests inaugurated Ma'ilikūkahi as paramount chief over the area. If Waimea Bay is primarily remembered for its line of indigenous priests, Waialua Bay is known for its line of indigenous chiefs. Traditional orally transmitted accounts from the Waialua area claim that the Kapukapuakea *heiau* was constructed by *menehune*, the little people of legend (Sahlins 1992:21). Normally seen in visions and dreams, these imaginary people were believed to have built numerous other monumental structures on O'ahu and neighboring islands within the Hawai'i Archipelago.

It was in the highlands southeast of Waialua that the original and indigenous Nanaulu line of chiefs, within which Chief Ma'ilikūkahi was an early one, is believed to have been born. On the watershed near the present-day Schofield military base was the Kūkaniloko temple, a place that contained a sacred birth stone against which royal women gave birth to future chiefs (Sahlins 1992:23). The line of indigenous chiefs came to an end when King Kahekili from Maui killed Chief Elani of Waialua at Puaena Point on the northern edge of Waialua Bay (Sahlins 1992:25). The new rulers from the Windward Islands, such as Kahekili and later Kamehameha, continued to use the places sacred to the indigenous population in their ceremonies, including the *heiau* in the vicinity of Waialua and Waimea bays.

Historical and Archaeological Accounts of Kawailoa and Neighboring *Ahupua'a*

Soon after going ashore at Waimea Bay in 1779, Captain Clerke walked up the Waimea River valley, which he described as "well cultivated and full of villages" (Kuykendall 1938:12-20). When the crew of Captain Vancouver went ashore at Waimea Bay to replenish their water supply in 1792, they allegedly saw an "amphitheater, with hamlets, trees, and plantations" (Brigham 1849: 295). According to local oral traditions, the bodies of two of the crew members of Vancouver's, who were killed by Waimea Bay inhabitants, were taken to Puu'O'Mahuka *heiau* where they were burned and de-boned (Thrum 1912). The chief at Waimea at the time of this incident was the warrior priest Koi.

Roughly 1.5 miles southwest of Waimea Bay are the well-known fish ponds of 'Uko'a and Loko'ea. Unlike the fairly densely populated Waimea Bay area, the ponds, being located close to Waialua Bay, have no prominent habitation sites associated with them (Athens et al. 1995:21). Two separate boulders on the nearby coastline are the closest archaeologically recorded sites; one was used to block the mouth of the Anahulu River and the other was believed to possess curative powers. Moore et al. (1993:70) found three isolated fire pits on the Hale'iwa Beach Park, the charcoal radiocarbon dates averaging to the mid-sixteenth century. This post-dates by roughly six centuries charcoal evidence from ‘Uko‘a pond for initial human clearing of the surrounding indigenous coastal forests (Athens et al. 1995:iii). Fish, ducks, and bulrushes used to be abundant within ‘Uko‘a pond. Although it contained abundant fish, there is no mention in the historical record or any archaeological evidence that the pond was ever enhanced or modified through the construction of walls, gates, or canals (see discussion in Athens et al. 1995). Historic sources, dating back to 1815, describe ‘Uko‘a pond as the property of the *ali‘i*; fish could only be taken out with the local chief's permission (Athens et al. 1995:23-24). However, Land Commission Award documents suggest that by the time of the *Māhele* in 1848, royal control over fishing rights in the pond were virtually non-existent. At this time the *makai* edge of the pond contained seven small house sites and communally cultivated sweet potato plots (Athens et al. 1995:26). Four households made claim to aquatic resources in the pond, which included gobey, surgeon, mullet, fresh water shrimp, and seaweed.

Generally speaking, the coastal lands southwest of the project area and southeast of Waimea Bay were occupied by houses, occasional fishponds, and small cultivation plots containing taro and sweet potato (e.g., Pfeffer and Hammatt 1992:27). *Mauka* of the coastal plain, irrigated taro fields were created in the bottoms of river valleys, such as those within the Anahulu River valley. Higher up the valley slopes were hillside, or *kula*, cultivation of crops and trees. Isolated pockets of planted areas occurred even higher up in the narrower confines of the valleys and their numerous tributaries. Families owned plots in these different zones so that they could utilize the diverse resources. At the very high end of the river valleys Hawaiians collected a variety of wild plants and hunted birds.

It is only after the armed forces of Kamehameha I permanently occupied O‘ahu in 1804 that the interior of the Anahulu River valley became used and modified more intensively, which included the construction of irrigation canals and terraced fields for as much as three miles up the valley that had up until then only experienced low-intensity cultivation and resource extraction. Whereas the coastal area was already rich in fish and taro, its size and production output was simply not sufficient to supply King Kamehameha I, his close political and military officials, and their followers with arable land and produce. Only by quickly and drastically transforming the middle and upper portions of Anahulu valley through landscape modification, could Kamehameha's officials, such as Ke‘eaumoku, effectively rule over the newly acquired Waialua District (Kirch 1985:311-313). A few of the older *maka‘āinana* families displaced from land in the Waialua coastal plain perhaps also moved into the Anahulu valley and started to cultivate it (Kirch 1992:167).

By 1810, some 20 years after sandalwood was first exploited on the Hawaiian Islands, King Kamehameha I, and subsequently various powerful chiefs, gained monopoly over the sandalwood trade. Judging from historical documents, people living in the Waialua area were known for cutting sandalwood in the interior mountain forests. In a scramble to obtain foreign goods, chiefs in the area had commoners work very hard to cut and transport the sandalwood to the coast (Kirch 1985:314). Preoccupation with sandalwood extraction resulted in the abandonment of several residential homesteads in the upper Anahulu valley. The return of Kamehameha I with his court to Hawai‘i Island in 1812 lead to additional abandonment; by 1820 the upper valley was almost deserted.

With the complete collapse of the sandalwood trade in 1829, chiefs who accumulated debt fell back to an earlier strategy of supplying provisions and other materials, such as *wauke* bark for caulking, to visiting ships, especially whalers (Kirch 1985:314). In the early 1830s the *konohiki* in the Waialua area gave land to cultivators with the aim of once again increasing the agricultural output of the area. Archaeological evidence suggests that previously abandoned terraces and canals were re-used and re-arranged to accommodate the newly placed cultivators. Taro, yams, bark cloth, and sweet potatoes were important products aimed to supply ships.

A variety of stone features have been identified on the colluvial and talus slopes of the Anahulu valley uplands. Among these are stone piles, stone walls, stone-lined planting circles, small stone-walled garden plots, and terraces cleared of talus. Judging from *Māhele* documents, these features were probably related to the growing of sweet potato, paper mulberry, yam, and banana (Kirch 1992:174). Handy and Handy (1972:86) maintain that the dry gulches between Anahulu and Waimea Rivers (those within the project area) probably never watered taro.

It is likely that cultivators within the Anahulu valley used the rich tablelands on both sides for shifting cultivation even prior to the settlement of Europeans in the area. In *Māhele* land claims, for example, some of the upper valley claimants refer to swidden-like garden plots in the flat portions of mountains, which could refer to the surrounding tablelands (Kirch 1992:23). Moreover, maps of land claims in upper portion of the valley, known as Kawailoa-uka, show winding trails connecting valley bottom residences and terraced fields with tableland top ridge spurs (Kirch 1992:51). By 1832 missionaries were operating from near the mouth of the Anahulu River. The increased influence and presence of European ideas and material culture is testified by recovery of glass bottles, musket balls, and iron tools from excavations from the inland house sites (Kirch 1985:314).

The *Māhele* of 1848 marked irreversible changes in the make-up of the traditional Hawaiian political-economy. By the middle of the nineteenth century the ever-growing population of Westerners forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership, and the *Māhele* became the vehicle for determining ownership of native lands. During the *Māhele*, land interests of the King (Kamehameha III), the high-ranking chiefs, and the low-ranking chiefs, the *konohiki,* were defined. The chiefs and *konohiki* were required to present their claims to the Land Commission to receive awards for lands provided to them by Kamehameha III. They were also required to provide commutations to the government in order to receive royal patents on their awards. The lands were identified by name only, with the understanding that the ancient boundaries would prevail until the land could be surveyed. This process expedited the work of the Land Commission (Chinen 1961:13). During the *Māhele* all lands were placed in one of three categories: Crown lands (for the occupant of the throne), Government lands, and *konohiki* lands. All three types of land were subject to the rights of the native tenants therein, who could make claims for property they occupied and/or farmed. The native tenant awarded lots are referred to as *kuleana* parcels.

As a result of the *Māhele*, Kawailoa Ahupuaʻa was a *konohiki* award to Victoria Kamamalu as LCA # 7713:33, thus ownership eventually fell to the Bishop Estate (now Kamehameha Schools). According to the Waihona ʻAina database there were ninety-five *kuleana* claims made for Kawailoa Ahupuaʻa. Most of these were for land *makai* of the project area and in Anahulu Valley (Figure 30), however, Cane Haul Road, which follows a former railway alignment, traverse five small *kuleana* parcels (LCA # 2727, TMK:1-6-2-02:002; LCA # 10364:2, TMK:1-6-1-05:020; LCA # 8419:1, TMK:1-6-1-05:021; LCA # 7417:1, TMK:1-6-1-05:022, LCA # 7169, TMK:1-6-2-02:3 (por.)). All five of these *kuleana* were house lots obtained during the time of Kamehameha I (post 1795). The locations of all five of these lots afforded the residents access to fishpond resources as well as *kula* planting areas. A sixth *kuleana* parcel (LCA # 8304:3) with a similar land use history as the other five is traversed by Kawailoa Drive.

The change from a labor-based barter system to one based on taxes and money accompanied the division of land during the *Māhele*. The formerly close socio-economic ties between the *aliʻi* and the *makaʻāinana,* that revolved around land rights and tribute, rapidly dissolved. The *makaʻāinana* cultivators increasingly entered the cash economy to pay taxes and meet other obligations. This disintegration of the traditional socio-economic fabric is reflected by the abandonment of house sites, terraced plots, and irrigation ditches in the middle and upper Anahulu valley by 1890.

That the project area has been used for a variety of purposes, including pasture for cattle, becomes evident when historical records are reviewed. Whereas pigs, dogs, and fowl were the main supply of meat for Hawaiians, cattle were brought to the islands in 1798 to supply visiting whaling ships with meat. During the 1830s and 1840s, numerous cattle herds grazed the uplands of the Waialua District (Wyllie 1848:23), most belonging to Robinson and Company. Cattle became a scourge by 1845, damaging houses and garden plots within the Anahulu River valley and degrading indigenous plant life on the adjacent tablelands (Kirch 1992:169).

If the history of the coastal Waimea Bay and Waialua Bay areas focuses on priests and rulers, that of the Anahulu Valley concerns commoners. The *Māhele*-era records show that many of the *makaʻāinana* cultivators were awarded core taro lands within their ancestral estates, the Land Commission generally did not consider the commoners' dispersed dry land plots (*kula*) or their swidden garden sites (*ʻokipū*). This loss of "peripheral" land holdings following the *Māhele* was exacerbated by the emergence of a cash-based economy. Commoner land owners now had to pay cash for land surveys, annual taxes, and implements. It is accordingly not surprising that commoner households in the middle and upper Anahulu valley faded during the 1860-80s (Kirch 1992:167). Most indigenous Hawaiians did not stay on the land after 1900. Intermittent, but severe floods, such as those that occurred in 1894 and 1898, wiped out numerous features in the lower river valleys, particularly above Waimea Bay (Takemoto 1974:12-13).

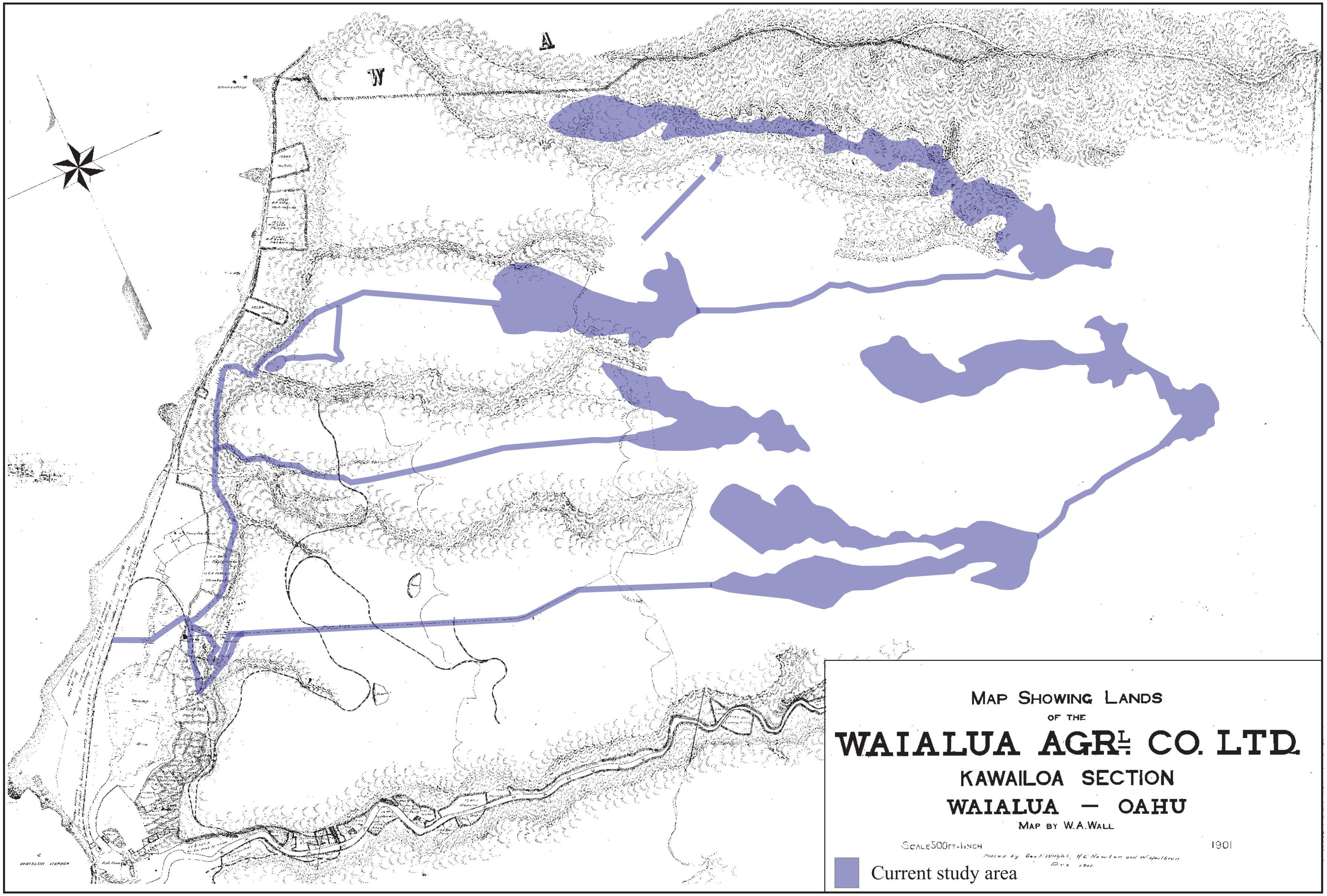

Figure 30. Portion of Hawai‘i Registered Map No. 2054 of the Waialua Agricultural Co. lands (prepared by W. Wall in 1901) showing *kuleana* parcels and the current study area.

RC-0660

The Sugar Era in Kawailoa Ahupuaʻa

A Chinese merchant is credited with the first making of sugar in the Hawaiian Islands in 1802 (Deerr 1949). The first sugarcane milled in the Waialua area dates to ca. 1840 and the missionary Rev. John Emerson, who set up a small mill powered by horses that made sugar and molasses for the natives on shares (Kuykendall 1938). The first commercially grown sugar in Waialua can be traced back to the Levi and Chamberlain Sugar Company in ca. 1865 (Wilcox 1996). In 1875 the sugar plantation at Waialua was purchased by R. Halstead and Gordon, and later owned by the Halstead brothers. In 1898 when the Oahu Railway and Land Company's (O. R & L. Co.) railroad reached the Halstead brother's plantation at Waialua, the small mill did not produce much freight and large tracts of the surrounding land remained uncultivated (Dorrance and Morgan 2000). Benjamin Dillingham, who founded the O. R & L. Co., encouraged Castle & Cooke to purchase the Halstead brother's plantation. In that same year, Castle & Cooke formed the Waialua Agricultural (later changed to Sugar) Company primarily on lands leased from the Bishop Estate and Dillingham (Dorrance and Morgan 2000). Castle & Cooke hired William Goodale from the Onomea Plantation on Hawaiʻi Island as the first plantation manager.

Goodale described the plantation's humble beginnings in his final report as manger, writing that, "at the time Waialua Agricultural Co., Ltd., was organized in October, 1898, it took over the old Halstead Plantation with about 600 acres of cane, certain leases of large tracts of unimproved land covered with lantana and stones, several hundred acres of rice and ranch land, a small mill, one five million gallon pumping station, no reservoirs or railroads, one small set of steam plows and other equipment of a small plantation" (Goodale in Clark 2007:57). Early in the plantation's history sugarcane did not extend higher than the 200-foot contour above sea level.

In the first years of ownership Castle & Cooke expanded the acreage of the plantation, built a new mill, put in a railway system, and developed a reliable water supply, utilizing both ground and surface water (see Figure 30). The strategy resulted in sugar yields increasing from 5,000 tons in 1900 to nearly 20,000 tons in 1905 (Wilcox 1996). The northern portion of the project area was part of the plantation's Waimea fields, and the southern portion was part of the plantation's Kawailoa fields. A 1901 map of the Waialua Agricultural Company's lands in Kawailoa (Hawaii Registered Map No. 2054B; see Figure 30) shows ditches paralleling the 300-foot and 500-foot contours, a railway extending from the main O. R & L. Co. line along the coast into the Kawailoa fields (in the vicinity of the Kawailoa Road and Cane Haul Road Corridors, stretching to the Mid-Line Road Corridor), a collection of buildings and water tanks (an early plantation camp) located above the *pali* and along the railroad tracks in the vicinity of Kawailoa Road Corridor, a pump house (Pump # 4) with a waterline running to the upper ditch line (following the Kawailoa Road corridor), and two reservoirs.

Above the sugarcane fields in Kawailoa pineapples were grown, and below the *pali*, in the swampy areas surrounding ʻUkoa Pond, rice was grown. The sugar and pineapple companies modified and utilized most of the land within the project area, clearing original vegetation, leveling original landforms, digging ditches, constructing reservoir walls, and building roads and railroads. Substantial amounts of foreign laborers (mostly Chinese, Filipino, and Japanese) were imported to work the fields, with labor camps dotting the landscape (e.g., Pfeffer and Hammatt 1992:36). Many of the *mauka* lands were leased to the Hawaiian Pineapple Company, which was founded by James Dole in 1901. The Waialua Agricultural Co. and Hawaiian Pineapple Co. operated in such close proximity to one another that the field boundaries often changed. Castle & Cooke purchased a 21% share of the pineapple company in 1932, and the entire company in 1961. The name of the company was changed to Dole Food Company, Inc. in 1991.

Waialua Agricultural Company had the largest water storage capacity in Hawaiʻi, and arguably the most efficient irrigation system. The distribution system was especially flexible with interconnected ditches that allowed water to be sent to any part of the plantation (Wilcox 1996). The Waialua Agricultural Company also had steam and electric powered pumping stations that sent groundwater from wells in the lower elevations of the plantation to the ditches in the upper elevations (Wilcox 1996). Developed between 1902 and 1911 the plantation had four surface water collection systems — the Wahiawa, Helemano, Opaeula, and Kamananui systems. The lower fields in the vicinity of the current project area were initially watered by Pump # 4 and the Opaeula ditch system, but were later watered by the Kamananui ditch system. The Opaeula Ditch, which carried water from the tree main tributaries of the Anahulu River (Kawainui, Opaeula, and Kawaiiki Streams) to the Opaeula and lower Kawailoa fields, was completed in 1903.

Construction of the Kamananui Ditch, which tapped Kawainui Stream at a higher elevation and carried water to the lower Waimea and upper Kawailoa fields, began in 1903, but was not completed until 1911 (Goodale 1911, 1912).

On February 3, 1911, in the Waialua Agricultural Co. annual report for the year 1910, W. W. Goodale, reported that:

> [Kamananui Ditch], referred to in the Annual reports of the years 1902, 1904 and 1909, was commenced in 1903, but abandoned in 1904. At that time 1,068 feet of tunnels had been excavated. On June 10, 1910 we began work again and have carried it on as rapidly as possible since that time.
>
> The ditch will deliver the water of the Kamananui stream at a point at a point 669 feet above sea level on the upper lands of Kawailoa and on the line of the ditch that crosses the plantation carrying the water from the Wahiawa reservoir.
>
> The ditch is 20, 175.5 feet long, with 17,852.5 feet of tunnels, 325 feet of flume and 1,998 feet of open ditch.
>
> On December 31, 1910, 13,832.5 feet of total length, had been completed leaving 6,343 feet unfinished. The entire cost of the work will be about $69,628.00, of which amount $35,561.00 had been paid on December 31, 1910. Water should be running in the ditch on or about May 1, 1911. (Goodale 1911:4)

The Kamananui Ditch was actually completed on December 7, 1911 at a total cost of $76,963.81. From the outset it carried an average of 2,188,471 gallons of water a day to the Kawailoa fields (Goodale 1912). For the year 1910 it was reported that "the Opaeula Ditch system delivered during the year 2,112,401438 gallons of water, used entirely on Kawailoa" (Goodale 1911:4). The Kamananui ditch system was redesigned and realigned in the mid-1920s to increase its water carrying capacity and to allow it to function independent of the Opaeula ditch system (Wilcox 1996). Due to the innovative efforts of Goodale, a self-propelled drag-line excavator was digging new ditches by 1920. The same machine could also lift harvested cane bundles onto railway cars in the field (Dorrance and Morgan 2000).

When William Goodale retired in 1923, after 25 years as the plantation's manager, he summarized the growth of the Waialua Agricultural Company in the annual report for that year, writing "we now have 70 million gallons per day pumping capacity, 30 miles of permanent railway, the Wahiawa reservoir, capacity 2,540,000 gallons, and 33 other reservoirs, ditches to bring the water to Poanoho, Halemano, Opaeula, Kawaiiki, Kamananui and Waimea gulches, a good mill, six locomotives, cane cars, six plow engines and plows, tractors, trucks, buildings, and about 9,000 acres of cane" (Goodale in Clark 2007:57-58). Goodale had also installed a 450-kilowatt hydroelectric plant in the uplands of Kawailoa that supplied not only plantation's needs, but when excess energy was produced, it was sold to the Hawaiian Electric Co. (Dorrance and Morgan 2000). Goodale's management had made the Waialua plantation one of the most productive in the Hawaiian Islands. In 1925, shortly after his retirement, sugar production had grown to 32,585 tons annually (Dorrance and Morgan 2000).

A 1924 Hawai'i Territory Survey map of the Kawailoa Forest Reserve prepared by C. Murray (HTS Plat 2069; Figure 31) shows the upper limits of the sugarcane fields near the 650-foot contour in the Kawailoa fields and the 400-foot contour in the Waimea fields. The upper Waimea and Kawailoa fields in the northern section of the plantation are shown as planted in pineapples and the upper fields in the southern section of the Kawailoa tablelands (along the Kawailoa Road Corridor) are shown as a eucalyptus forest. Eucalyptus was first introduced from Australia by the Waialua Agricultural Company in the late nineteenth century to counteract deforestation and erosion caused by cattle (Kirch 1992:169). Eucalyptus and other trees were also planted by the plantation as sources of lumber, fencing, and firewood (Goodale 1911, 1912). Drum road, and portions of all three of the project area roads appear on the HTS Plat 2069 map (see Figure 31). Ashley Road closely matches its current alignment, Mid-Line Road is present to the first crossroad near the 440-foot contour, and Kawailoa Drive (Alternative-1 of the Kawailoa Road Corridor) has been built, but only the upper portion of Kawailoa Road, between the upper limits of the sugarcane fields and Drum Road, matches its current alignment.

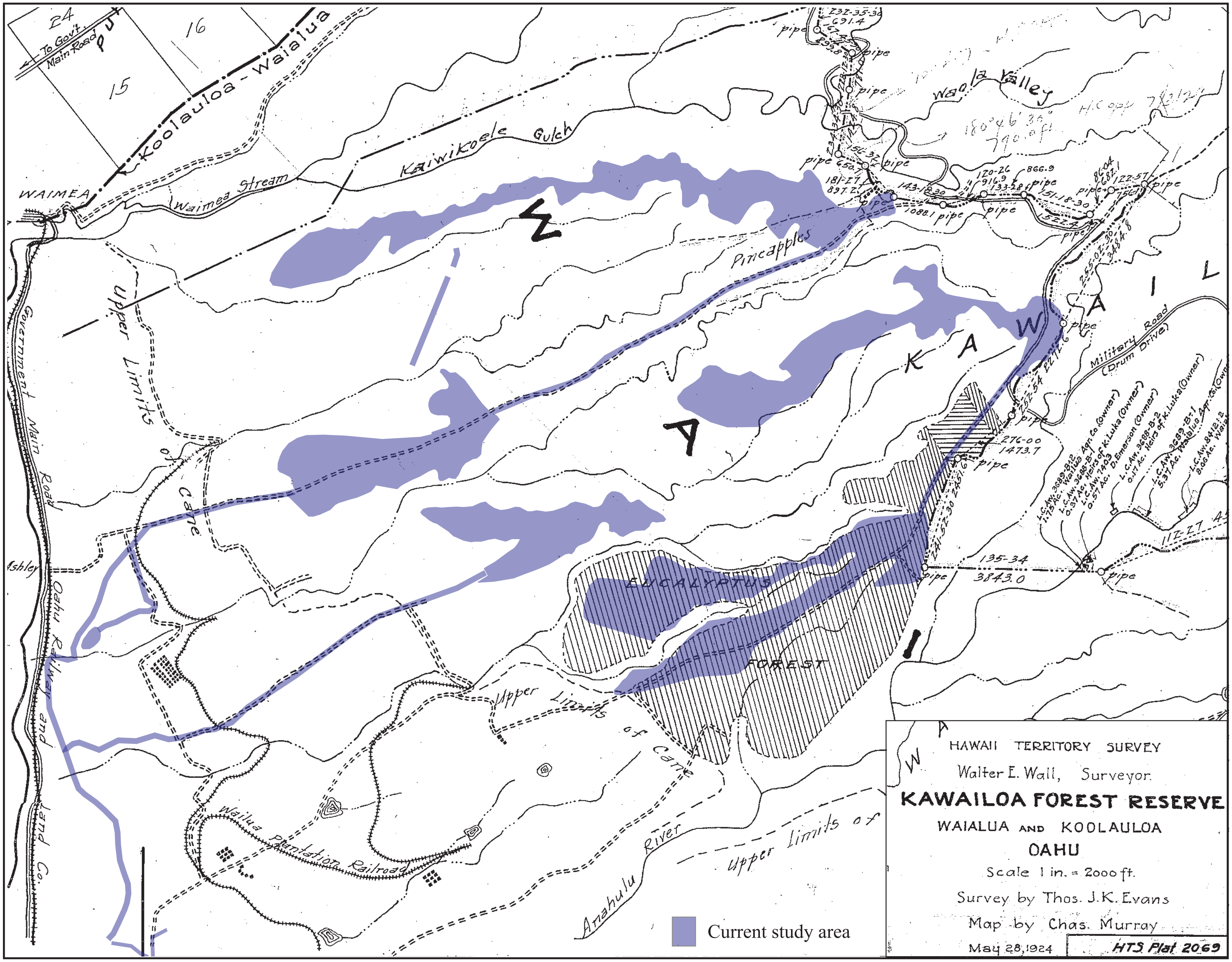

Figure 31. 1924 Hawai'i Territory Survey map of the Kawailoa Forest Reserve prepared by C. Murray (HTS Plat 2069) showing the current study area.

In 1924 the largest camp in the Kawailoa section of the plantation is shown between Mid-Line Road and Ashley Road (see Figure 31). Other camp buildings at this time arelocated along Kawailoa Drive inland of the buildings depicted on the 1901 map of the Waialua Agricultural Company's Kawailoa Lands (see Figure 30). These buildings are part of the Kawailoa Japanese Camp. One of the buildings is undoubtedly the Kawailoa Ryusenji Soto Mission, which was established in 1904 on land provided by the plantation for that purpose (Clark 2007). By 1929, as shown on the U.S.G.S. Hale‘iwa and Kaipapau quadrangles (see Figure 4), the camp between Ashley Road and Mid-line Road (Camp 8) has remained the same, but "Kawailoa Camp", stretching across the Kawailoa Road Corridor, has grown exponentially. This large camp actually comprised the Waialua Agricultural Company's Camps 2, 3, 4, 5, and 6. Kawailoa Camp was the largest of the company's villages, which were spread across the plantation to allow workers to walk to the fields. The majority of the residents at Kawailoa Camp were Japanese. At its height the camp included over 500 homes, an elementary school, a gym, a swimming pool, a theater, two stores, two barber's shops, three community *furo*, a Japanese-language school, and a Buddhist temple (the Kawailoa Ryusenji Soto Mission) (Clark 2007). The plantation built and maintained the homes, but the residents paid monthly rent, and they were owned by the Bishop Estate. A third camp shown along Ashley Road at an elevation of 600 feet above sea level on the 1929 map (see Figure 4) was not depicted on the 1924 map (see Figure 31), and may have been constructed during the intervening time period. This camp (Figure 32), known as the Waimea Camp, was operated by the Hawaiian Pineapple Company until it was removed in ca. 1960.

Figure 32. Aerial photograph taken on June 4, 1951 showing the Waimea Camp along the southern edge of Ashley Road.

In addition to the plantation camps, the 1929 U.S.G.S. quadrangle (see Figure 4) also shows irrigation ditches following contours at roughly every 100-foot change in elevation up to about the 650-foot contour in the Kawailoa fields and the 400-foot contour in the Waimea fields, with water pipes (siphons) connecting the various ridgelines, and reservoirs feeding into ditches that are oriented upslope/downslope (see Figure 4). The project area road corridors mostly match their current alignments by 1929. The only project area road sections not yet built are Hakina Bypass Road (portion of Kawailoa Road Corridor Alternative-2), and the northern end of Cane Haul Road. The southern portion of Cane Haul Road follows the Wailua Agricultural Company's rail lines. Ditches are shown following the edges of sections of Kawailoa Road and Mid-Line Road. Rice paddies are still shown in the swampy area surrounding ‘Uko‘a Pond. By 1936 improved irrigation and infrastructural development at the plantation had drastically increased sugar production output, which reached 54,671 tons in that year (Dorrance and Morgan 2000).

Prior to the United States involvement in World War II (WWII) the Hawaiian Defense Project revision of 1939 set into motion a large-scale modernization of the defenses of the Hawaiian Islands (Bennett 2002). During 1939 and the early 1940s defenses of O‘ahu’s north shore were vastly improved. The coastal defenses in the vicinity of the southern portion of the current project area were part of the Kawailoa Military Reservation, which operated between 1939 and 1945, and the coastal defenses in the vicinity of the northern portion of the current project area were part of the Waimea Military Reservation, which operated between 1934 and 1945. The Kawailoa Military Reservation included Battery Hale‘iwa, Battery Ashley, and Battery Kawailoa. Battery Hale‘iwa, located to the north of Kawailoa Drive along the main line of the O. R & L. Co. railroad (Figure 33), consisted of four 8-inch railway guns (Figure 34) with alternate firing positions, a projectile weight of 260 lbs. and a maximum range of 21,000 yds., and two 155mm GPF guns with a projectile weight of 96 lbs and a maximum range of 17,400 yds. that were added in 1944. Battery Ashley, located near Kawailoa Beach and Ashley Road, consisted of four 155mm GPF guns on Panama Mounts with a projectile weight of 96 lbs. and a maximum range of 17,400 yds. Battery Kawailoa, located near Kawailoa Camp north of the Kawailoa Road Survey Corridor, also contained four 155mm GPF guns on Panama Mounts, four buildings that made up Fire Control Station “T” of O‘ahu’s command and fire control cable system, and after 1941 a mobile SCR-270 radar station (Bennett 2002).

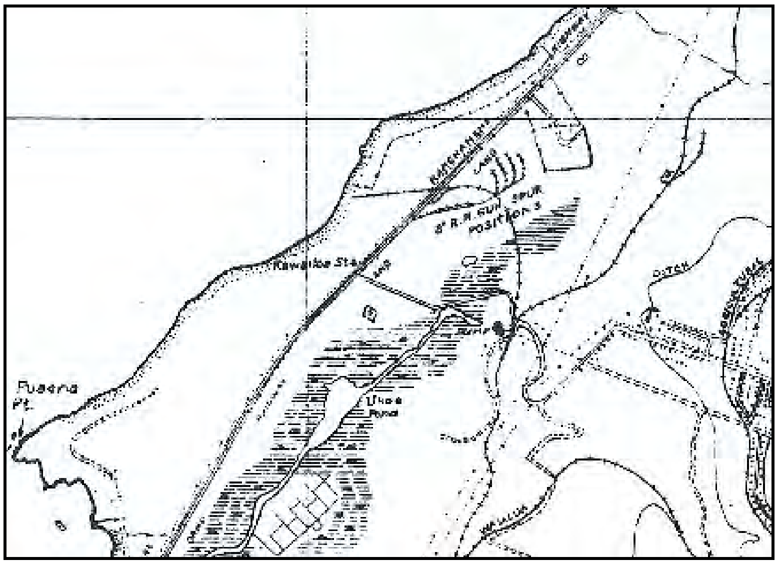

Figure 33. 1940 map showing the location of the 8-inch railroad gun spur positions at Battery Hale‘iwa (from Gaines 2002).

Figure 34. 8-inch railroad gun at Battery Hale‘iwa (from Gaines 2002).

The Waimea Military Reservation originally consisted of two concrete machine-gun pillboxes were built on either shore of Waimea Bay in 1934. In 1941-1942 four 75mm field guns were emplaced around the bay, and four additional 75mm guns were emplaced inland, along Ashley Road, at Waimea Camp. Construction on a third gun emplacement (Waimea Battery) that was to contain three Panama Mounts with a 180-degree field of fire began in 1942, but was never completed. The earthworks for the Waimea Battery are located three miles inland from Waimea Bay along Kaiwikoʻele Stream to the north of the Eastern Tableland Array (Sugimoto 1996). Inland of Battery Waimea, located northeast of the current project area along Kamananui Stream, was Battery Pupukea II which contained four 155mm GPF guns on Panama Mounts.

Following the Japanese bombing of Pearl Harbor on December 7, 1941 and the United States involvement in WWII, the U. S. military drastically increased its coastal defenses on the north shore of Oʻahu. Drum Road, which runs inland from Helemano to the Army's Kahuku training range and was constructed by the United States Army in the 1920s and 30s, was improved in the early years of the war to handle increased military vehicle traffic and to provide an alternative route to the north of the island in the event of potential damage to Kamehameha Highway.

To the south of the project area, in 1942, the United States Army built Battery Carroll Riggs at the location of Opaeula plantation camp (see Figure 4), in an area that is currently known as Opaeula Ranch (Bennett 2002:49). Containing two 8-inch guns salvaged from the U. S. S. Lexington and U. S. S. Saratoga Navy ships, the battery was used to protect the north and west shores of Oʻahu during World War II (Takamura 1995). Underground command posts and ammunition supply rooms were complimented by above-ground observation posts and towers. A few anti-aircraft gun emplacements occurred on the periphery of the battery. After the war, the United States government acquired the property from the B. P. Bishop Estate, but returned it to the Estate in 1953.

Located on the level landform south of Battery Riggs and of the Opaeula River, Brodie Camp No. 4 had a cable hut and a 100-pair cable installed prior to 1939 (Bennett 2002:42, 49). This cable was part of a tactical network of subterranean communication cables, or trunk lines, through the northwestern interior portion of Oʻahu. Numerous cable huts, concrete pedestals, manholes, and actual cables are physical testimony of this circum-island command and fire control communication system. A map prepared by Bennett (2002) shows that the two main lines of the cable in the vicinity of the project area ran (1) along the coast, and (2) from Brodie Camp No. 4 across the tablelands and gulches to Waimea Valley and then down to Fire Control Station "O" to the north of Waimea Bay. In 1939 an extension from the main cable was connected to Fire Control Station "T' at Battery Kawailoa (Bennett 2002). Other extensions likely connected to Batteries Haleʻiwa, Ashley, Waimea, and Pupukea, as well. The cable network was designed so that if any of the trunk lines were cut or damaged, they could be rerouted through other circuits to prevent total shut down of communications while they were fixed (Bennett 2002:44). Although many of the coastal defenses along the north shore were dismantled after 1945, intact segments of this robust command and fire control cable system infrastructure are currently used by Verizon Hawaii.

Following the war, by the end of 1947, the Oʻahu Railway and Land Company, with its ailing infrastructure, went out of business, and by 1950 much of the railroad infrastructure had been dismantled. The Waialua Agricultural Co. also dismantled its plantation railways and began hauling the sugarcane by truck. During the modern era the plantation would eventually grow to include over 12,000 acres of cultivated lands. By 1991 the renamed Waialua Sugar Company, which had merged with the Hawaiian Pineapple Company (in 1961), and was now operated by the Dole Food Co., Inc., the successor to Castle & Cook, produced 62,255 tons of sugar (Dorrance and Morgan 2000). By this time sugar production in the Hawaiian Islands had become largely unprofitable. In 1996 the Waialua Sugar Company, the last sugar plantation to operate on Oʻahu, harvested its final crop of sugarcane, and by 1998, after 100 years of operation, the company closed its doors for good.

When the Waialua Sugar Co. shut down it voluntarily surrendered its lease of 24,000 acres of agricultural and conservation land to Kamehameha Schools (IMUA 2005). Currently Kamehameha Schools operates the Kawailoa Plantation on this land, leasing plots to individual farmers for diversified agricultural purposes. Roughly 3,600 acres of land, mostly below the 400-foot elevation contour, is suitable for crops that are currently grown there including corn, lettuce, asparagus, plumeria, banana, tuberose, taro, and *noni*. Above the agricultural areas Kamehameha Schools has planted *koa* trees in some areas, and at the time of the current inventory survey fieldwork extensive fencing was being placed within the *mauka* sections of the study area (above the 650-foot contour) for a new cattle lease. Water and electrical services on the leased lands are still provided by the infrastructure installed by the Waialua Agricultural Co. between 1898 and 1950 (IMUA 2005).

Previous Archaeological Research

The earliest published descriptions of archaeological sites near the project area were compiled by Thrum (1906) and McAllister (1933). These early descriptions were of sites on O‘ahu that were readily visible on the surface, such as stone *heiau* platforms, stone mounds, caves, ditches, ponds, and unusual-looking stones (Tables 1 and 2). McAllister (1933) compiled, from various sources, stories concerning the sites and plotted them on maps based on actual surface remains or remembered former locations (Figure 35). Smaller and less dramatic stone-walled enclosures or buried structures made from perishable materials were for the most part overlooked in the early studies on the coastal plain. With the exception of a few prominent *heiau* structures of stone and ponds, most archaeological sites on the coastal plain behind Hale‘iwa and Waialua Bay (see Table 1) had been destroyed by sugar mill construction activities and housing for plantation workers by the 1930s. McAllister accordingly had to base his site descriptions mostly on statements made by old Hawaiians who were born and raised in the Waialua and Hale‘iwa area. With additional housing and commercial development since the 1930s, only a handful of the sites witnessed and/or described by McAllister survived (see Table 2; see thorough summary in Hommon 1982).

Instead of being based on excavated features and analyses of excavated materials, McAllister described the sites and features in terms of ethnographic accounts that he and Thrum collected from people familiar with local history. The orally transmitted traditions recall interesting information on chiefs, priests, fishing, cultivation, deities, myths, rituals, and site functions. Among other things, the stories show how interconnected different parts of the landscape were in the minds of the people and how certain rituals were deemed necessary for subsistence purposes. One story recalls a stone near Pump Station 4 of the Waialua Agricultural Company that local people used to leave offerings for the female deity, known as Lehuanui (also known as Laniwahine). Among other things, this deity ensured abundant fish in the nearby pond. According to McAllister (1933) the stone was gone by the time of his visit.

Makai of the current project area, McAllister (1933:197) also mentions a small *heiau*, reputedly destroyed, near Kawailoa Gorge (the Anahulu River valley). According to local spokespeople, the small *heiau* was for the purposes of “husbandry,” or, agricultural productivity. Another *heiau*, known as ‘Ili‘ilikea (Site 237) (Sterling and Summers 1978:121), was located northeast of ‘Uko‘a pond in a sugarcane field. This *heiau*, with its well-defined walls, was reputedly destroyed in 1916 by the Waialua Agricultural Company. A third *heiau*, called Puupea (Site 238), which was not well remembered by old Hawaiians during McAllister’s time, was described by Sterling and Summers (1978:121) as a few scattered stones located at Punanue Point not more than fifty feet from the beach. An *akua* stone called Punanue (Site 239) was said to be located at the point near Puupea Heiau. Kohokuwelowelo (Site 240), located on an oval-shaped elevation inland of Cane Haul Road south of its intersection with Ashley Road (see Figure 35), was described by McAllister (1933) as a former dwelling place of priests that the commoners never approached. The site had a steep approach from the north, west and south, but from the east it was gradual. McAllister prepared a sketch map of the site (in Sterling and Summers 1978:122) showing several interconnected, partially enclosed, terraces with dirt floors and a number of small rock platforms. He also noted the presence of low walls and a pavement 200 feet seaward of Kohokuwelowelo at a lower elevation (Sterling and Summers 1978:122).

With the advent of Cultural Resource Management (CRM) work in the 1970s (e.g., Barrera 1979), archaeologists started to record less noticeable sites. Among the sites assessed by Barrera (1979) were a 1880s post-*Māhele* Hawaiian midden, a stone-walled remnant of a *heiau*-like structure, stone-walled cultivation terracing, a nineteenth-century house structure, and an old church (see Table 2). In 1982 Hommon reported a partial enclosure with an attached pavement on top of a bedrock outcrop near the intersection of Kawailoa Drive and Cane Haul Road. Two long walls that Hommon (1982) interpreted as a possible enclosure remnant, connected to the southeastern and northwestern sides of the platform-like pavement structure and terminated at mechanical disturbance near the edges of both roads. Hommon (1982) interpreted the pavement as a possible foundation for a surface structure that was no longer present, but was not able to determine the age or function of the site based solely upon the surface remains.

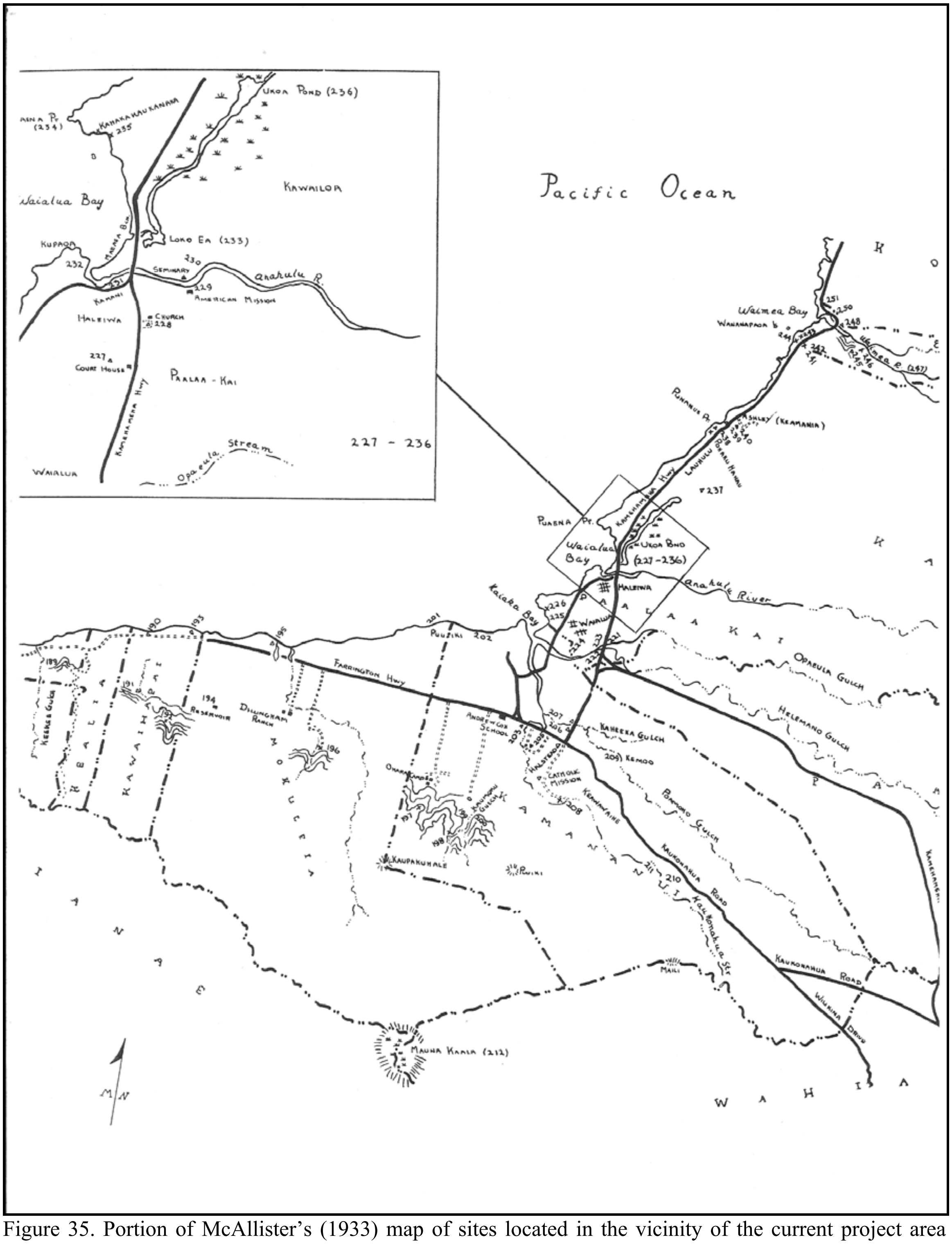

Figure 35. Portion of McAllister's (1933) map of sites located in the vicinity of the current project area (from Sterling and Summers 1978).

Table 1. Sites located southwest of the project area.

Site Number	*Site Type*	*Area/Ahupua'a*	*Author (date)*
197	Kalakiki Heiau	Waialua/Kamananui	McAllister (1933)
198	Burial Cave	Waialua/Kamananui	McAllister (1933)
199	Stone Mounds	Waialua/Kamananui	McAllister (1933)
200	Burial Cave	Waialua/Kamananui	McAllister (1933)
201	Keauau Fishing Shrine	Waialua/Kamananui	McAllister (1933)
202	Sand Dune Burials	Waialua/Kamananui	McAllister (1933)
203	Heiau	Waialua/Kamananui	McAllister (1933)
204	Oahunui Stone	Waialua/Kamananui	McAllister (1933)
205	Akua Stone	Waialua/Kamananui	McAllister (1933)
206	Kahakahuna Heiau	Waialua/Pa‘ala‘a	McAllister (1933)
207	Kawai Heiau	Waialua/Pa‘ala‘a	McAllister (1933)
208	Irrigation Ditch	Waialua/Kamananui	McAllister (1933)
211	Burial Cave	Waialua/Kamananui	McAllister (1933)
223	Hekili Heiau	Waialua/Kawailoa	McAllister (1933)
225	Kapukapuakea Heiau	Waialua/Kawailoa	McAllister (1933)
226	Pohaku Lanai Stone	Waialua/Kawailoa	McAllister (1933)
227	Puupilo Heiau	Waialua/Kawailoa	McAllister (1933)
228	Kepuwai Heiau	Waialua/Kawailoa	McAllister (1933)
229	Kawaipuolo Spring	Waialua/Kawailoa	McAllister (1933)
231	Anahulu Heiau	Waialua/Kawailoa	McAllister (1933)
232	Akua Stone	Waialua/Kawailoa	McAllister (1933)
235	Stone for Healing	Waialua/Kawailoa	McAllister (1933)

Increasingly detailed CRM surface inspections and excavations on the flat coastal plain behind Waialua Bay resulted in the discovery of highly fragmented surface features and buried remains. Avery and Kennedy (1993), for example, unearthed disturbed human remains near Kawailoa Beach, while Moore et al. (1993) discovered a number of human burial sites, three fire pits, a historic house site, and a posthole with charcoal lens at the Hale‘iwa Beach Park (see Table 2). Charcoal from a buried fire pit yielded a radiocarbon assay that calibrated to between A.D. 1400 and 1670. Borthwick et al. (1998) conducted a survey and testing of the area immediately north of Hale‘iwa Beach Park. Among the sites they recorded were a prehistoric coral ledge, a human burial, WWII-era concrete features, and disturbed prehistoric cultural layers. During archaeological excavations south of Hale‘iwa Beach Park, on the shore of Loko‘ea pond, McGerty and Spear (2000) found a stacked basalt boulder wall and a charcoal layer. Charcoal from the layer yielded a radiocarbon assay that calibrated to between A.D. 1420 and 1530. Two charcoal samples collected from a buried feature associated with a posthole, cooking pit, and human burial at the Ali‘i Beach Park *makai* of Hale‘iwa, dated to between A.D. 1430 and 1680 (McDermott et al. 2001). Directly north of the Anahulu River, not far from where it empties into the ocean, Yeomans (2001) unearthed 11 features that contained charcoal. An un-calibrated assay of a charcoal sample from one feature dated to A.D. 1500-1590. Borthwick et al. (2001) reported a foundation of an O‘ahu Railway and Land Company’s wooden tank and base of the railway line’s right-of-way within the Hale‘iwa Beach Skate Park. Nearby, Borthwick et al. (2001) excavated a basalt boulder structure and a cultural layer. In 2005 Pantaleo and Titchenal (2005), during backhoe testing at a parcel south of Ashley Road across the highway from Kawailoa Beach, found the remains of a late nineteenth century female burial in an unmarked pit. In 2007 Moore and Kennedy reported on a traditional modified outcrop and a shrine that were probably associated with agricultural activities in the flatlands south of ‘Uko‘a pond.

Table 2. Sites *makai* of the project area.

Site Number	*Site Type*	*Area/Ahupua'a*	*Author (date)*
236	‘Uko‘a Pond	Waialua/Kawailoa	McAllister (1933)
237	Iliilikea Heiau	Waialua/Kawailoa	McAllister (1933)
238	Puupea Heiau	Waialua/Kawailoa	McAllister (1933)
239	Punanue Akua Stone	Waialua/Kawailoa	McAllister (1933)
240	Kohokuwelowelo	Waialua/Kawailoa	McAllister (1933)
241	Kupopolo Heiau	Waialua/Kawailoa	McAllister (1933)
242	Stone in Rock Shelter	Waialua/Kawailoa	McAllister (1933)
1439	Historic Midden	Waialua/Kawailoa	Barrera (1979)
1440	Stone Wall Remnant	Waialua/Kawailoa	Barrera (1979)
1441	Agricultural Terraces	Waialua/Kawailoa	Barrera (1979)
1442	House Structure	Waialua/Kawailoa	Barrera (1979)
1443	Old Church	Waialua/Kawailoa	Barrera (1979)
50-80-04-4670	Human Burials	Waialua/Kawailoa	Avery and Kennedy (1993)
4589	Historic House	Waialua/Kawailoa	Moore et al. (1993)
4590	Fire Pit	Waialua/Kawailoa	Moore et al. (1993)
4591	Fire Pit	Waialua/Kawailoa	Moore et al. (1993)
4592	Fire Pit	Waialua/Kawailoa	Moore et al. (1993)
4593	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4594	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4595	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4596	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4597	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4598	Human Burial	Waialua/Kawailoa	Moore et al. (1993)
4601	Posthole and Lens	Waialua/Kawailoa	Moore et al. (1993)
50-80-04-3400	Stone enclosure/pavement	Waialua/Kawailoa	Hommon (1982)
50-80-04-234	Coral Ledge	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-235	Stone	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5495	Human Burial	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5641	WWII Concrete	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5642	WWII Airfield	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5643	WWII Bunker	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5644	Pre-WWII Midden	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5661	Mixed cultural layer	Waialua/Kawailoa	Borthwick et al. (1998)
50-80-04-5795	Charcoal Layers	Waialua/Kawailoa	McGerty and Spear (2000)
50-80-04-5839	Stone Wall Remnant	Waialua/Kawailoa	McGerty and Spear (2000)
50-80-04-5850	Prehistoric Pits	Waialua/Kawailoa	McDermott et al. (2001)
50-80-01-5795	Charcoal Layers	Waialua/Kawailoa	Yeomans (2001)
50-80-04-5791	OR&L Rail ROW	Waialua/Kawailoa	Borthwick et al. (2001)
50-80-04-5915	Stone Foundation	Waialua/Kawailoa	Borthwick et al. (2001)
50-80-04-5916	Cultural Layer	Waialua/Kawailoa	Borthwick et al. (2001)
50-80-10-6768	Human Burial	Waialua/Kawailoa	Pantaleo and Titchenal (2005)
50-80-04-6867	Driveway and Structures	Waialua/Kawailoa	Moore and Kennedy (2007)
50-80-04-6868	C-shape Shrine	Waialua/Kawailoa	Moore and Kennedy (2007)
50-80-04-6869	Modified Outcrops	Waialua/Kawailoa	Moore and Kennedy (2007)

To summarize then, radiocarbon dates of charcoal from buried excavated occupation layers on the fairly narrow coastal plain *makai* of the project area range in age between A.D. 1400 and 1670, which falls well within the so-called Expansion Period prior to the arrival of Captain Cook (e.g., Kirch 1992). It is in this relatively active area of modern urban expansion, centered on Haleʻiwa and Waialua, that most CRM archaeological work has been done in the vicinity of the project area. Unfortunately, a clear picture of intra- and inter-settlement layout in the area has not emerged, due to three main reasons. First, only pockets of deposits seem to have survived land alterations in the area. Secondly, only relatively narrow and deep backhoe trenches were used for sampling. And thirdly, no attempt has been made to try link up results from different trenches. Over and above this lack of synthesis has been the absence a coordinated attempt to combine the archaeological sequence with oral histories and documented historical developments in the area. The inter-disciplinary research of the Anahulu Valley hinterland *mauka* of coastal plain, instigated by Kirch and Sahlins, is perhaps a useful model to emulate for future CRM work on the coastal plain.

The earliest radiocarbon evidence for the occupation of sites in Anahulu Valley (Table 3), immediately *mauka* of the coastal plain, comes from the Keʻekeʻe rock shelter. Kirch (1992:47-48) found dating and subsistence evidence that this large rock shelter was used as an intermittent camp, sometime after A.D. 1300. By A.D. 1500 two other shelters in the valley, known as Kuolulo and Kēʻae, were also occupied intermittently. A radiocarbon date from an artifact and faunal rich earth oven within the Keʻekeʻe Nui rock shelter and from a similarly rich basal layer of the nearby Keʻekeʻe Iki rock shelter suggest that by A.D. 1650 these shelters were used as permanent residences. Kuolulo rock shelter shows similar artifact and feature evidence for permanent occupation some time after A.D. 1700. Taken together, excavated artifacts, features, and dated charcoal suggest that by the so-called Proto-Historic Period, people from the Haleʻiwa coastal plain started occupying the adjacent Anahulu valley on a more permanent basis.

Radiocarbon dates and the lack of occupational refuse suggest that in the early nineteenth century the rock shelters in the Anahulu River valley were abandoned (Kirch 1992:166). These were replaced by a series of open house sites that were constructed in the upper valley in association with taro irrigation terraces. A combination of radiocarbon, artifact, and documentary evidence, show that soon after A.D. 1804, six houses were built on alluvial terraces in the upper valley. Between A.D. 1804 and 1814, the six-kilometer previously barren stretch of interior valley was transformed to irrigated pond fields, associated with at least eight permanent houses. By 1820, with the return of Kamehameha and his retinue to Hawaiʻi Island, at least four of the houses and many terraced fields were abandoned. However, by 1830 two new houses appeared in the upper valley, most likely in response to supply whaling ships with taro, yams, sweet potato, hogs, and bark cloth. Physical evidence for restructuring the irrigation system occurs as late as 1845 (Kirch 1992:167). Following the *Māhele* in the late 1840s houses and fields in the valley were increasingly abandoned, so by the 1880s the area was virtually deserted.

Earlier CRM work conducted by Rosendahl (1977) showed that prehistoric sites occurred quite high up the Kawailoa and neighboring gulches; farther removed from the coastal plain than the sites subsequently excavated by Kirch (1992). All five sites reported by Rosendahl (Table 4) occurred either within or on the edges of gulches and at the confluences of streams. The sites included two platforms, a habitation complex, an agricultural complex, and an enclosure. These sites, all of which occur south of the current project area, within the US Army Kawailoa Training Area, represented the inland limits of Proto-historic and Historic Period occupation of the various stream gulches that open out onto the coastal plain (Dega 1996:32-33).

Partly overlooked or at least downplayed by archaeologists in the study area is rock art. Apart from one incised name on a large boulder inserted into the boundary wall of a site (Kirch 1992:98), only one other rock art site is mentioned for the Kawailoa Gulch area, through which the Anahulu River flows. Cox and Stasack (1970:97) mention three human figures and two dogs (Site D6-19) that were pecked above the opening of a rock shelter (Site D6-14) on the north side of the Anahulu River (see Table 3). As not all rock surfaces suitable for rock art production have actually been utilized and knowing that most rock art panels occur along trails, on *ahupuaʻa* boundaries, and on the edges of settlements and structures, the very choice of their placement may contain clues as to their cultural significance.

Table 3. Sites recorded in Anahulu Valley.

Site Number*	***Site Type***	***Area/'Ili***	***Author (date)***
D6-14	Rockshelter	Anahulu Valley/‘Imi‘imi	Kirch (1992)
D6-19	Rockshelter petroglyphs	Anahulu Valley/‘Imi‘imi	Cox (1970)
D6-25	Habitation complex	Anahulu Valley/Kaloala	Kirch (1992)
D6-26	Irrigation complex	Anahulu Valley/Kaloala	Kirch (1992)
D6-27	Habitation terrace	Anahulu Valley/Kaloala	Kirch (1992)
D6-28	Rockshelter	Anahulu Valley/Haka'ai	Kirch (1992)
D6-29	Stone structure	Anahulu Valley/Haka‘ai	Kirch (1992)
D6-30	Upright stone	Anahulu Valley/Haka‘ai	Kirch (1992)
D6-31	Stone-walled house site	Anahulu Valley/Lahuimoho	Kirch (1992)
D6-32	Earthen terraces	Anahulu Valley/Pulepule	Kirch (1992)
D6-33	Habitation terrace	Anahulu Valley/Pulepule	Kirch (1992)
D6-34	Habitation complex	Anahulu Valley/Pulepule	Kirch (1992)
D6-35	Habitation terrace	Anahulu Valley/Pulepule	Kirch (1992)
D6-36	Rockshelter	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-37	Habitation complex	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-38	Habitation terrace	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-39	Habitation terrace	Anahulu Valley/'Ua'u	Kirch (1992)
D6-40	Habitation complex	Anahulu Valley/Mikiai	Kirch (1992)
D6-41	Irrigation complex	Anahulu Valley/Mikiai	Kirch (1992)
D6-42	Irrigation complex	Anahulu Valley/Koilau	Kirch (1992)
D6-43	Irrigation complex	Anahulu Valley/Pulepule	Kirch (1992)
D6-44	Irrigation complex	Anahulu Valley/Kapuahilua	Kirch (1992)
D6-45	Irrigation complex	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-46	Irrigation complex	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-47	Irrigation complex	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-48	Irrigation complex	Anahulu Valley/'Ua‘u	Kirch (1992)
D6-49	Cliff burial	Anahulu Valley/'Ua‘u	Kirch (1992)
D6-50	Platform burial	Anahulu Valley/Kaloaloa	Kirch (1992)
D6-51	Habitation complex	Anahulu Valley/Kapuahilua	Kirch (1992)
D6-52	Rockshelter	Anahulu Valley/Ke‘ae	Kirch (1992)
D6-53	Irrigation complex	Anahulu Valley/Ke‘ae	Kirch (1992)
D6-54	Irrigation complex	Anahulu Valley/Ke‘ae	Kirch (1992)
D6-55	Burial Cave	Anahulu Valley/‘Imi‘imi	Kirch (1992)
D6-56	Rockshelter	Anahulu Valley/‘Imi‘imi	Kirch (1992)
D6-57	Rockshelter	Anahulu Valley/Kaha‘aloa	Kirch (1992)
D6-58	Rockshelter	Anahulu Valley/Ke‘kek‘e	Kirch (1992)
D6-59	Burial Cave	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-60	Rockshelter	Anahulu Valley/Ke‘eke‘e	Kirch (1992)
D6-61	Platform burials	Anahulu Valley/ Ke‘eke‘e	Kirch (1992)
D6-67	Stone enclosure	Anahulu Valley/ Ke‘eke‘e	Kirch (1992)
D6-68	Platform burial	Anahulu Valley/ Ke‘eke‘e	Kirch (1992)

* Bishop Museum Numbers

Table 4. Sites recorded by Rosendahl (1977) south of the current project area.

Site Number	*Site Type*	*Area/Ahupua'a*	*Author (date)*
50-80-05-9510	Platform	Waialua/Kawailoa	Rosendahl (1977)
50-80-05-9511	Agricultural Complex	Waialua/Kawailoa	Rosendahl (1977)
50-80-05-9512	Habitation Complex	Waialua/Kawailoa	Rosendahl (1977)
50-80-05-9513	Enclosure	Waialua/Kawailoa	Rosendahl (1977)
50-80-05-9514	Platform	Waialua/Kawailoa	Rosendahl (1977)

Near the bottom of a cliff line *makai* of the project area, Cluff (1968) found a series of rock art panels with pecked depictions of human figures and dogs (Table 5). This rock art rock shelter is not far from the coast and slightly southeast from the Kupopolo Heiau (Site 241), located on the narrow coastal plain south of Waimea River mouth. Pecked triangular-bodied human figures and dogs with curved tails are depicted within the shelter, as are some incised motifs. The chronological relationship between the rock art and the stacked rock walls in front of the shelter still needs to be researched. Whatever the date of the petroglyphs might turn out to be, they are almost certainly prehistoric in age, based on dates of similar motifs on the Island of Hawaiʻi (Lee and Stasack 2005, Rechtman et al. 2003).

Slightly to the northwest and across the Kamehameha Highway of Kupopolo Heiau (Site 241) and the petroglyphs, Athens and Shun (1982) found 12 sites on the coastline (see Table 5). The sites included two prehistoric midden areas, two stone-walled enclosures, two small rock shelters, a stone pile complex, a stone platform, a stone wall, a *heiau* platform, a natural water hole, and the Oʻahu Railway and Land Company's railroad bed. Taken together, the prehistoric sites recorded by Cluff (1968) Athens and Shun (1982) were probably a southern extension of the Waimea River settlement spilling out of the valley down the coast.

Table 5. Sites recorded *makai* of the project area (Cuff 1968; Athens and Shun 1982).

Site Number	*Site Type*	*Area/Ahupua'a*	*Author (date)*
D6-17	Kupopolo Heiau and Rockshelter Petroglyphs	Waialua/Kawailoa	Cluff (1968)
D6-62	Midden	Waialua/Kawailoa	Athens and Shun (1982)
D6-63	Enclosure	Waialua/Kawailoa	Athens and Shun (1982)
D6-64	Midden	Waialua/Kawailoa	Athens and Shun (1982))
D6-65	Stone Piles	Waialua/Kawailoa	Athens and Shun (1982)
D6-66	Stone Platform Complex	Waialua/Kawailoa	Athens and Shun (1982)
D7-2	*Heiau*	Waialua/Waimea	Athens and Shun (1982)
D7-48	Water Hole	Waialua/Waimea	Athens and Shun (1982)
D7-49	OR&L Rail Bed	Waialua/Waimea-Kawailoa	Athens and Shun (1982)
D7-50	Enclosure	Waialua/Waimea	Athens and Shun (1982)
D7-51	Wall	Waialua/Waimea	Athens and Shun (1982)
D7-52	Rock Shelters	Waialua/Waimea	Athens and Shun (1982)

Sites within the Waimea River Valley are among the first recorded within the vicinity of the project area, considering that many are prominent features and/or features recalled in local oral histories. McAllister (1933) recorded four *heiau*, two fishing shrines, two rock shelters with burials, one rock shelter with a sacred stone, a boundary stone, and a prominent stone-walled agricultural terrace complex within the valley (Table 6; see Figure 35). Moore and Luscomb (1974) recorded an additional 32 sites within the valley, indicating that it was densely populated in both Precontact and early Historic times. Reported excavation results of previously discovered sites within the Waimea River valley comes from two of Mitchell's excavations. The first set of excavations, on a *heiau*-like platform structure and associated walls and piles against the southern slopes of the valley, labeled Site D7-26, were reported by Mitchell (1977). In 1985 and 1986 Mitchell reported work on a separate stepped-platform structure, labeled Site D7-23, near its northern entrance. Whereas a radiocarbon assay of a coral fragment from the Site D7-23 platform yielded a calibrated date range of A.D. 1470 to 1700, the recovery of ceramic sherds, bottle glass, a nail, and a button from associated midden deposits suggests that the structure dates to the Historic Period.

Table 6. Sites recorded in the Waimea River Valley.

Site Number	*Site Type*	*Area/Ahupua'a*	*Author (date)*
242	Rock Shelter Stone	Waialua/Waimea	McAllister (1933)
243	Boundary Stone	Waialua/Waimea	McAllister (1933)
244	Fishing Shrine	Waialua/Waimea	McAllister (1933)
245	Fishing Shrine	Waialua/Waimea	McAllister (1933)
246	Burial Cave	Waialua/Waimea	McAllister (1933)
247	Agricultural Terraces	Waialua/Waimea	McAllister (1933)
248	Heiau Kuhale	Waialua/Waimea	McAllister (1933)
249	Heiau Puu O Mahuku	Waialua/Waimea	McAllister (1933)
250	Kalaku and Kalakoi	Waialua/Waimea	McAllister (1933)
251	Burial Cave	Waialua/Waimea	McAllister (1933)
D7-7	Rock Shelter Burials	Waialua/Waimea	Moore and Luscomb (1974)
D7-8	Enclosure	Waialua/Waimea	Moore and Luscomb (1974)
D7-9	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-10	Enclosure	Waialua/Waimea	Moore and Luscomb (1974)
D7-11	Walls	Waialua/Waimea	Moore and Luscomb (1974)
D7-12	Japanese Shrine	Waialua/Waimea	Moore and Luscomb (1974)
D7-14	Stone Pile	Waialua/Waimea	Moore and Luscomb (1974)
D7-15	Stone Pile	Waialua/Waimea	Moore and Luscomb (1974)
D7-16	Agricultural Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-17	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-18	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-19	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-20	Stone Pile	Waialua/Waimea	Moore and Luscomb (1974)
D7-21	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-22	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-23	Shrine	Waialua/Waimea	Moore and Luscomb (1974)
D7-24	Wall	Waialua/Waimea	Moore and Luscomb (1974)
D7-25	Walls	Waialua/Waimea	Moore and Luscomb (1974)
D7-26	Walls and Piles	Waialua/Waimea	Moore and Luscomb (1974)
D7-27	Sandstone Pounder	Waialua/Waimea	Moore and Luscomb (1974)
D7-28	Basalt Adze	Waialua/Waimea	Moore and Luscomb (1974)
D7-29	Grinding Stone	Waialua/Waimea	Moore and Luscomb (1974)
D7-30	Ulu Maika Stone	Waialua/Waimea	Moore and Luscomb (1974)
D7-31	Terrace Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-32	Stone Pile	Waialua/Waimea	Moore and Luscomb (1974)
D7-33	Wall complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-34	Wall	Waialua/Waimea	Moore and Luscomb (1974)
D7-35	Rock Shelter Burials	Waialua/Waimea	Moore and Luscomb (1974)
D7-36	Wall	Waialua/Waimea	Moore and Luscomb (1974)
D7-37	Rock Shelter Burials	Waialua/Waimea	Moore and Luscomb (1974)
D7-38	Rock Shelter	Waialua/Waimea	Moore and Luscomb (1974)
D7-39	Agricultural Complex	Waialua/Waimea	Moore and Luscomb (1974)
D7-41	Historic House	Waialua/Waimea	Mitchell (1985)
D7-42	Burial	Waialua/Waimea	Mitchell (1985)

PROJECT AREA EXPECTATIONS

Although no formal archaeological work has been conducted within the study area, the results (discussed in detail above) of previously conducted archaeological research in the vicinity of the study area allow for an informed guess as to the types of sites one would expect to encounter given the physical setting. The background knowledge of intensive land-use history and alteration afforded additional predictive information as to the condition and level of disturbance any such sites could have experienced.

Judging from previous ethnohistorical and archaeological work, it was anticipated that most Precontact sites will be located along the *makai* escarpment adjacent to the study area, through which the access road corridors extend. McAllister (1933) and Sterling and Summers (1978) describe a priestly residential area (Site 240) located on an oval-shaped elevation inland of Cane Haul Road south of its intersection with Ashley Road. Locally transmitted oral traditions relate (Genz and Hammatt 2011), and archaeological work (Pantaleo and Titchenal 2005) documents, that the area of the *makai* escarpment and below were a favored place for burial during precontact and early historic times. On the lower slopes of the escarpment along Cane Haul Road, Hommon (1982) found a small platform structure (Site 3400), near the intersection of Kawailoa Drive and Cane Haul Road, not far northeast of ‘Uko‘a Pond (Site 236). *Māhele* records also identify a several *kuleana* lots that once extend across the southern and lower portions of what are now Cane Haul Road and Kawailoa Drive.

As for later Historic Period resources, late nineteenth and early twentieth century maps show several plantation camps (representing multiple ethnicities) located both below and above the *makai* escarpment along with an extensive network of irrigation features farther upslope. The plantation camps and the irrigation features were part of successive plantation efforts associated with large-scale sugarcane and pineapple cultivation. Historical documentation (e.g., see Dorrance and Morgan 2000; Wilcox 1996) indicates that plantation agricultural may have began impacting the Kawailoa landscape as early as 1898, and that by the late 1920s irrigated fields and associated infrastructure (formal and informal ditches, pipes, tunnels, a few pump houses, several reservoirs, roads, and railway lines) covered vast portions of the study area (see Figure 4). Beginning in ca. 1939 gun emplacements and a military command and fire control communication system were established at key locations in and around the study area (along the shore near Kawailoa Drive and Ashley Road, at Kawailoa and Waimea Camps, and along the upper ridges of the Waimea River catchment) as part of O‘ahu’s coastal defenses (Bennett 2002; Gaines 2002; Sugimoto 1996; Takamura 1995). The defenses were mostly dismantled immediately following World War II (in ca. 1945). By the middle twentieth century the plantation railway system was defunct and was replaced by roads for trucks to haul cane. Within the study area the formal plantation activities persisted until 1996.

Given the extensive and intensive plantation use of the current study area, it is likely that any earlier archaeological features were significantly impacted if not completely destroyed. It is the expectation that within the study area, Historic Period features related to plantation irrigation, transportation, and housing and to military activity, including artillery and communications, will make up the majority of the archaeological features observed. It is possible, however only remotely so, that Precontact features have survived in the tablelands in spite of the more recent land use activities. Precontact archaeological features may also be present along the margins of the tablelands and in the areas adjacent to Cane Haul Road and the *makai* escarpment, through which the other study area roadways extend.

FIELDWORK

The fieldwork for the current project was carried out during two major sessions–between April 12 and May 14, 2010, and between February 15 and February 25, 2011; with follow-up field days on March 30, 2011, April 14, 2011, and April 27, 2011. The field effort was supervised by Robert Rechtman, Ph.D., directed by Johannes Loubser, Ph.D. and Matthew Clark, B.A., and the field crew included Ashton Dircks Ah Sam, B.A., Owen Moore, M.A., Morgan Schmidt, Ph.D., and Mark Winburn, B.A. During the first fieldwork session the areas studied included the Eastern Tableland Array, the Kawailoa Road Corridor, the southern end of the Cane Haul Road Corridor, and the Ashley Road Corridor. The second session of fieldwork focused on the Western Tableland Array, the Mid-Line Road Corridor, and the bulk of Cane Haul Road Corridor. Follow-up fieldwork days were spent surveying the Makai Interconnection Facility Corridor and the Overhead Collector Line Corridor. An estimated total of 1088 labor hours were expended in the field.

Methods

As described above, the study area consists of tableland ridges for the placement of wind turbine towers and appurtenant facilities, and the margins of existing roadways that may be widened or graded to facilitate construction transportation. The existing roadways and their margins were subject to intensive surface survey with fieldworks spaced on either side of the existing roadway examining the limits of the survey corridor.While surveying the landforms on which the wind turbine towers are to be erected, every effort was made to maintain regularly spaced survey transects. The spacing interval ranged between 20 and 40 meters depending on terrain and visibility. The tablelands were generally traversed from gulch edge to gulch edge (north/south) or, when *mauka/makai* roads were present, between the roads and the gulch edges. Narrow tableland formations were traversed *mauka*/*makai*. Thick stands of Guinea grass limited visibility to a few meters in many areas on the tablelands, a factor that required closer spacing and meandering transects to surface inspect specific areas anticipated to be developed. The only un-mechanically disturbed portions on the tablelands appear to have been the outer edges. The comparatively intact rims of the tablelands and the ridge fingers that spread out from them at the drop-off into the surrounding natural gulches were surface inspected in a *mauka*/*makai* direction independently of the pedestrian transects. These comparatively intact gulch edges and ridge fingers were inspected in the hope of finding features that once might have extended up onto the tablelands from the gulches. However, the upper plateaus on which the turbines are to be erected contained virtually no natural stone, which made the occurrence and identification of surface features unlikely.

During the surface inspection of the survey corridors all encountered archaeological resources, natural boundaries, survey markers, existing plantation infrastructure, and land alterations (e.g., bulldozing, fence lines, roads, etc.) were plotted on a scaled map of the study area using Garmin 76s handheld GPS technology (set to the NAD 83 datum). Potential archaeological features, or groupings of features, dentified in the field were sequentially assigned temporary site numbers (T-1, T-2, T-3, etc.), and then cleared of vegetation, mapped (with a tape and compass), photographed, and described using standardized description forms. Long linear features, such as the plantation ditches, were mapped using the Garmin 76s handheld GPS, and then individual plan views of complicated sections where more detail was needed were prepared using a tape and compass. No subsurface testing was deemed necessary at any of the recorded sites to assess age and function. In addition to the archaeological fieldwork, archival cartographic material concerning plantation infrastructure was reviewed and correlated with the field findings.

During the fieldwork an attempt was also made to inspect those sites previously identified outside of the current study area but within the overall subject property to verify their locations relative to the current study area boundary. In addition to this, reconnaissance level survey was undertaken in the areas adjacent to Alternatives-1 and 2 of the Kawailoa Road Corridor, and near the intersection of Cane Haul Road and Ashley Road, where the study area encroaches on the coastal escarpment, and where any surviving Precontact features were expected to be found. This work helped guide the eventual selection of a project area that would have the least impact on potentially significant archaeological resources. Archaeological features identified nearby, but outside, the study area were also assigned a temporary site number, and basic information was collected to record their locations, condition, possible function, and potential significance. In most cases these features were cleared of thick vegetation and photographed, and a sketch map was prepared with a brief description of the resource.

FINDINGS

As a result of the current study, seventeen archaeological sites were identified within the study area (Table 7; Figure 36). All of these sites date from the Historic Period and were likely associated with either former military operations (Site 7155, 7156, 7158), or former plantation activities (Sites 7157, 7159, 7160, 7161, 7162, 7163, 7164, 7165, 7166, 7167, 7168, 7169, 7170, 7171). In addition to the sites identified within the study area, six previously identified archaeological sites and nineteen newly identified sites were inspected during the current study (Table 8) nearby, but outside of, the study area. These sites represent both Precontact and Historic use of the general study area. Their locations are shown on Figure 37. Each of the sites identified within the study area is discussed in detail below. For ease of presentation the following presentation of findings is organized by survey area location (Western Tableland Array, Eastern Tableland Array, Kawailoa Road Corridor, Cane Haul Road Corridor, Mid-Line Road Corridor, Ashley Road Corridor, Makai Interconnection Facility Corridor, and Overhead Collector Line Corridor).

Table 7. Sites recorded during the current study.

*Site #**	*Description*	*Function*	*Association*	*Area***
50-80-04-7155	Concrete pillar	Military communication	WWII	ETA
50-80-04-7156	Concrete pillar	Military communication	WWII	ETA
50-80-04-7157	Concrete marker	Boundary marker	Plantation	ETA
50-80-04-7158	Metal pole/concrete base	Military communication	WWII	ETA
50-80-04-7159	Ditch complex	Agricultural irrigation	Plantation	KRC
50-80-04-7160	Stone abutments	Agricultural transportation	Plantation	KRC 1
50-80-04-7161	Concrete foundations	Stables	Plantation	KRC 1
50-80-04-7162	Kerbstone alignment	Agricultural transportation	Plantation	KRC 1
50-80-04-7163	Stone/concrete culvert	Drainage control	Plantation	KRC 2
50-80-04-7164	Metal pipeline	Agricultural irrigation	Plantation	CHRC
50-80-04-7165	Stone/concrete culvert	Drainage control	Plantation	CHRC
50-80-04-7166	Stone/concrete culvert	Drainage control	Plantation	CHRC
50-80-04-7167	Stone/concrete culvert	Drainage control	Plantation	CHRC
50-80-04-7168	Concrete bridge	Agricultural transportation	Plantation	CHRC
50-80-04-7169	Ditch complex	Agricultural irrigation	Plantation	MLRC
50-80-04-7170	Ditch complex	Agricultural irrigation	Plantation	MLRC
50-80-04-7171	Ditch complex	Agricultural irrigation	Plantation	ARC

*State (50-Hawai‘i)-Island (80-O‘ahu)-USGS quad (04-Hale‘iwa)-SIHP Site # (71xx)
**ETA-Eastern Tableland Array; KRC 1-Kawailoa Road Corridor (Alternative 1) KRC 2-Kawailoa Road Corridor (Alternative 2); MLRC-Mid-Line Road Corridor, CHRC-Cane Haul Road Corridor; ARC-Ashley Road Corridor.

Table 8. Sites identified near, but outside, the study area.

Site #	*Description*	*Study*	*Proximity*
236	‘Uko‘a Pond	McAllister (1933)	KRC
240	Kohokuwelowelo	McAllister (1933)	CHRC
3400	Stone enclosure/pavement	Hommon (1982)	KRC/CHRC
T-10	Stone and concrete pedestal	Current study	KRC
T-13	Terraced platform	Current study	KRC
T-14	Slab paved pathway	Current study	KRC/CHRC
T-15	Concrete slab foundation	Current study	KRC
T-16	Walled enclosure against cliff	Current study	KRC
T-17	Walled enclosure	Current study	KRC
T-18	Walled enclosure	Current study	KRC
T-19	Wall on bedrock outcrop	Current study	KRC
T-20	Wall on bedrock boulders	Current study	KRC
T-21	Walled enclosures against cliff	Current study	KRC
T-23	Parallel terrace walls	Current study	KRC
T-24	Rock/soil terrace against cliff	Current study	KRC
T-25	Soil-filled terraces (gardens?)	Current study	KRC
T-26	Rock/soil terraces against cliff	Current study	KRC
T-27	Concrete and rock foundation	Current study	KRC
T-28	Concrete and rock foundation	Current study	KRC
T-29	Concrete and rock foundation	Current study	KRC
T-35	Old rail bed (?)	Current study	KRC/CHRC
T-36	Japanese cemetery	Current study; Genz and Hammatt (2011)	KRC
T-37	Modified areas on cliff face	Current study	ARC/MIFC
-	Burials in cliff face	Genz and Hammatt (2011)	ARC
-	Concrete bunker	Beckett and Singer (1999)	CHRC

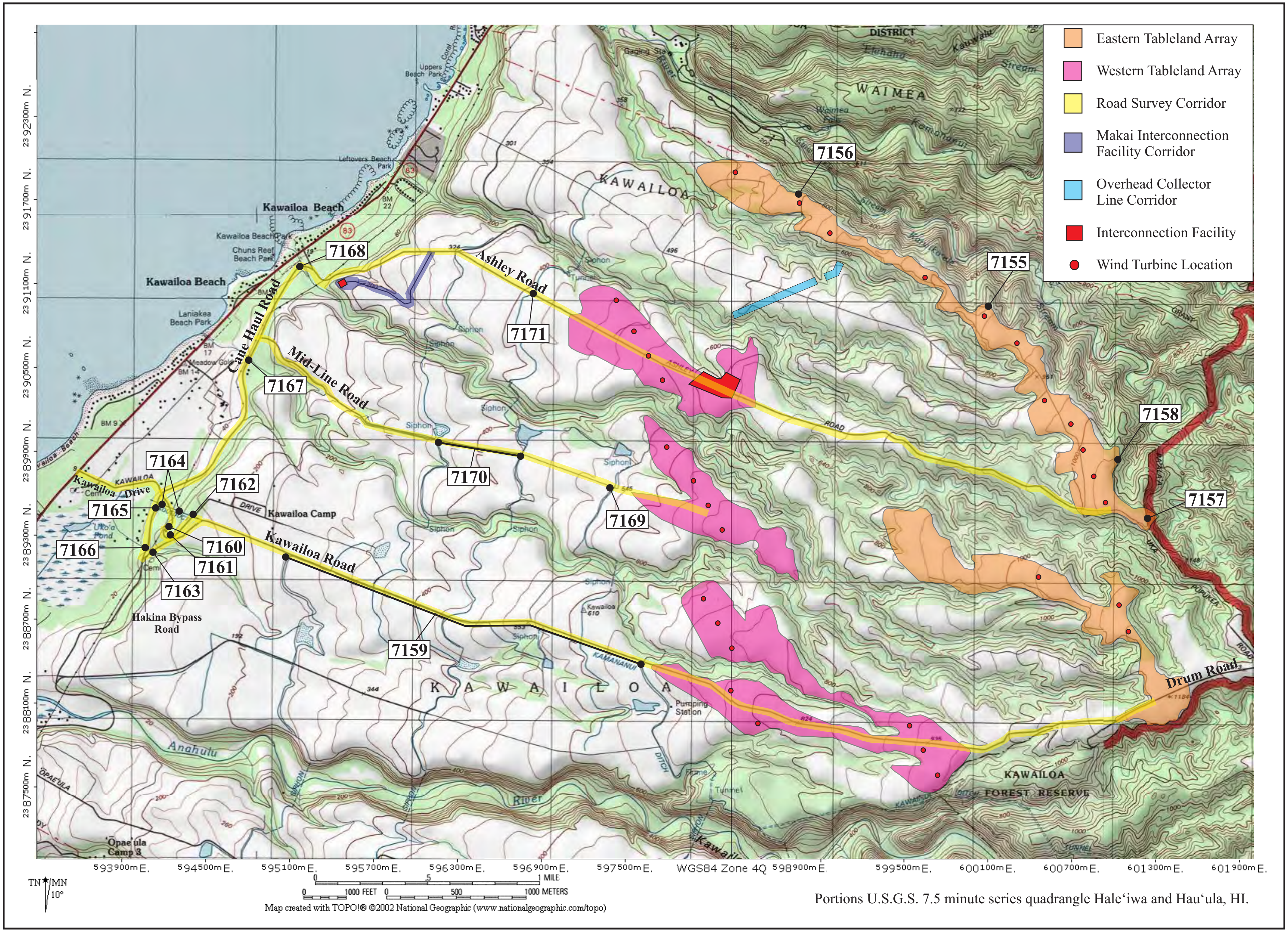

Figure 36. Project area map showing site locations.

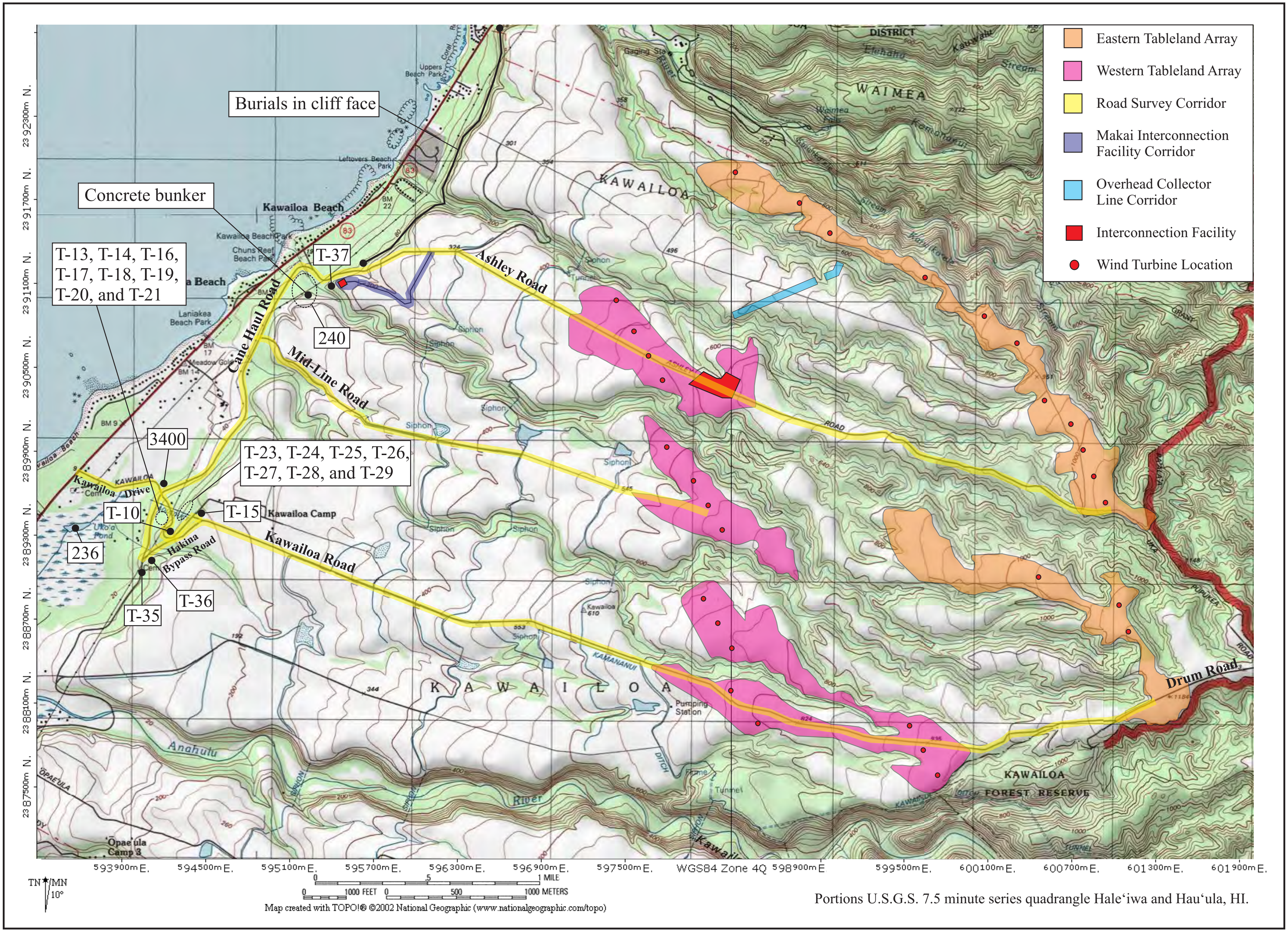

Figure 37. Project area map showing sites nearby, but outside, the current project area.

Western Tableland Array

The Western Tableland Array consists of three distinct survey areas that are slated for the proposed development of sixteen wind turbines, an O & M (office and maintenance) building, a *mauka* point of interconnection and associated infrastructure. The proposed array of turbines runs in a northwesterly line across TMKs:1-6-2-11:001, 1-6-1-07:001, and 1-6-1-06:001 from Drum Road at an elevation of roughly 1,000 feet above sea level to a point northwest of Ashely Road at an elevation of roughly 500 feet above sea level (see Figures 1 and 2). The tablelands that contain the survey areas are separated from one another by steep sided gulches that do not permit interconnected access. The survey areas included only the flat tablelands and not the steep sided gulches. All of the survey areas in the Western Tableland Array contain a thick growth of Guinea grass (*Panicum maximum*) interspersed with albizia trees (*Acacia lebbek*) and other less frequently occurring species of trees, shrubs, vines, ferns, and grasses. The two southeastern most survey areas are accessed by Kawailoa Road, the central survey area is accessed by Mid-Line Road, and the northwestern survey area that includes the O & M building is accessed by Ashley Road.

The Western Tableland Array survey areas correspond to the former Waialua Sugar Company's fields Kawailoa-15, 17a, 17b, 20, 24a, and Waiamea-6 and 8 (see Figure 9). As can be seen in aerial photographs (see Figures 5-8), these fields were completely cultivated in sugarcane and pineapple during the second half of the twentieth century. The Hawaiian Pineapple Company's (H. P. Co.) Waimea Camp (see Figure 4) was formerly located within the Western Tableland Array survey area along Ashley Road, at the location of the *mauka* point of interconnection. The camp, which was built prior to 1929, was removed during the 1950s, and by the 1960s the area had been replanted in pineapples. During WWII four 75mm field guns were emplaced at Waimea Camp. Owing to the later use of the Waimea Camp area for agricultural fields, no surface remnants of it or the WWII gun emplacements, were found in the vicinity of the *mauka* point of interconnection. No archaeological sites of any kind were identified within the Western Tableland Array survey areas.

Eastern Tableland Array

The Eastern Tableland Array consists of two distinct survey areas that are slated for the proposed development of fourteen wind turbines (see Figures 1 and 2). The two survey areas are separated from one another by a deep gulch that does not permit interconnected access. The southeastern most survey area, which is accessed by Kawailoa Road, runs northwest across TMK:1-6-1-07:001 from the edge of Anahulu Gulch near Drum Road at an elevation of roughly 1,200 feet above sea level to a point along the edge of the unnamed gulch at an elevation of roughly 800 feet above sea level. The northwestern survey area, which is accessed by Ashley Road, runs northwest across TMK:1-6-1-06:001 following a narrow tableland formation between the unnamed gulch and southwestern edge of the Kaiwikoʻele Stream Gulch from an elevation of roughly 1,000 feet above sea level to an elevation of roughly 400 feet above sea level. Both survey areas in the Eastern Tableland Array contain a thick growth of Guinea grass (*Panicum maximum*) interspersed with albizia trees (*Acacia lebbek*) and other less frequently occurring species of trees, shrubs, vines, ferns, and grasses.

The Eastern Tableland Array survey areas correspond to the former Waialua Sugar Company's fields Kawailoa-21 and 22 and Waimea-7 and 25 (see Figure 9). Aerial photographs of the project area (see Figures 5-8) show that these fields were completely cultivated in sugarcane and pineapple during the second half of the twentieth century. No archaeological sites were identified within the former field areas, but four Historic sites (Sites 7155, 7156, 7157, and 7158) were identified along the edge of the Kaiwikoʻele Stream Gulch in areas that were not formerly cultivated (see Table 7 and Figure 36). All four sites consist of existing or former metal poles held upright by a base of concrete. Site 7157 is interpreted as being a possible boundary marker for the Kawailoa Forest Reserve placed at its present location during a 1924 survey of the area (see Figure 31). The three remaining sites may have been part of a communications system laid by the U. S. military just prior to the outbreak of World War II. Each of the recorded sites is discussed in detail below and their location relative to one another and the proposed tower locations are shown in Figure 38.

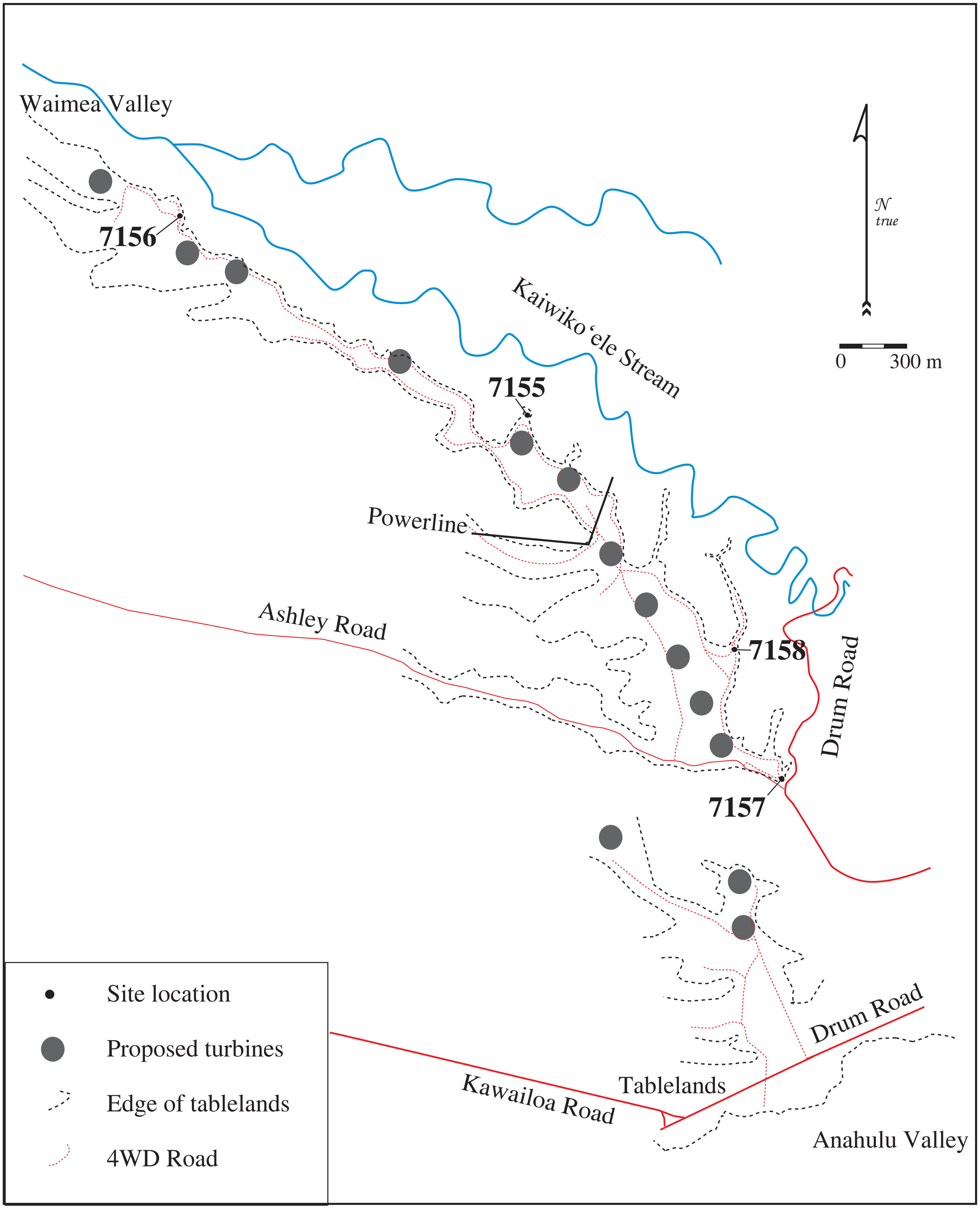

Figure 38. Eastern Tableland Array showing the site locations.

SIHP Site 50-80-04-7155

This site is a short concrete pillar on a narrow landform at approximately 820 feet above sea level, near the northern edge of the Eastern Tableland Array (see Figure 38). The square pillar, which measures 15 centimeters by 15 centimeters across and 25 centimeters high, consists of poured cement and gravel (Figure 39). Each of the pillar's four corners has been flattened to an edge that measures 2.5 centimeters long. A steel plate covers the top of the pedestal. The four corners of the plate are folded down and were inserted into the pillar when the cement was still wet. Embossed on the steel plate are the following letters and numbers: "MK" and "11 FAB 231." Indented dots and short scattered puncture marks are also visible on the surface of the metal plate. In the center of the plate is a five-centimeter diameter hole that contains the remains of a rusted and truncated galvanized iron pipe. This pipe is most probably the base of a formerly upright pole. The function of the pillar and pole feature is not known, although it may very well had something to do with the military communication system set up immediately prior to the outbreak of World War II (e.g., Bennett 2002). The site offers a commanding view across the Waimea Gulch to the north, stretching from the ocean to the mountains. The area immediately around the pillar is fairly open and clear of vegetation, although the slopes below are covered by guava plants and the plateau behind by *koa* and albizia trees.

Figure 39. Site 7155, overview to the north.

SIHP Site 50-80-04-7156

This site is a short cone-shaped concrete pillar on the northern edge of the Eastern Tableland Array, at approximately 440 feet above sea level, overlooking the steep-sided gulch that contains Kaiwiko‘ele Stream (see Figure 38). The pillar, which resembles a truncated cone, has a height of 36 centimeters and a diameter of 35 centimeters (Figure 40). The flat-surfaced apex of the cone-shaped pillar has a diameter of 25 centimeters. Lichen grows on the northward facing side of the pillar. Sticking out from the center of the flat-surfaced apex is a four-centimeter diameter galvanized iron pipe. This pipe, which appears to have been shortened with a hack-saw, was most probably the lower part of a taller upright pole. The feature is located on the *mauka* edge of an old road that leads down into the gulch. The function of the pillar and pole feature is not known, although it may very well had something to do with the military communication system set up immediately prior to the outbreak of World War II (e.g., Bennett 2002). Alternatively, the hollow pole could have been used to hold a flag, either as a military signal or as an agricultural marker during the days of sugarcane cultivation. The site offers a commanding view across the Waimea catchment to the north, stretching from the ocean to the mountains. The area immediately around the pillar is fairly open and clear of vegetation, although the slopes below are covered by guava plants and the plateau behind by a stand of *koa* trees.

Figure 40. Site 7156, view to the south.

SIHP Site 50-80-04-7157

This site is a short flat-topped concrete pyramidal block situated at approximately 1,030 feet above sea level on the northern edge of the Eastern Tableland Array at the top of a steep slope that leads down to the Drum Road cut as it descends into the Kaiwikoʻele Stream drainage (see Figure 38). The pillar, which resembles a typical pier block, has a height of 35 centimeters (Figure 41). The square-shaped pyramid has a base measuring 35 centimeters by 35 centimeters, while its flat-top measures 20 centimeters by 20 centimeters. Incised in the flat-surfaced top of the block, when the cement was still wet, are the following letters and numbers: “K-27” and “FRM” (see Figure 41). In the center of the flat-topped surface is inserted an eight-centimeter diameter rusted and truncated galvanized iron pipe. The area immediately around the pillar is covered by guava plants and the plateau behind by eucalyptus and albizia trees. This concrete feature is similar in construction to Site 7156, but based on its location, may have been erected as a boundary marker. A Hawaiʻi Territory Survey map of the Kawailoa Forest Reserve (HTS Plat 2069) prepared by C. Murray on May 28, 1924 shows a pipe marking the location of the forest reserve boundary in the general location of Site 7157 (see Figure 31).

Figure 41. Site 7157, overview to the north.

SIHP Site 50-80-04-7158

This site consists of a 1.15-meter tall steel pipe (6 cm diameter) which is anchored off-centered into a rectangular-shaped concrete footing (30 x 28 cm and 10 cm deep). The site is located at the beginning of a long and narrow landform on the northern edge of the Eastern Tableland Array (approx. 1,000 ft above mean sea level), overlooking the steep-sided gulch that was formed by the Kaiwiko'ele Stream (see Figure 38). At the top of the pipe is a cast iron cap with an olive green paint coating mounted on a black steel plate (Figure 42). The cap has a two centimeter diameter with a circular protruding opening on one side. A hexagonal bolt within the opening is attached to a rubber-coated wire that descends through the pipe down into the ground. The area immediately around the pipe is covered by a dense stand of guava plants. A tear-drop shaped depression (3.5 m x 2.2 m x 0.45 m) occurs in the ground immediately south of the pipe. An old road runs past the pipe out onto the narrow landform. Machine gun shell casings, a hub cap, and a wooden post occur along the road farther down the same landform outside of the survey corridor.

The function of the pipe feature is not certain, although it may very well had something to do with the military communication and fire control system set up immediately prior to the outbreak of World War II (e.g., Bennett 2002). The placement of the site at the top end of a prominent landform, which once also had a gun emplacement farther downhill, offers a commanding view across the Waimea catchment, stretching from the ocean to the mountains. Roughly 310 meters northwest of the steel pipe feature (outside of the current project t area) is the location of a former WWII gun emplacement (Sugimoto 1996:4).


Figure 42. Site 7158, view to the north.

Kawailoa Road Corridor

The Kawailoa Road Corridor, which will be used to access the southeastern portion of both the Eastern and Western Tableland Arrays, follows existing paved/gravel roadways from Kamehameha Highway (Hwy 83) to Drum Road (see Figure 1). Two alternate routes, both following existing roads (Alternative-1 and Alternative-2), were surveyed for the portion of the Kawailoa Road Corridor that traverses the steep escarpment (*pali*) inland of ʻUkoʻa Pond. Alternative-1 follows Kawailoa Drive to Kawailoa Road, and then Kawailoa Road to Drum Road. Alternative-2 follows Kawailoa Drive from Kamehameha Highway to Cane Haul Road, and then Cane Haul Road to Hakina Bypass Road, which traverses the *pali* to Kawailoa Road, and then follows that road to Drum Road. The Kawailoa Road Corridor (Alternatives-1 and 2) crosses portions of TMKs:1-6-1-02:001, 002, 003, 025, 1-6-1-07:001, 1-6-2-09:001, and 1-6-2-11:001 (see Figure 2). Kawailoa Drive, *makai* of the Kawailoa Waste Transfer Station, passes by a marshy area located to the north of ʻUkoʻa Pond (Site 236), and through a small *kuleana* parcel (LCA # 8304:3). This portion of the existing roadway will not be widened or improved as part of the current project. The Cane Haul Road portion of Alternative-2 passes through one *kuleana* parcel (LCA # 2727) and turns onto Hakina Bypass road near the northern boundary of a second *kuleana* (LCA # 7169). A Japanese cemetery (T-36) is located *mauka* of Hakina Bypass Road and the *kuleana* parcel near this turn (Figure 43). The survey corridor, between the *pali* and the roughly 450-foot contour, runs through agricultural fields that are currently cultivated. Vegetation in areas that are not currently cultivated consists primarily of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and albizia (*Acacia lebbek*).

Figure 43. Japanese cemetery (T-36) located along Hakina Bypass Road outside of the study area, view to the south.

The Kawailoa Road Corridor, above the *pali*, traverses the former Waialua Sugar Company's fields Kawailoa-4, 6, 7, 9, 10, 12, 17a, and 20 (see Figure 9). Aerial photographs of the project area (see Figures 5-8) show that these fields were completely cultivated in sugarcane during the second half of the twentieth century. Near the Kawailoa Drive/Cane Haul Road intersection the survey corridor passes by the Waialua Sugar Co.'s Pump # 4. The 1929 U.S.G.S. Hale‘iwa quadrangle shows a portion of Kawailoa Camp within the Kawailoa Road Corridor, ditches and railways crossing the corridor, and a ditch, waterline, and power poles following the lower portion of Kawailoa Road (see Figure 4). As indicated on various Historic maps reviewed for this study, the existing roads that the Kawailoa Road Corridor follows were built during the early to middle twentieth century by the Waialua Agricultural Company. Kawailoa Drive, which served as the main access route to Kawailoa Camp, was built between 1901 and 1924. The upper portion of Kawailoa Road was in place by 1924 (see Figure 31), and the lower section, following the route of the waterline from Pump # 4 to a ditch near the 500-foot contour, was built between 1924 and 1929 (see Figures 4 and 31). Hakina Bypass Road and Cane Haul Road, the second of which follows the route of a former plantation railway, were both built around ca. 1950 after the railroad shut down (in ca. 1947) and the tracks were dismantled. Both roads are depicted on the 1953 U. S. Army Mapping Service (AMS) Hale‘iwa quadrangle (see Genz and Hammatt 2011).

Five archaeological sites were identified within the Kawailoa Road Corridor (see Table 7 and Figure 36): one along Kawailoa Road (Site 7159), three along Kawailoa Drive within the Alternative-1 survey corridor (Sites 7160, 7161, 7162), and one along Hakina Bypass Road within the Alternative-2 survey corridor (Site 7163) (Figure 44). Site 7159 is a ditch complex (still used for irrigation purposes) that follows the southern edge of Kawailoa Road between roughly the 675-foot contour and the 240-foot contour; Site 7160 consists of two parallel abutment walls that line a portion of the edge of Kawailoa Drive; Site 7161 consists of three concrete foundations that are a part of the former Kawailoa Camp stables; Site 7162 is a section of kerbstones that line the *mauka* edge of Kawailoa Drive near the old Kawailoa Camp # 2; and Site 7163 is a stone and concrete culvert that passes beneath Hakina Bypass Road. Each of these sites is discussed in detail below. Three additional sites, found within the Cane Haul Road portion of the Alternative-2 survey corridor (Sites 7164, 7165, and 7166; see Table 7), are discussed with the Cane Haul Road Corridor findings (see below).

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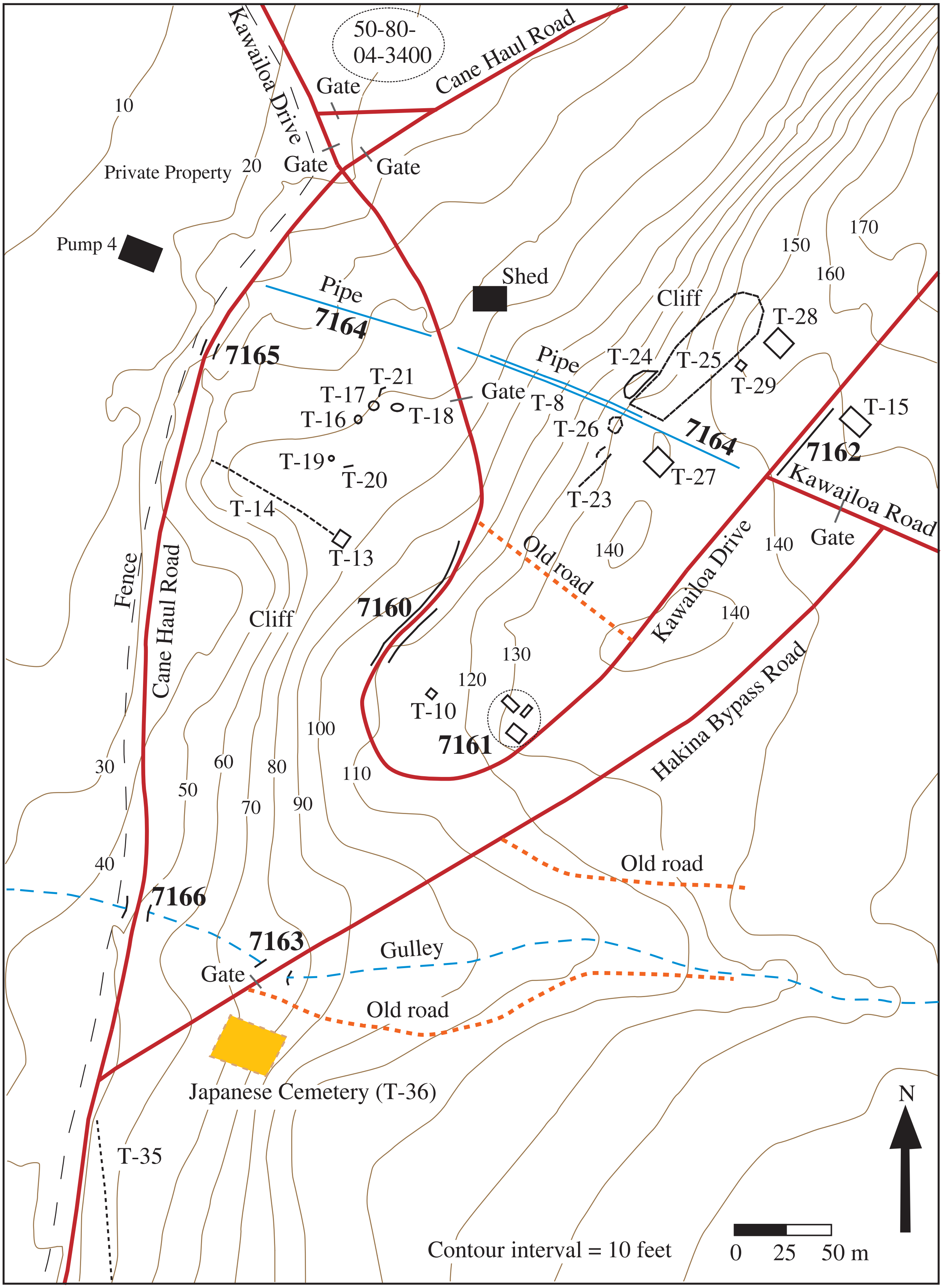

Figure 44. Plan view of archaeological sites identified within (and nearby) the lower portion of the Kawailoa Road Corridor and the southern section of the Cane Haul Road Corridor.

During the survey of the Kawailoa Road Corridor the presence of several archaeological sites was noted nearby, but outside, the study area (in the vicinity of Alternatives-1 and 2; see Table 8 and Figure 44). These additional sites, which appear to represent both Precontact and Historic use of the area, are all located on and nearby the steep *pali* formation traversed by Kawailoa Drive and Hakina Bypass Road. They will not be impacted by any of the proposed road improvements within either of the potential Kawailoa Road Corridor alternatives. The nearby sites include a remnant enclosure/pavement (Site 50-80-04-3400) previously recorded by Hommon (1982) near the intersection of Cane Haul Road and Kawailoa Drive; a Japanese cemetery (T-36) located *mauka* of Hakina Bypass Road near its intersection with Cane Haul Road (see Figure 43); a section of old rail bed (T-35) located near the intersection of Cane Haul Road and Hakina Bypass Road; a cluster of eight sites including a terraced platform, a slab paved pathway, three small enclosures, and three short wall segments (T-13, T-14, T-16, T-17, T-18, T-19, T-20, and T-21) located east of Cane Haul Road below the horseshoe in Kawailoa Drive; a stone and concrete pedestal (T-10) within the Kawailoa Drive horseshoe; a cluster of seven sites including a set of parallel terrace walls, two rock and soil terraces against the cliff face, an area of soil filled terraces on a steep slope (possible gardens), and three stone and concrete foundations (T-23, T-24, T-25, T-26, T-27, T-28, and T-29) located north of Kawailoa Drive below its intersection with Kawailoa Road; and a concrete slab foundation located near the Kawailoa Drive/Road intersection. As part of the current study brief descriptions and sketch maps of these sites were prepared, photographs were taken, and their locations were plotted on a map of the project area (see Figure 44).

SIHP Site 50-80-04-7159

Site 7159 designates the irrigation ditch system that runs along Kawailoa Road, starting near the 675-foot contour and extending roughly 1.5 kilometers down to just above the 240-foot contour (see Figure 36). This irrigation ditch is part of the Kamananui ditch system created by the Waialua Agricultural Co. during the early to mid-1900s. Portions of the ditch system are still in use today. For the purposes of description, this southeast/northwest trending irrigation ditch has been subdivided into 14 sections, with bridges and culverts separating one section from the next (Figure 45). Starting with Section 1 at the top end, the following description highlights the main features of each section.

<u>Section 1</u> of Site 7159 originates a few kilometers *mauka* of the current project area, where the ditch is fed by the Kawainui Stream (see Figure 45). The ditch approaches the southern side of the Kawailoa Road and the project area roughly along the 675-foot contour from the southeast. A side road also follows this contour, directly *makai* and downhill from the ditch channel. Most of the former walls of the Section 1 ditch are destroyed, with a dirt ridge now demarcating the *makai* edge. However, the last two meters of the ditch, immediately south of a sluice gate complex and roughly four meters from the road, still have intact walls. The almost vertical walls consist of four courses of basalt rocks, the biggest blocks being at the bottom. The opposing *mauka/makai* basalt block and cement walls of the ditch are roughly 92 centimeters high and 188 centimeters apart. This was probably the make-up and dimensions of the rest of the Section 1 ditch farther to the southeast.

Section 1 terminates in a sluice-gate complex (Figure 46) four meters south of Kawailoa Road. The sluice-gate complex abuts a pre-cast concrete bridge that extends beneath Kawailoa Road. The sluice-gate complex consists of two closely juxtaposed sluices within the *makai* wall of the ditch; each of which allows water to enter a separate 70-centimeter diameter pipe that empties into the main channel. This main channel runs along the southern side of Kawailoa Road in a *makai* direction. A one-meter long section of wall separates the two pipe intakes. The virtually vertical walls of the sluice-gate complex comprise three courses of cut-stone basalt blocks, with an average measurement of 50 by 50 centimeters pier block. Cement has been used to join and cap the basalt blocks in the wall. The floor of the sluice gate complex is covered by silt. Each of the two sluice gates measures 105 centimeters high, 60 centimeters wide, and is framed on either side with wooden planks (15 x 8 cm), each with two vertical and parallel notches. Wooden sluices are still inserted in the notches of both gates.

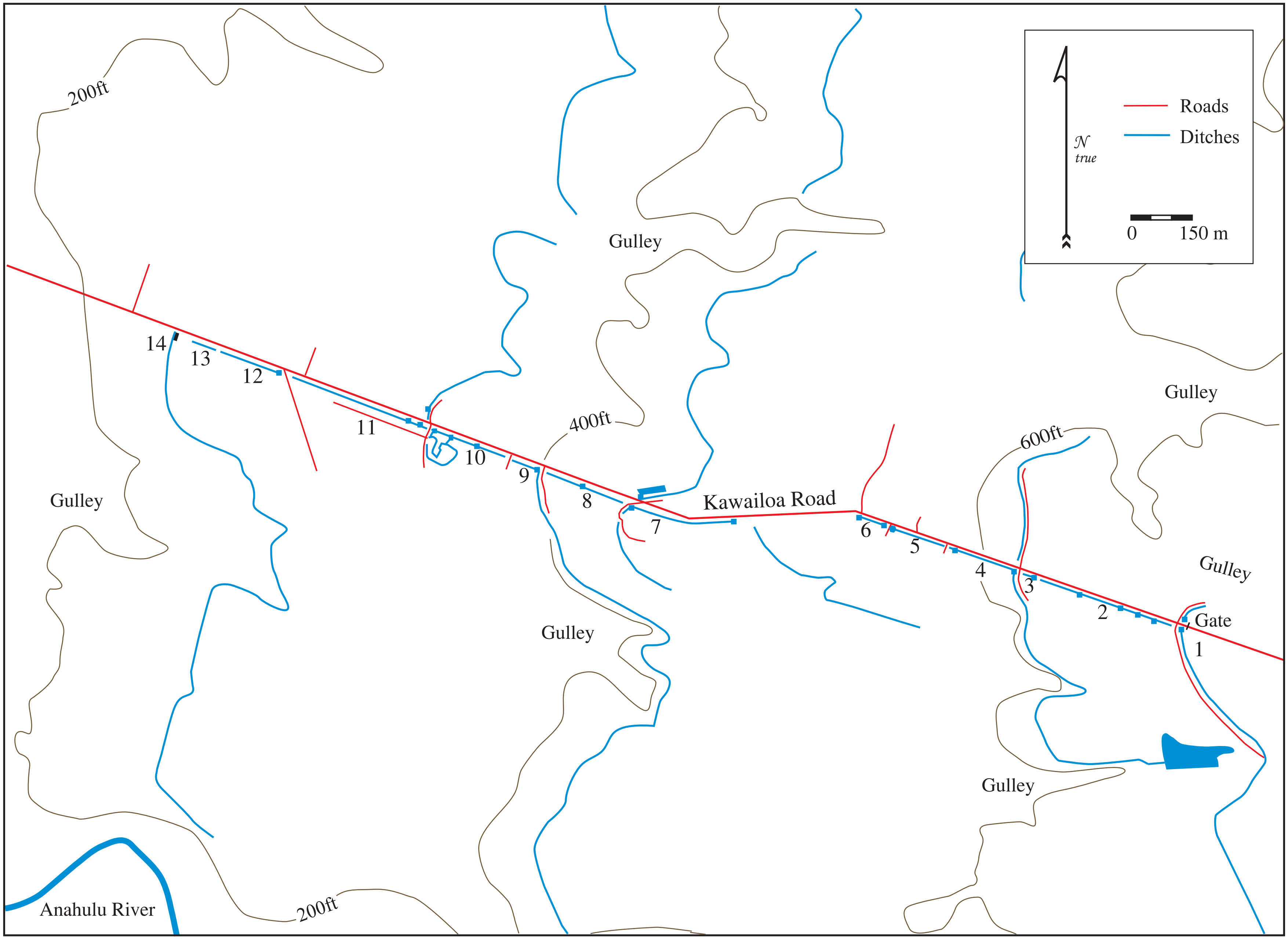

Figure 45. Site 7159 plan view.

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Figure 46. Site 7159 Section 1 sluice gate complex, view to the southwest.

Section 1 continues north of the 7.2-meter wide pre-cast concrete bridge that is located underneath Kawailoa Road. This northern extension of the Section 1 ditch has comparatively neatly cut basalt blocks, cemented together to form four courses (Figure 47). The intact portion of the ditch extends for almost 20 meters north of Kawailoa Road and then changes into an earth-lined ditch that continues for another 30 meters before emptying into a gully. The intact portion of the channel measures 1.30 meters deep, 1.80 meters across its top, and 1.65 meters across its bottom. Small sections of metal pipe adjacent to the ditch where it enters the gully suggests that a siphon once occurred in the locality.

At the start of the Section 1 ditch north of Kawailoa Road is another sluice gate complex (Figure 48). Within this concrete-lined complex are two sluice gates; the first within the main channel and the second leading to a pipe branching *makai*. The main sluice gate is 1.07 meters high and 1.85 meters wide, while the side sluice gate is 90 centimeters high and 50 centimeters wide. A surviving wooden sluice still occurs within the side gate. Through a slit behind the sluice can be seen a pipe with a diameter of 50 centimeters. The derelict state of the walls and sluices together with absence of water flow impressions on the bottom of the ditch suggest that Section 1 is no longer operational.

Section 2 of Site 7159 starts at the culvert immediately south of Kawailoa Road (see Figure 45). This culvert is 1.07 meters *makai* of where the two parallel pipes start at the double sluice gates across the side road. Where the pipes exit the culvert on the Section 2 side, the ditch walls are 1.26 meters high and the ditch is 2.34 meters wide. Each pipe is made up of 90-centimeter long sections. The pipe sections are a pre-cast mixture of cement and crushed basalt gravel.

The ditch is at its widest for the first 3.30 meters *makai* from the culvert (i.e., 2.34 m wide) but then narrows to around 80 centimeters. The walls of the narrower channel taper slightly inwards down to a floor, which is roughly 69 centimeters wide. Overall, the first three to five-meter portion of the Section 2 ditch narrows down in a funnel-like fashion. The stones that line the walls and floor of the channel are neatly cut basalt, measuring between 20-40 centimeters wide. At its highest the wall is five courses high, but drops down to three courses. Cement that once bonded the lower courses has eroded away, but cement still occurs within the top courses. Basalt fragments are inserted in the gaps between some of the bigger blocks. Lighter-colored cement in the uppermost course and in the wall capping suggests that the walls were heightened at some time after their initial construction.

Figure 47. Site 7159 Section 1 northern portion of main ditch, view to the south.

Figure 48. Site 7159 Section 1 north side sluice gate complex, view to the south.

Capping each of the 15-centimeter wide walls is cement. The cement that caps the curb above the culvert wall has incised the following two dates: "1927" and "1930." The "1927" date is north of the "1930" date. A layer of cement that partly covers the "1" in "1927" suggests that a section of the wall was added. However, considering that no structural evidence within the wall exists to suggest that it was lengthened or that a second culvert was added in "1930," the later date probably reflects a re-plastering episode. A cross-in-circle motif that occurs north of the "1927" date could have served as an original benchmark. A more recent benchmark occurs two meters south of the culvert. This benchmark is a circular metal geodetic marker installed almost at ground level in 1969 by the U.S. Coast and Geodetic Survey.

Four separate sluice gate complexes occur along the Section 2 ditch. Roughly 45 meters *maka*i of the culvert is the first sluice gate complex, consisting of two sluices. The 60-centimeter high ditch walls in the vicinity of the sluice gates increase in height to one meter. The main gate allows water to flow down the main channel along Kawailoa Road, whereas prior to being sealed by a thick cement slab the side gate (75 cm high x 75 cm wide) used to allow water flow diagonally southwest out of the main channel (Figure 49). Like the rest of the side gates farther down Section 2, the floor of the side ditch is one course shallower than that of the main channel. Roughly 20 meters *makai* from the first sluice complex is a second one, very much sharing the features of the first, except that the side channel is sealed by a rock and cement wall and faces diagonally northwest (Figure 50). Another 25 meters *makai* of the second sluice complex is the third one. The third sluice complex resembles the first two except that it contains two side gates, both which are sealed (Figure 51). The gates are directly opposite one another, the one in the south wall is sealed with a concrete slab and the one in the north wall is sealed by a rock and cement wall. The fourth sluice gate, which is approximately 200 meters *makai* of the third, differs from the first three in that it is made out of poured concrete (Figure 52). The concrete envelops the top two courses of the ditch, leaving the bottom course exposed. The concrete walls are 77 centimeters high and 3.93 meters long. Within the main channel are two sets of sluice gate slots. Almost 70 centimeters *mauka* of the main gate, within the north wall, is a side sluice gate. This gate, which points diagonally northwest, contains two sets of slots. The entrance to this side canal has been sealed with a stone and cement wall.

Figure 49. Site 7159 Section 2 first sluice gate complex, view to the south.


Figure 50. Site 7159 Section 2 second sluice gate complex, view to the south.


Figure 51. Site 7159 Section 2 third sluice gate complex, view to the south.

Figure 52. Site 7159 Section 2 fourth sluice gate complex, view to the south.

A 22-meter long section of the main channel's northern wall is tilted inwards near the *makai* end of Section 2. A cement repair patch to the *mauka* end of the tilted wall was done most likely to prevent its collapse, knowing that *makai* of the tilted wall section there is an eight-meter long stretch that has collapsed. The walls of the main channel increase in height to 1.10 meters roughly 3.4 meters *mauka* of the culvert. The culvert is a concrete pipe approximately 75 centimeters in diameter. Three rusted railroad ties have been inserted at an angle within the ditch to prevent large objects from blocking the pipe.

The curb above the pipe, which is 1.34 meters long and 26 centimeters wide, is capped with a layer of cement. Incised within the cement is the date "1/26/43." This date is eight years later than the "SEPT. 31 1935" date on the wall of the second side sluice gate. On the north wall of the main ditch channel, a few meters *mauka* of the third sluice gate, are inscribed the names "Pedro + Ayama." On the north wall between the third and fourth sluice gates is the name and date "S. WAKUU 1950."

<u>Section 3</u> of Site 7159 starts at the exit of the pipe that comes from the *makai* end of Section 2 (see Figure 45). A roughly 18-meter long culvert separates the two sections. A sluice gate complex occurs immediately *makai* of the culvert (Figure 53). Two sluice gates occur within the complex; one allows water to continue down the main channel south of Kawailoa Road and a side gate allows water to flow underneath the road to the north. Concrete that was poured over the stone and cement wall houses the slotted grooves of both gates. The side gate in the northern wall of the complex has been sealed with a cement slab. Each sluice gate is 80 centimeters high and 50 centimeters wide.

The approximately 70-meter long Section 3 ditch terminates in a culvert catchment section. The walls of the channel are 60 centimeters high and consist of a two course of neatly cut square basalt blocks, each measuring 45-50 centimeters across. Roughly two meters *mauka* of the culvert intake the wall increases in height 80 centimeters. The culvert continues underground for 18 meters *makai*.


Figure 53. Site 7159 Section 3 sluice gate complex, view to the south.

Section 4 of Site 7159 starts where the buried pipe exits 1.4 meters *mauka* of a bridge constructed of concrete and railroad rail (see Figure 45). This bridge covers Section 4 of the main Kawailoa Road ditch for a distance of 5.22 meters. Where the ditch exists from below the bridge its walls are 1.5 meters high, 1.07 meters wide across the top, and 70 centimeters wide across the bottom. The channel is constructed of neatly cut basalt blocks, cemented together three courses high.

Four meters *makai* of the bridge is a sluice gate complex and the location where a feeder ditch from the south joins the main ditch (Figures 54 and 55). Running roughly along the 620 foot contour, the feeder ditch has its origin in a reservoir to the southeast and outside the project area. The feeder ditch is still active and supplies the main Kawailoa Road channel with water. The feeder ditch is badly eroded with only a 10 meters section of the *makai* wall of basalt and cement remaining. The partly collapsed soil walls of this channel have widened the U-shaped ditch to 1.75 meters. Within an intact portion of the southern wall, water erosion has removed soil from around a funnel-shaped concrete drain and left it on a pedestal-like soil column.

The sluice complex on the northern end of the eroded feeder ditch includes five gates (see Figure 54). The first sluice gate, which is in the *makai* wall of the feeder ditch, consists of a poured concrete section with three sets of slots for sluices. This first gate has been sealed with a concrete slab, but once allowed water to enter the *makai* fields. One meter north of this gate is a second gate with one set of slots for a sluice. A pipe from this gate runs diagonally northwest, toward the main ditch channel three meters distant. Water would be forced into the pipe when the third sluice gate within the feeder ditch is closed. This third gate is near the T-junction with the main channel. The T-junction terminates in a fourth sluice gate. This gate, with a set of opposing slots for a sluice, allows water to enter a pipe underneath Kawailoa Road to its north side. The entrance to the pipe has been sealed with a wooden board. The fifth sluice gate is immediately *makai* of the T-junction. This gate allows water to flow down the main channel, which runs parallel to Kawailoa Road.

Immediately *makai* of the sluice gate within the main channel is a small bridge. Constructed of concrete reinforced by sections of railroad tracks, the 60-centimeter wide bridge allows a person to lift the H-shaped sluice handle from directly above. Fragments of wooden (possibly *koa*) sluices are scattered across the ground south of the bridge.

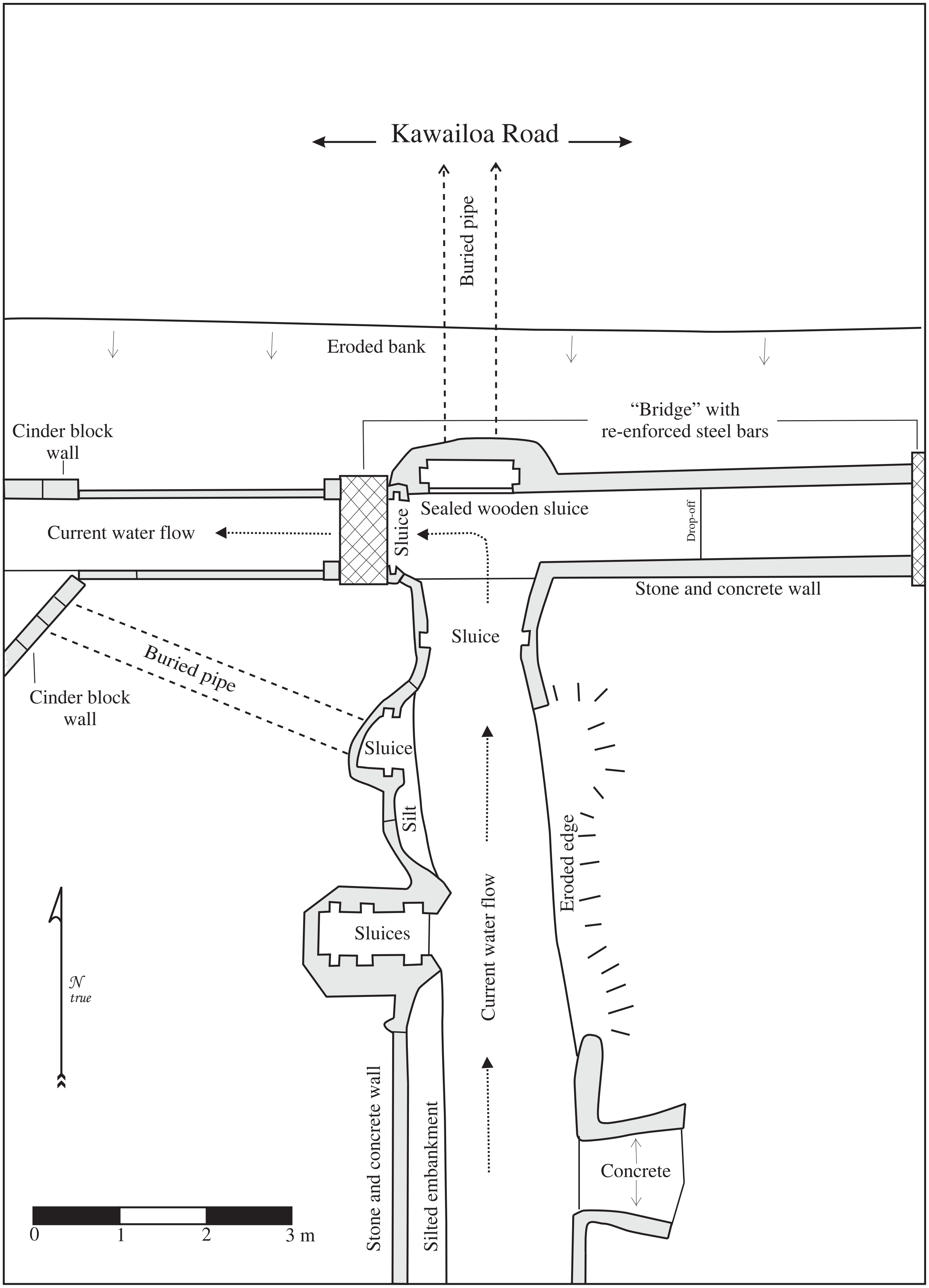

Figure 54. Site 7159 Section 4 sluice gate complex plan view.

Figure 55. Site 7159 Section 4 sluice gate complex, view to north.

Where the feeder ditch and the diagonal side ditch empty into the main channel the walls of the main ditch have been heightened with the addition of a cinder block layer. The elevated height of the walls in the area where the ditches converge could function to prevent rushing water from eroding the ditch's exterior. Below the cinder block capping, the walls of the main channel are 1.3 meters high and includes three courses of neatly cut basalt blocks. The bottom two courses contain bigger blocks, measuring between 25-30 centimeters, with the top layer consisting of smaller and irregular-shaped stones. Smaller stones have also been inserted in the cement where gaps exist between the coursed stones. The flowing action of water has eroded away cement from between the bottom course of stones.

A branch of the feeder ditch extends north of Kawailoa Road. This section has been sealed-off by the sluice gate immediately south of the road. Evidence of abandonment, neglect, and perhaps even deliberate dismantling are evident at the feeder ditch north of Kawailoa Road. For example, a huge push pile ridge runs *makai* of the silted ditch, while broken sections of basalt block and cement wall are scattered on the eroded *mauka* edge. Within the northwestern corner of where the northern extension of the ditch meets Kawailoa Road is a modern pump complex with five metal containers and pipes that are surrounded by a chain link fence (see Figure 55).

The main ditch that runs south of Kawailoa Road shows signs of deterioration in Section 4.The middle third of the north wall has sections that have collapsed inwards. Within these collapsed sections only the bottom course of the once three course high wall remains. The loose remnants of basalt chunks and concrete have been removed from the canal to prevent blockage. These chunks are now scattered on the ground south of the main canal. Farther *makai*, where a buried metal pipe enters the main canal from the northeast, soil erosion from the road run-off has caused a small section of north wall to collapse.

Fourteen meters before the *makai* termination of Section 4 is a side sluice gate in the southern wall of the main channel (Figure 56). The floor of the side sluice is slightly elevated above the floor level of the main channel. The side sluice gate has been sealed with a thick cement slab. The last two meters before the end of Section 4 has a culvert wall similar to the one at the end of Section 3. Incised in the cement layer that caps the wall above the pipe is the date "1943 Feb. 6."

Figure 56. Site 7159 Section 4 blocked side sluice, view to the south.

Section 5 of Site 7159 begins after a 13-meter long and 30-centimeter thick pre-cast concrete slab bridge across the main Kawailoa Road ditch (see Figure 45). Immediately *makai* of the bridge the walls of the main channel are 97 centimeters high, 90 centimeters across the top, and 50 centimeters across the bottom.

Almost 20 meters *makai* of the bridge, the walls drop in height to 70 centimeters. Pressure built-up with the accumulation of deposits on the road-side of the wall caused sections of the northern wall to collapse into the ditch. Piles of broken wall fragments south of the ditch testify to attempts to unclog the flow of water. For the most of Section 5 the neatly cut basalt block and cement walls are two courses high. In attempts to prevent water from spilling over the edges of the ditch a layer of cinder blocks has been added. The Section 5 walls appear to be unique in that the smallest layer of stone coursing occurs at the bottom, directly above the level of the floor, instead of at the top as is normally the case.

Near the *makai* termination of Section 5 there are two incisions on top of the cemented wall. On the south wall are the letters “S.F.” and on the north wall is the date “1926.” The ditch walls increase in height to 90 centimeters immediately before the culvert termination of Section 5. The base of the ditch drops down almost 20 centimeters into the culvert. The diameter of the steeply dipping pipe is 70 centimeters.

Almost four meters *makai* of the culvert is an octagonal-shaped cement slab, 4.3 meters wide and 33 centimeters thick (Figure 57). The underside surface of the slab is irregular due to containing protruding basalt cobbles. A slot that extends from the *mauka* edge into the slab is 78 centimeters long and 30 centimeters wide. This slot could be the base for a water tank. A water tank is indeed located on this spot in the 1929 Haleiwa Quadrangle Survey map (see Figure 4). Sheet erosion has washed soil away from below the sides of the slab.

Figure 57. Site 7159 Section 5 octagonal slab, view to the southwest.

Section 6 of Site 7159 commences at the *makai* end of a 30-meter long deeply buried culvert (see Figure 45). Looking at the pipe's exit it is clear that it emerges at a steep angle. The culvert empties into a sluice gate complex that includes two gates (Figures 58 and 59). The gate in the southern wall of the complex has the remains of a 50-centimeter diameter pipe that comes from the southeast, whereas the gate branching diagonally out of the southwestern corner of the complex has the remains of a sectional square channel. The ditch is made up of 93-centimeter long pre-cast sections (concrete flumes) that are 42 centimeters wide across the top and 27 centimeters wide across the bottom. The sluice of the southern gate has been closed with plywood, whereas the southwestern gate has been sealed with two concrete slabs. The square impressions for holding a wooden bridge can be seen immediately *makai* of the southwestern gate.

The walls of the sluice gate complex and the main channel farther *makai* are made up of cut square blocks of basalt and cement. Whereas the sluice gate complex is approximately one meter deep with four courses, the main channel is merely 55 centimeters deep with two courses. The main ditch that runs south of Kawailoa Road is 92 centimeters across its top and 67 centimeters across its base.

A row of three circular impressions made by the end of a metal pipe occur on the cement capping of where the southern sluice wall transitions into the ditch wall. The incised initials "S.K." occur nearby.

Just over 20 meters *makai* from the sluice gate complex is a bridge of pre-cast concrete. This bridge measures eight meters long by two meters wide by 20 centimeters thick. Raised curbs on the *mauka*/*makai* edges of the bridge measure 15 centimeters wide by 10 centimeters high. The underside surface of the bridge is irregular due to containing protruding basalt cobbles.

A second bridge that covers the ditch is 4.5 meters *mauka* of Section 6's termination. The bridge is a pre-cast concrete slab that has been inverted; the uneven side faces upwards and the even surface with raised culvert edges faces downwards. The slab measures 3.7 meters wide, 1.86 meters long, and 32 centimeters thick.

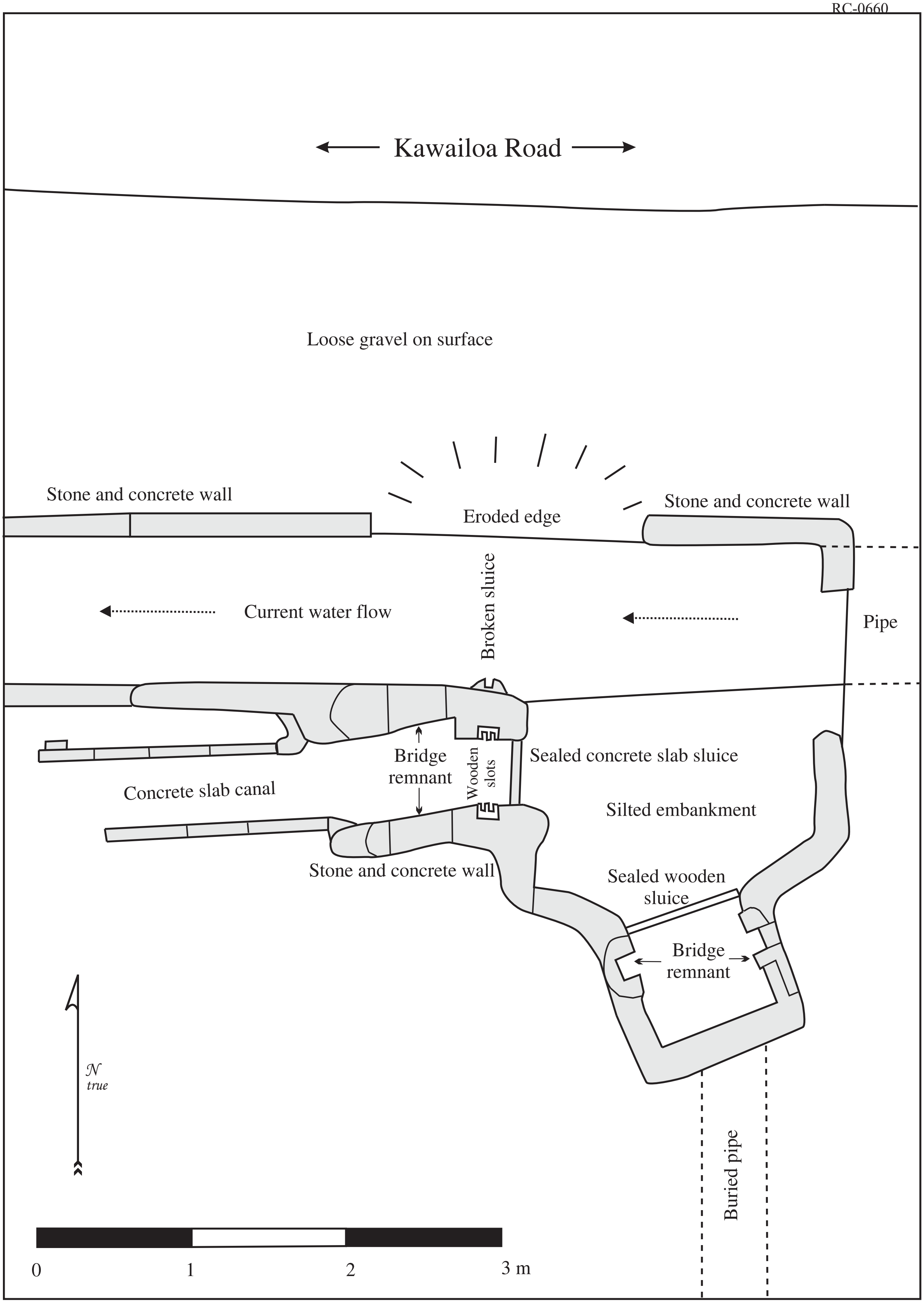

Figure 58. Site 7159 Section 6 sluice gate complex plan view.


Figure 59. Site 7159 Section 6 sluice gate complex, view to the south.

The Section 6 main ditch channel ends in a sluice gate complex (Figure 60). This complex, which has a poured concrete layer on top of a regular basalt and concrete wall, is one meter high and 92 centimeters across. The sluice gate in the main canal allows water to flow *makai*, whereas a side sluice gate allows water to flow underneath Kawailoa Road to the northern side. Both gates have slots that once held sluices, the slots of the main gate still contain remains of wooden beams. The northern side gate has been sealed by irregular shaped basalt chunks and cement. The walled remains of the side ditch north of the road are barely visible above a layer of silt and loose rock.

Makai of the gate the ditch angles down steeply and enters an underground pipe. The last two meters of the ditch are covered with sections of corrugated iron (see Figure 60), presumably to prevent big objects from falling in and clogging the pipe. The 75-centimeter diameter pipe continues underground *makai* for approximately 500 meters.

Roughly 240 meters *makai* from the end of Section 6 is a rectangular-shaped cement structure. Measuring two meters *mauka*/*makai* by 90 centimeters north/south by 20 centimeters high, the rectangle is covered by two thin concrete slabs, each measuring 90 centimeters by 70 centimeters. The feature probably acts as an access point to the pipe that can be seen through surface slots, roughly 1.5 meters below the surface. The remains of an old side ditch can be seen emanating from the southern side of the surface rectangle.

<u>Section 7</u> of Site 7159 begins within a sluice gate complex (see Figure 45; Figure 61). The complex contains two sluices; one allowing water to flow down the main channel along the southern side of Kawailoa Road and a side gate that allows water to flow underneath the road to the northern side. The side gate has been closed with solid concrete (see Figure 61), but remains of slotted wooden beams can still be seen within the concrete slots on both sides of the blocked exit. Concrete walls that have been poured in a mold cover two bottom courses of rock within the sluice gate complex. The 1.9-meter high poured concrete section drops down to 70 centimeters where the complex changes into the main channel.


Figure 60. Site 7159 Section 6 sluice gate complex at end of section, view to the southwest.


Figure 61. Site 7159 Section 7 sluice gate complex at start of section, view to the north.

The rock and concrete walls of the Section 7 ditch differ noticeably from the *mauka* ones described above. First, the wall contains basalt rocks of different shapes and sizes, varying from 10 centimeters to 1.1 meters wide. Secondly, the irregularly surfaced basalt blocks do not appear to be cut. Thirdly, walls vary from one to four courses high. Fourthly, wall height varies from 50 centimeters to 75 centimeters. And fifthly, the width of the main channel varies between 60 centimeters and one meter. The irregular walls of Section 7 also lack the cement capping typically found on top of the other ditch walls.

The northern wall has collapsed in places and it is now only the elevated road surface that serves as a convenient barrier to direct water flow downhill. An anomalous widening and heightening of the south wall halfway down Section 7 could be the remains of a former sluice gate complex. The height of the main channel walls increases to 75 centimeters and its width to one meter. This anomalous wall section is roughly 14 meters *mauka* from Section 7's terminal point.

The sluice gate complex at the terminal point of Section 7 contains two sluices; one in the main channel that allows water to flow *makai* and the other in the northern ditch wall that allows water to flow north of Kawailoa Road (Figures 62 and 63). The stone and cement walls of the sluice gate complex are 1.4 meters high. An actual H-shaped wooden sluice is still operational within the main sluice. This sluice diverts water to a pond north of the road. A bridge, made from several parallel sections of railroad tracks, occurs immediately *makai* of the sluice. This bridge allows the sluice operator to open and close the sluice from directly above. Three parallel rail line tracks have been diagonally inserted at the *makai* end of the main ditch channel, most likely to prevent debris from blocking the buried outlet pipe.

The sluice gate complex at the end of the Section 7 ditch was probably modified or rebuilt in the early 1950s, bearing in mind that the date and words "March 15 1951 JOB #121-3-50" are inscribed in the cement on top of the north gate. The faint and hardly legible letters "LAWOT RINUL" are also inscribed on the cement of the *makai* gate. The slots of both sluice gates have also recently been modified, as evidenced by the fresh-looking cement inserts.

A tubular-shaped side channel brings water from a feeder ditch from a southwesterly direction, outside the project area. The tubular-shaped side channel is assembled from a series of two conjoined quarter-circle pre-cast concrete sections, each measuring 90 centimeters long by 80 centimeters deep by three centimeters thick. The ditch is 90 centimeters wide across its top and 1.15 maters across its widest central diameter. Where the side ditch joins the main one, there is a 40-centimeter drop.

The pipe leading from the open north sluice gate currently takes water below Kawailoa Road to the north, where a sluice gate complex diverts water into a retention pond and an adjacent feeder ditch. Both the pond and the feeder ditch extend northward, outside the project area. The sluice complex consists of three sluice gates; one that allows water to flow down the feeder ditch to the north, a sealed sluice that once allowed water to flow into a former side ditch, and one that diverts the water to the pond (Figures 64 and 65). Located four meters north of Kawailoa Road, the complex includes different sections. Where the pipe exits from the direction of Kawailoa Road is a core section characterized by walls built from stone and cement. The more recent ditch *makai* of this core is made up of a series of 93-centimeter long pre-cast concrete "Waialua" flumes that are 42 centimeters wide across the top and 27 centimeters wide across the bottom. The side walls contain square openings with slits for small metal sluices. To the north of the sluice gate complex the channel has collapsed walls and a silted-up bottom.

Although sections of the complex are in disrepair, others are indicative of recent use or even ongoing maintenance. Examples of maintenance include: the cement slots still contain slotted wooden beam inserts; a wooden bridge, painted blue, still occurs immediately north of the northern sluice gate; and piles of silt, that include fresh water clams, are the products of channel clearance. Moreover, the gaps on both sides of the concrete slab seal of the blocked side ditch have recently been patched with strips of epoxy resin and a layer of hollow tile has been added to the top of the square canal. Incised on the cement that caps the hollow tiles are the following two names: "Orlando RAFANAN" and "LAYDO RAFANAN."

<u>Section 8</u> of Site 7159 begins at where the buried pipe exists, roughly 20 meters *makai* from where it goes underground at the end of Section 7 (see Figure 12). The culvert wall is 1.63 meters high and consists of two courses of nicely cut square basalt blocks joined with cement. Comparatively fresh-looking cement has been inserted around the 75-centimeter diameter pipe at the bottom of the wall.

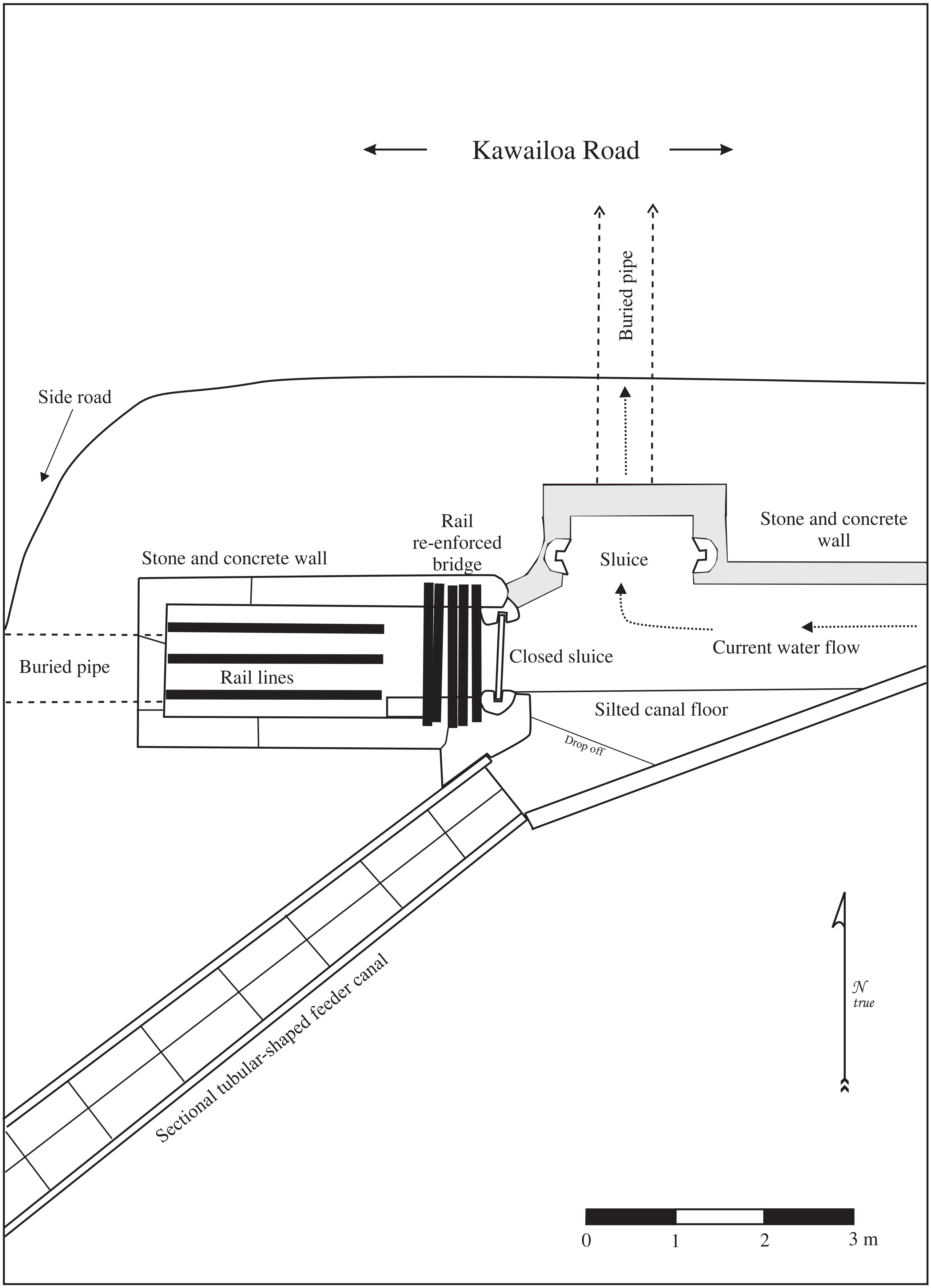

Figure 62. Site 7159 Section 7 terminal sluice gate complex plan view.

Figure 63. Site 7159 Section 7 sluice gate complex at end of section, view to the southwest.

The ditch walls *makai* of the culvert include irregular-shaped rocks that vary in size and number of courses. In many places the channel walls have been plastered over with a thin layer of cement. A section of the main ditch, stretching between 20 and 30 meters from the culvert wall, has walls raised to a height of 1.5 meters and the ditch widened to 1.43 meters. This section is lined with walls made from a series of conjoined rectangular-shaped concrete slabs. The floor of the channel is made from a mixture of cement and crushed rock. Strips of fresh-looking cement have been used to patch the lower wall seams and the corner junctures between the lower walls and the floor. Farther down the main channel are a few single large basalt boulders that are inserted into the wall and so take up the entire height. The cement capping of a portion of the north wall with neatly cut stones has the names "ADAC KIMUA STANLEY" and date "1937" incised in it. The cement in this portion of the ditch has been mixed with crushed shell.

A metal pipe, with a diameter of 31 centimeters, drains into the main channel diagonally from the northeast. The pipe enters the north wall of the pipe roughly 250 meters makai from Section 8's start. This pipe is protected by a rectangular wall of basalt stones and cement. Incised on the cement capping of this wall is pentagon with the numbers and words "370TH A-3 ENGRS." This is also a point where the floor of the main ditch drops down steeply with the walls increasing in height to 135 centimeters.

Roughly 10 meters *maka*i of the culvert, roughly halfway down Section 8, is a sluice gate within the main ditch channel (Figure 66). A rock wall built on top of a cement beam is immediately *makai* of the sluice slots. The 90-centimeter wide wall that crosses the main ditch probably served as a platform for the sluice gate operator to access the sluice from directly above. Incised onto a corner of the bridge is the date "12-28." Once closed the sluice would have forced water into two side ditch. The north gate goes underneath Kawailoa Road and the southern gate into the fields. Both gates have been sealed with a stone and cement wall. Incised into the cement capping of the wall above the southern gate is "MAR-15-1951."

Between the sluice gate and the *makai* end of Section 8 the main ditch that runs south of Kawailoa Road is in need of repair; portions of the northern wall have collapsed and *mauka* of the outlet culvert the floor of the channel has disintegrated.

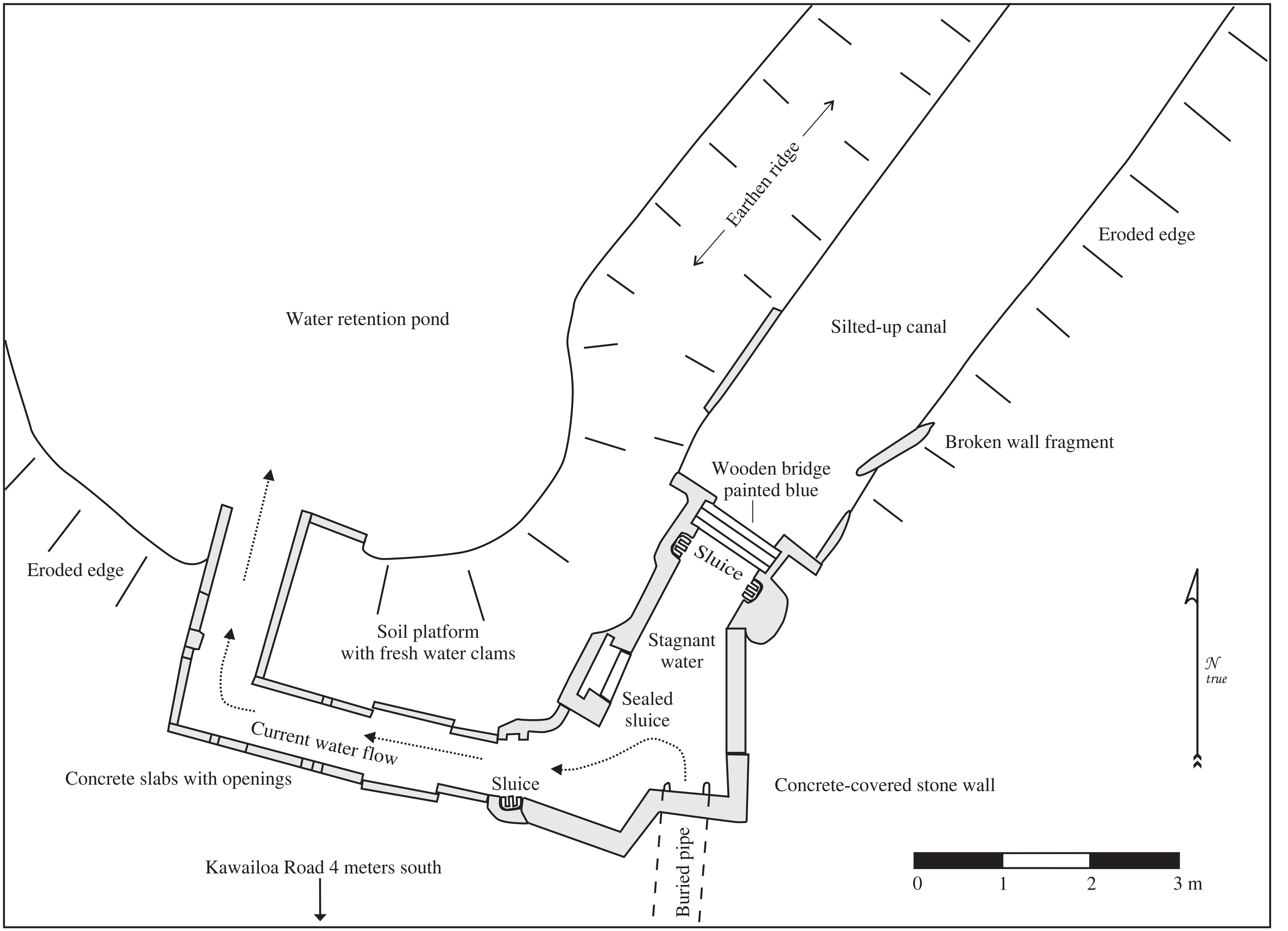

Figure 64. Site 7159 Section 7 north sluice gate complex plan view.


Figure 65. Site 7159 Section 7 sluice gate complex north of Kawailoa Road, view to the north.


Figure 66. Site 7159 Section 8 sluice gate complex at middle of section, view to the southwest.

Section 9 of Site 7159 begins 15 meters *makai* of where the 75-centimeter diameter pipe from Section 8 re-emerges (see Figure 45). A one-meter high rock and cement wall topped by a cement curb has been constructed around the pipe. Inscribed on top of the cement curb is the date “8-5-1953”.

Immediately *makai* of the curb are slots in the cement wall for a sluice gate (Figure 67). When closed this gate would allowed water to flow into a side sluice, the entrance to which has now been sealed with a solid concrete insert. The main ditch walls here are 1.3 meters high.

A feeder ditch from the southeast and outside the project area follows the 405 feet contour and joins the main Kawailoa Road ditch channel immediately *makai* of the culvert exit. The side ditch measures 2.5 meters wide across its top, 1.15 meters wide across its base, and not more than 90 centimeters deep. The floor and walls of this feeder ditch consist of extremely broken cement and plaster. However, the last two meters of wall and floor from where the feeder ditch enters the main ditch consist of solidly casted cement.

Roughly three meters *makai* of the culvert and ditch intersection, a pre-cast concrete bridge spans the main Kawailoa Road ditch channel. This bridge is 1.6 meters long by 1.6 meters wide by 15 centimeters thick (see Figure 66). *Makai* of the bridge the south wall drops in height to 90 centimeters and the north wall to one meter. The height of both walls drops to 80 centimeters halfway down the ditch. Although the irregularly-shaped basalt chunks in the walls are not coursed, the walls appear to be in a good state of repair and are covered with a translucent outer plaster-like layer. The floor has a cement bottom with crushed stones. Strips of light-colored cement mark those seams that have been patched fairly recently.

Figure 67. Site 7159 Section 9 sluice gate complex at start of section, view to the southwest.

Section 10 of Site 7159 begins 1.5 meters *mauka* of a sluice complex, at the culvert exit that is 15 meters *makai* of Section 9 (see Figure 45). A wall of neatly cut rectangular basalt and cement extends for 65 centimeters above the culvert exit.

The first sluice complex within Section 10 is cement-covered. This complex, which is 1.04 meters deep and 80 centimeters wide, contains at least three sluice gates (Figure 68). Two of the sluice gates occur in the main Kawailoa Road channel and a third occurs where a former side ditch exits the main ditch perpendicularly to the south. The former location of a possibly fourth sluice gate occurs in the north wall of the main ditch, directly *makai* of the culvert exit. The possible northern gate is now solidly blocked by a cement insert that is fused with the north wall. The southern gate is sealed with a cement slab insert. When closed, the *mauka* sluice in the main channel would have forced water through the northern gate, whereas the *makai* sluice would have forced water through the southern gate. The original northern wall that was associated with the *makai* gate is gone and has been replaced with a rough stone and cement wall; a wooden beam embedded in the ditch floor probably was the base of the sluice gate.


Figure 68. Site 7159 Section 10 first sluice gate complex, view to the north.

Broken pieces of a dismantled sluice gate bridge and ditch walls are scattered across the ground surface southwest of the sluice complex. In the southwest exterior corner of the complex, where the southern ditch exits from the main one, is a cement patch. This patch, which runs diagonally up the corner, has footprints left by a mongoose when the cement was still wet.

Roughly 1.5 meters *makai* of the sluice gate complex, in the northern wall of the main channel, is a pipe entering diagonally from below Kawailoa Road to the northeast (see Figure 68). The pipe is protected by a side-walled insert into the main ditch wall.

Seams within the main channel, particularly where the rock and cement walls join the crushed stone and cement floor, has recently been patched by light-colored cement. One patch, on a 2.5-meter long cement section on top of the southern wall, has incised on top of it the date "2-13-81." Another patch, which occurs on the floor immediately below the southern wall, is the very recent date of "5/22/09."

The main ditch within Section 10, that runs south of and parallel to Kawailoa Road, has an average depth of 70 centimeters and is 1.45 meters across the top and 85 centimeters across the bottom. Generally speaking, the walls of the main ditch are made up of irregular shaped basalt chunks with no apparent coursing.

Approximately half-way down Section 10, is the second sluice complex. Here two sluices occur on directly opposite sides of the main channel (Figure 69). The sluice gate in the southern wall points diagonally southwest, while the gate in the northern wall points diagonally northwest. Both sluice gates are made out of thick cement poured over a stone core. The gates are 80 centimeters high and 40 centimeters wide. Incised on top of the cement curb over the northern gate are the following: "Antonio" and "1913." If this is an actual date, then the side sluice is the oldest recorded surviving feature within Site 7159. Broken and partly cement-filled remains of slots for a former sluice gate on the main ditch can be seen roughly 75 centimeters *makai* of the side sluices. When closed, water from the main ditch would have been forced through one or both the side channels. The side sluices are sealed with heavy slabs of pre-cast cement. Exposed cement pipes that emanate from the sluice gates are now almost completely destroyed.

Figure 69. Site 7159 Section 10 second sluice gate complex, view to the south.

Roughly six meters *mauka* of the second sluice complex the walls of the main ditch have an added layer of hollow tile. This extra layer probably serves to prevent spillage over the edges of the channel and so help minimize soil erosion along the exterior edges.

The next 80 meters of the main ditch along Kawailoa Road is an intricate succession of sluice gate complexes, side channels, a retention pond, bridges, and culverts (Figure 70). The first sluice gate complex within this stretch (i.e., the third sluice complex within Section 10) serves to divert water from the main ditch into a retention pond that is almost 10 meters to the south (Figure 71). The complex includes two sluice gates; one in the main ditch and one at the beginning of the side ditch which branches off in a southwesterly direction. The gate in the main ditch appears to be still in use, as attested by a wooden foot bridge painted blue and by a wooden sluice with fresh mud and salt stains at roughly 70 centimeters above floor level. Although the side ditch no longer has a sluice gate, slotted wooden inserts still occur within the primary concrete slots.

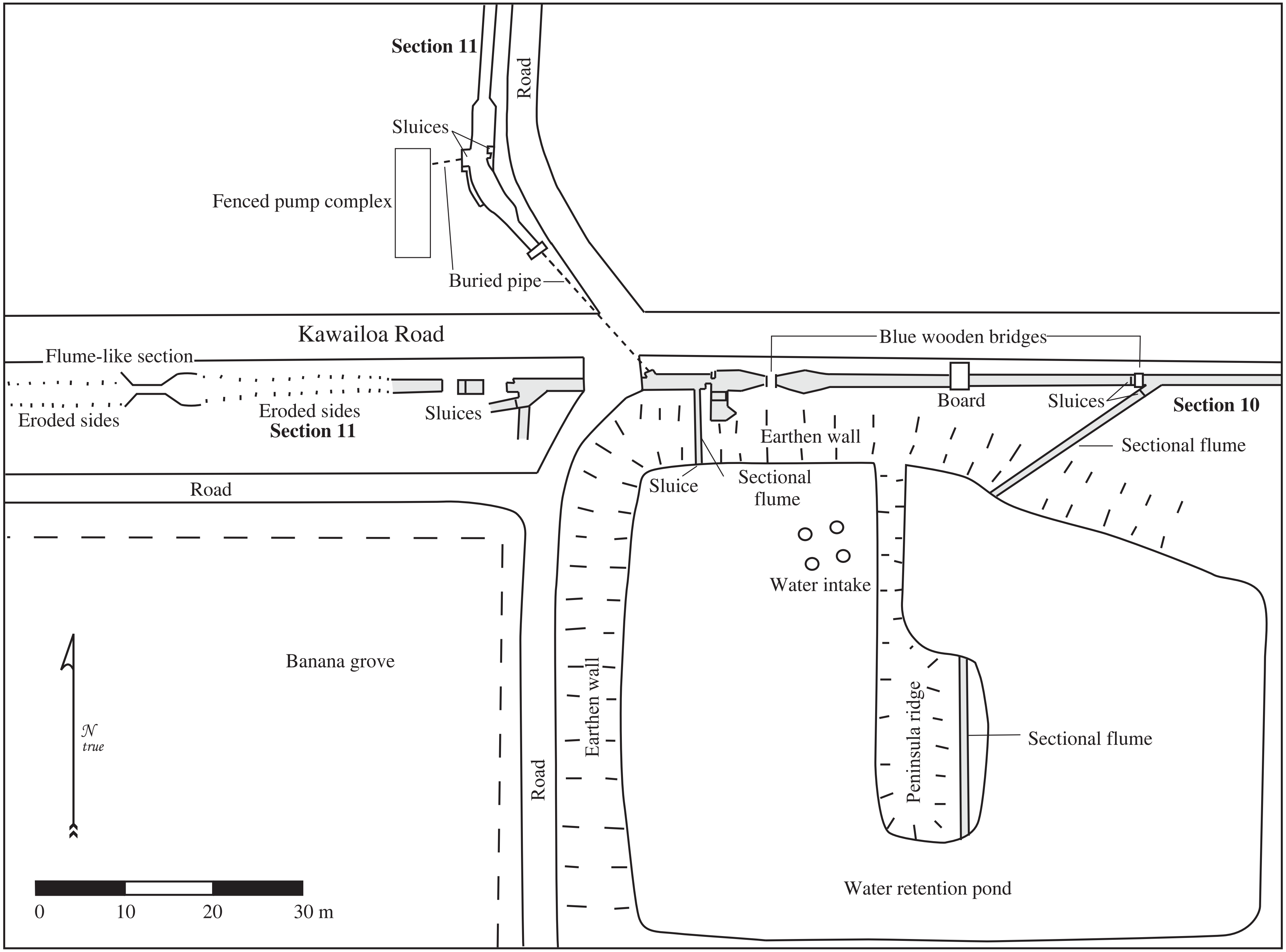

Figure 70. Site 7159 Sections 10 (west end) and Section 11 (east end) plan view showing sluice gate complexes.

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Figure 71. Site 7159 Section 10 third sluice gate complex, view to the south.

The side ditch, which consists of sections of square-shaped pre-cast units, connects the main channel with the retention pond. The walls of the sectional side ditch have been heightened by the addition of thin hollow tiles. Incised on the cement cap of the corner section, where the side ditch branches away from the main ditch, are the names “TRONG STRUCE” and date “9-87.” A portion of the sectional side ditch has been truncated by the *mauka* half of the pond, as can be seen by the continuation of the ditch on an extant peninsula in the center of the pond.

Almost forty meters *makai* from the sluice gate complex is another blue wooden footbridge (see Figure 70). This footbridge crosses a narrow section of the ditch, where it takes on an hourglass configuration (Figure 72). The wider *mauka* and *makai* portions on either side of the bridge measure 1.35 meters across, whereas the narrow neck with the bridge is merely 65 centimeters wide. The purpose of the narrow neck in the main channel is not known, although the occurrence of higher walls (i.e., 120 cm high) immediately *mauka* of the neck shows that it can contain a comparatively high level of water. Words incised into the cement capping of the heightened walls include the phrase “ESCAPE to Wisconsin” and “SAVE MONEY GANG WACO.”

Four meters *makai* of the bridge is an intricate sluice complex (the fourth one within Section 10) and a pre-cast triangular-shaped cement water retention facility (see Figure 70). Three sluice gates are currently visible in the complex; an open-one across the main ditch, a closed wooden gate currently blocking water in the triangular-shaped water retention facility from entering the main ditch, and an open-one at the rear of the triangle shaped water retention facility. The cast cement tank-like facility seems to receive its water supply from the big dirt-walled water retention pond 10 meters to the south. The fact that the southern wall of the main ditch has been sealed with concrete slabs immediately *mauka* of the cement tank suggests that pond water once entered the main ditch through a gate here. A blue painted wooden bridge covers a section of the cement water tank. Like most other platform-like bridges of similar dimensions and construction, this platform allows an operator to open and close the sluice gate from directly above. Slotted wooden beams for sluice gates are still present in all the cement slots of the complex


Figure 72. Site 7159 Section 10 fourth sluice gate complex, view to the north.

Words incised on top of the poured cement wall of the water tank near the bridge-like platform includes the name “CENDONG” and the dates “1-21-83” and again “1/21/83.” The two 1983 dates near the functional sluice in front of the concrete tank suggests the day that the job was completed.

Immediately *makai* of the triangular-shaped concrete tank is a square-shaped sectional side ditch (see Figure 70). This side channel, which extends from the retention pond to the main ditch, is made up of 93-centimeter long pre-cast concrete flume sections that are 42 centimeters wide across the top and 27 centimeters wide across the bottom. A PVC pipe currently runs along the bottom of the pre-cast cement flumes. The pipe brings water from the retention pond to Kawailoa Road and beyond. Roughly six meters *makai* from where the side ditch and pipe enter the main channel, the pipe and the main ditch turn northwest to pass underneath a concrete bridge below Kawailoa Road (see Figure 70).

This concrete bridge that supports Kawailoa Road covers the northern branch of the main ditch. The southern branch of the main ditch continues straight *makai* at a fifth sluice gate complex that represents the termination of Section 10 (Figure 73). The bridge that covers the northern branch is 1.25 meters wide, 73 centimeters high, and roughly 17 meters long. The concrete pipe that designates the southern branch and *makai* continuation of the main ditch has a diameter of 50 centimeters. The sluice gate that allows water to enter the pipe and the southern branch of the main ditch has been closed with dirt, rocks, and wooden planks. The sluice gate that allows water to flow northwestwards towards the northern side of Kawailoa Road is open, but is no longer operational. Slotted wooden beams still exist within the cement slots of both northern and southern sluice gates.

<u>Section 11</u> of Site 7159 is divided into two branches; one north of Kawailoa Road and the other south (see Figures 45 and 70). The northern branch starts at least seven meters north of Kawailoa Road where the ditch and PVC pipe exit from underneath the cement bridge (Figure 74). The first five meters of the ditch are lined by rock walls that have been plastered with a thick layer of cement. Words incised on the cement capping of the *makai* stone and cement wall of the northern ditch includes the phrases “WACO SAVE Money GANG A&B” and “2802 MADE FOR F.K.”

Figure 73. Site 7159 Section 10 fifth sluice gate complex, view to the southwest.

Figure 74. Site 7159 Section 11 north of Kawailoa Road, view to the north.

After five meters the northern ditch turns northeast to follow the 350 feet contour. From the bend in the ditch onwards the walls alternate between rock and cement constructions to conjoined pre-cast cement flumes. Thereafter the walls are made with cement and chicken wire that are badly broken up. A fenced modern pump facility with three tanks is located five meters *makai* of the northern channel.

Approximately 10 meters from the start of Section 11 north of the road is a sluice complex (see Figure 72). This complex contains two sluice gates, both still containing remnants of wooden slots. The sluice gate in the main ditch allows water to flow along the contour, whereas a slide sluice gate allows water to enter the *makai* orchard. The side sluice gate is currently blocked by a pre-cast cement slab.

The southern branch of the main ditch channel continues along the southern side of Kawailoa Road (see Figure 70). Section 11 of this branch starts six meters *makai* of the termination of Section 10. A culvert running below a side road separates the two sections.

Five meters *makai* from the start of Section 11 is the first sluice complex (see Figure 70; Figure 75). This complex consists of three sluices; one where the main ditch disappears in a culvert, one at the entrance to a three-meter long side ditch exiting diagonally southeast from the main ditch, and one within a three-meter long side channel exiting due south from the main ditch. The two side channels are sealed with pre-cast concrete slabs, while the main sluice gate is open. The sluice gate complex is characterized by 80-centimenter high cement-covered walls and floor, whereas the two side ditches have conjoined concrete slabs as walls. *Makai* of the main sluice gate is an outlet pipe, 50 centimeters in diameter. The culvert *makai* of the sluice gate complex is only 1.8 meters long and exits into a narrow stone-walled channel. The short rectangular box-like section of ditch is 5.15 meters long, 50 centimeters wide and 80 centimeters deep. Two-thirds of the way down each opposing wall are slots of the second sluice gate along Section 11 (Figure 76).

Figure 75. Site 7159 Section 11 first sluice gate complex, view to the south.

Figure 76. Site 7159 Section 11 second sluice gate, view to the south.

The box-like channel enters a 50-centimeter diameter culvert again only to emerge 1.2 meters *makai* in a continuation of the main ditch along Kawailoa Road. The first half of the eight-meter long intact channel is made up of conjoined tubular-shaped walls. Each pre-cast concrete and gravel section within this wall is 92 centimeters long, 60 centimeters wide, and three centimeters thick. The two halves are joined together with strips of cement to form a channel that is 60 centimeters across its widest central diameter. The second half of the intact channel is made up of stone and cement walls, within which no regular shaped stone or coursing is present. The walls end abruptly in an eroded gulley. The gulley is approximately four meters wide across its top and 2.5 meters across its base and one meter deep. The eroded gulley continues for almost 16 meters *makai* before an hourglass-shaped feature, made up of pre-fabricated cement slabs, is located within the main ditch (Figure 77). This feature is three meters long, 1.14 meters wide on both ends, and 55 centimeters across at its narrowest. Three wooden beams, arranged at regularly-spaced intervals along the flume-like feature, appear to hold the outer lips together. *Makai* of the hourglass-shaped feature, the dirt-lined ditch drops off for at least another 85 centimeters. Remnants of a formerly stone-lined channel can still be seen along the sides of the two-meter deep gulley. Roughly halfway down the eroded ditch a corrugated metal culvert enters the northern slope from underneath Kawailoa Road. The pipe is aligned northeast/southwest and probably originates somewhere north of the road. The northern side of the ditch around the pipe is severely eroded.

The Section 11 ditch ends at a 75-centimeter diameter culvert. A 1.8 meters high stone and cement wall has been built around and above the culvert. Intact remnants of stone and cement walls, arranged in a funnel-shape, extend for roughly two meters *mauka*. Together with the intact wall sections, a wooden railway sleeper on the curb above the culvert and two attached rail lines are the only remnants of the original channel at the *makai* end of Section 11.

Figure 77. Site 7159 Section 11 flume feature, view to the south.

Section 12 of Site 7159 starts within an enclosed elongated box-like sluice complex, which is approximately 180 meters *makai* of the end of Section 11 (see Figure 45). Measuring 1.16 meters north/south by 1.8 meters *mauka*/*makai* by 1.3 meters deep, the complex is rectangular-shaped and made up of walls with four courses of neatly cut basalt blocks joined by cement (Figures 78 and 79). Two pipes enter the complex; one from directly *mauka* and the other diagonally from the northeast. Each pipe has a diameter of 75 centimeters. Two sluice gates are present this section; one that ends in an outlet pipe and one in the southern wall that is partly covered by soil. Both sluices allowed water to flow out from the contained complex; one through the main ditch *makai* and the other into the fields to the south. Each sluice gate has the remains of a slotted wooden beam inserted into concrete slots. Incised into the cement capping of the *mauka* wall is the date "1/28/53," while a triangle is incised on top of the *makai* wall.

Roughly 1.4 meters *makai* of the stone-walled sluice gate complex the pipe exits into an eroded ditch that is lined with collapsed basalt rocks. Halfway down the eroded channel, resting on the ground surface above the southern edge, is a free-standing two-meter long section of a basalt rock and cement wall.

Section 12 of the ditch ends at a 75-centimeter diameter culvert. A 1.8 meters high stone and cement wall has been built around and above the culvert. Intact remnants of stone and cement side walls, arranged in a funnel-shape, extend for roughly two meters *mauka*.

Section 13 of Site 7159 commences where the culvert exits five meters *makai* of Section 12's end (see Figure 45). The ditch is virtually destroyed in this area an measures roughly 1.5 meters deep and 4 meters wide. Three quarters down the severely eroded Section 13 is a five-meter long remnant of the northern wall. Comprising irregular-shaped basalt rocks cemented together with no apparent coursing, the wall protects a cement pipe that emerges diagonally from underneath Kawailoa Road to the northeast. Here the three-meter deep dirt-sided channel has eroded well below the one meter level of the original cement floor.

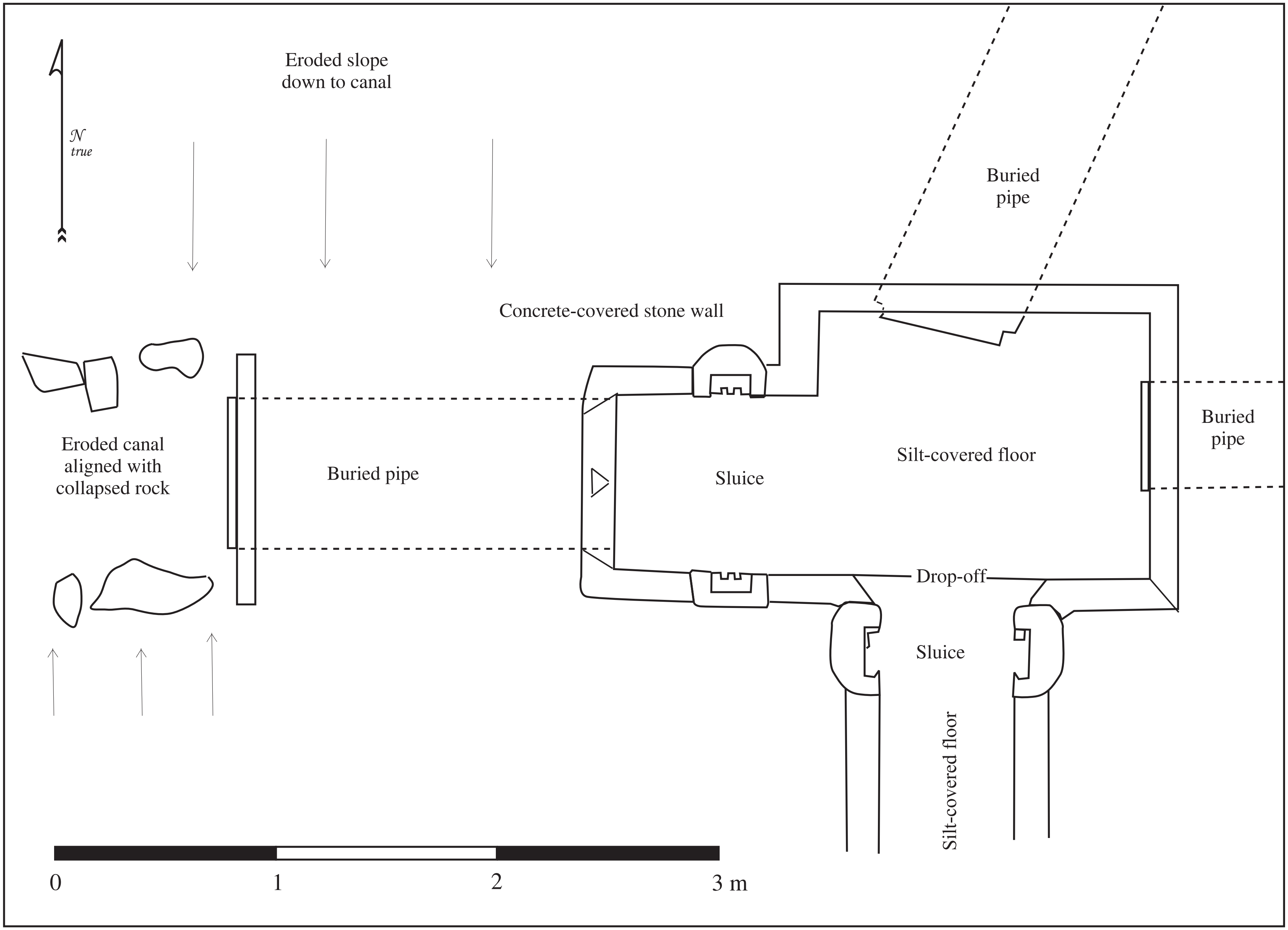

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Figure 78. Site 7159 Section 12 sluice gate complex plan view.

Figure 79. Site 7159 Section 12 sluice gate complex, view to the north.

Section 13 terminates in a 75-centimeter diameter culvert. A 1.8 meters high stone and cement wall has been built around and above the culvert. Intact remnants of stone and cement side walls, arranged in a funnel-shape, extend for roughly six meters *mauka*. A cement layer that covers the curbed wall above the culvert outlet has the following incisions: "C65;" "DH;" "EG;" and "JA."

Approximately five meters south of the ditch and 12 meters *mauka* of Section 13's termination is a modern pumping station. Similar to other functioning pumping stations in the general project area, this one is enclosed within a chain-link fence. Twelve metal tanks and brightly painted pipes are within the rectangular-shaped fenced area. Slightly upslope and *mauka* of the pumping station are two big metal tanks on metal pedestals.

Section 14 of Site 7159 starts almost 40 meters *makai* of Section 13's terminal point (see Figure 45). Section 14 contains a side feeder channel and a roofed building. Both features are approximately 10 meters south of Kawailoa Road, which place them immediately outside the project area.

The ditch, which follows the 240 feet contour, extends to the south well outside the project area and in the direction of the Anahulu River. This channel is badly eroded, with only the *makai* stone and cement wall still visible. It terminates immediately *makai* of the roofed building, where it is 1.5 meters wide and lined with a sturdy poured concrete wall. The northern end of the channel terminates in a cement pipe, 75 centimeters in diameter.

The building, which measures 13 meters north/south by five meters *mauka*/*makai*, has corrugated tin sidings and a pitched roof (Figure 80). There are sliding doors along the narrow north and south ends of the building, while the *mauka* and *makai* sides have two windows each. Two vents, probably containing extraction fans, occur on the two-sided sloping roof of the building. At the bottom of the *makai* side of the building is a large cement tank measuring five meters long by two meters wide by three meters deep. A spillway *makai* of the tank allows water to overflow into the ditch immediately outside the building. Judging from the "Danger Chlorine" sign at the front door of the building, the structure could have functioned as a water purification plant. A chain link fence storage and parking space abuts the *mauka* side of the building.


Figure 80. Site 7159 Section 14 building, view to the northeast.

Roughly 15 meters *makai* of the building is a large north/south aligned pile of stones, cement rubble, and discarded metal. This area appears to be a dump, probably containing pieces of broken flumes and other features, such as houses. The pile is at least five meters south of Kawailoa Road and extends *makai* for about 20 meters along the road. On the 1929 Haleiwa Quadrangle Survey map (see Figure 4), this is where a street with houses of the Kawailoa Camp crossed Kawailoa Road. It could be that the massive pile contains bulldozed remains of the old camp.

The 1929 map also shows a pipe line running along the southern side of Kawailoa Road. This pipe line was connected to Pump House 4, which is almost one kilometer *makai* of Section 14. This pipeline is identified in the current report as Site 7164 and is described in the subsequent Cane Haul Road Corridor section of this report.

SIHP Site 50-80-04-7160

Site 7160 consists of parallel stone abutments located on either side of Kawailoa Drive (Figure 81), where it follows a straight course below a sharp turn (see Figures 36 and 44). Extending for 30 meters between 100 and 110 feet contours, the abutment walls are made up of basalt stones. The basalt blocks within the upper wall (Figure 82), which is located immediately above the road, are neatly cut, with bigger blocks (each measuring 50 x 50 cm) making up the bottom course. This upper wall varies in height from 1.15 meters to 20 centimeters. The *mauka* wall consists of two outer “casings” with an infill of smaller stones. In certain areas the stones are joined with cement, while in others smaller rocks are stuck within gaps between neighboring stones. In spite of the cement and smaller rocks, the upper courses within the central and southern portions of the *mauka* wall have collapsed. The roots of two Banyan trees that grow upslope of the upper wall, have probably contributed to the collapse of certain sections. A barbed-wire fence runs upslope and parallel with the upper terrace. The wall below, or *makai*, of the road is two meters high. This abutment consists of relatively big stones that are roughly stacked. Although the abutment walls are clearly historic in age, their date of construction is not known. The current alignment of Kawailoa Drive, which the walls line, is shown on the 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4).

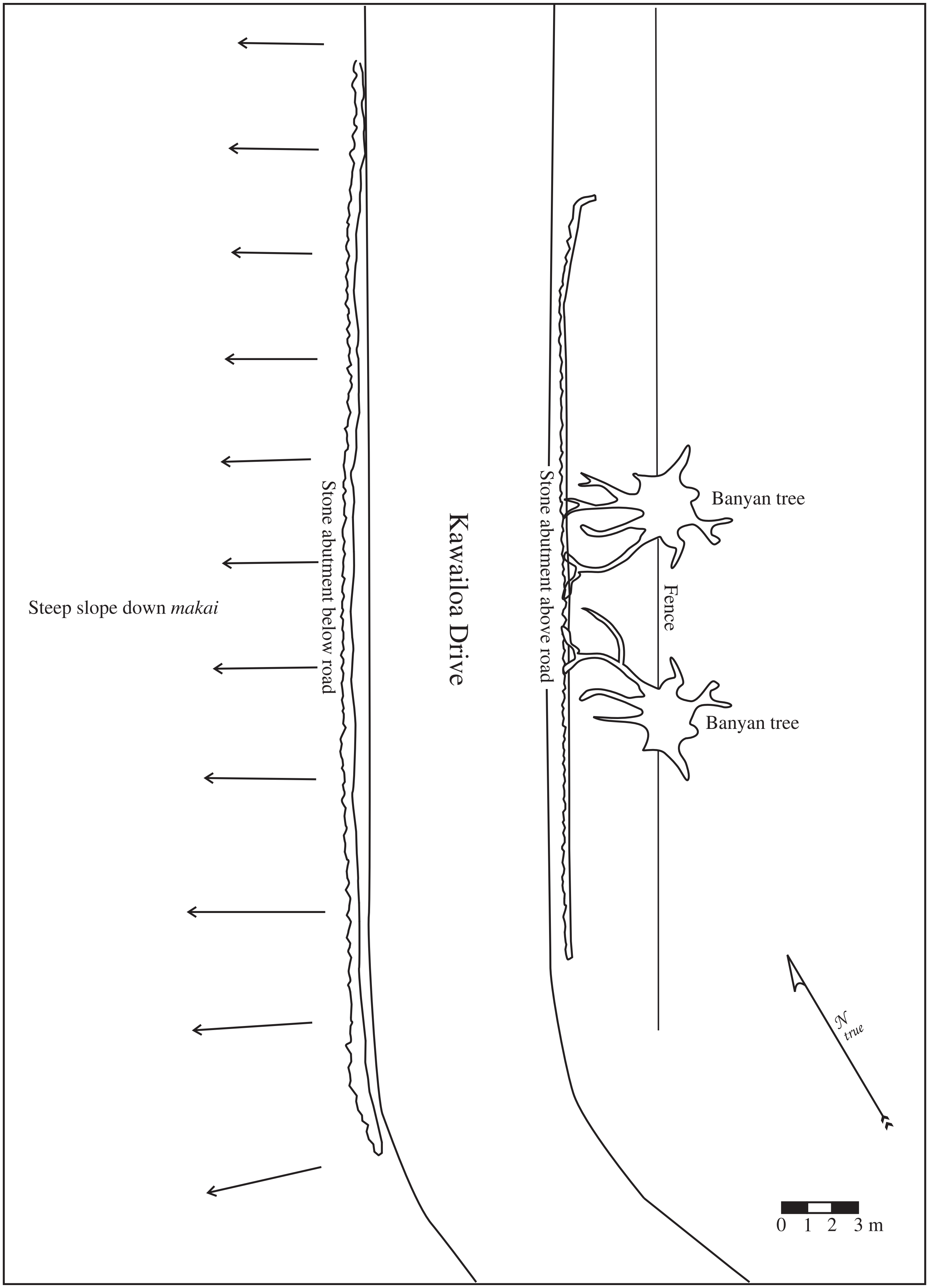

Figure 81. Site 7160 plan view.

Figure 82. Site 7160 upper stone abutment along Kawailoa Drive, view to the south.

SIHP Site 50-80-04-7161

Site 7161 consists of three separate rectangular-shaped concrete structures (Features A, B, and C) located three meters *makai* of Kawailoa Drive near the 130-foot contour (see Figures 36 and 44). The total area covered by the three structures measures 22 meters east/west by 19 meters north/south (Figure 83). The site's surface is covered by Guinea grass and a tall Banyan tree.

The largest feature, Feature A, which is closest to the road, is a rectangular-shaped concrete slab that measures 10 meters east/west by 7.5 meters north/south (Figure 84). A low concrete lip on the *makai* edge of the slab is the only part that stands above the otherwise level surface of the slab.

Seven meters north of the slab is Feature B, a rectangular-shaped cinder block wall with a wooden frame. Measuring five meters north/south by 1.8 meters east/west, this feature is made from a one course high wall of conjoined cinder blocks standing on end (i.e., approx. 20 cm high by 5 cm thick). Mounted on this low and thin foundation wall is a wooden frame (Figure 85). The frame presumably served as a base for a former floor and/or walls. A concrete cement pipe, presumably for drainage purposes, emanates from the southwestern corner of the structure, pointing downwards on the exterior end.

Three meters *makai* of this walled structure is Feature C, a rectangular feature. An L-shaped concrete pavement, with block-like incisions, occurs between the two features. The *makai* feature, which measures nine meters east/west by 4.5 meters north/south, has a lowered surface on its southern side and a raised trough-like feature on its northern side (Figure 86). Two ramps of cement, one on each side of the cemented lower surface, are incised with a cross-hatched pattern, presumably to create friction on the slippery slopes. A metal water pipe with a valve overlooks the *mauka* end of the concrete trough. The trough, which is subdivided into three sections, has pipes connecting the sections. An outlet pipe occurs in the western corner of the trough. The names "SHANE-N-SANDY" are incised on the top of the trough wall, near its southeastern corner. The lower section of Feature C is littered with several short sections of PVC pipe.

TMK maps 1-6-2-09 and 1-6-1-05, originally drawn in 1951, both label this portion of the project area, within the tight curve of Kawailoa Drive, as "stables." The presence of a raised trough on the northern side of one rectangular feature within Site 7161 makes this a likely identification of the site's former function. No buildings are shown at this location on the 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4). A structure first appears at the location of Site 7161 on the 1953 AMS Hale‘iwa quadrangle (see Genz and Hammatt 2011).

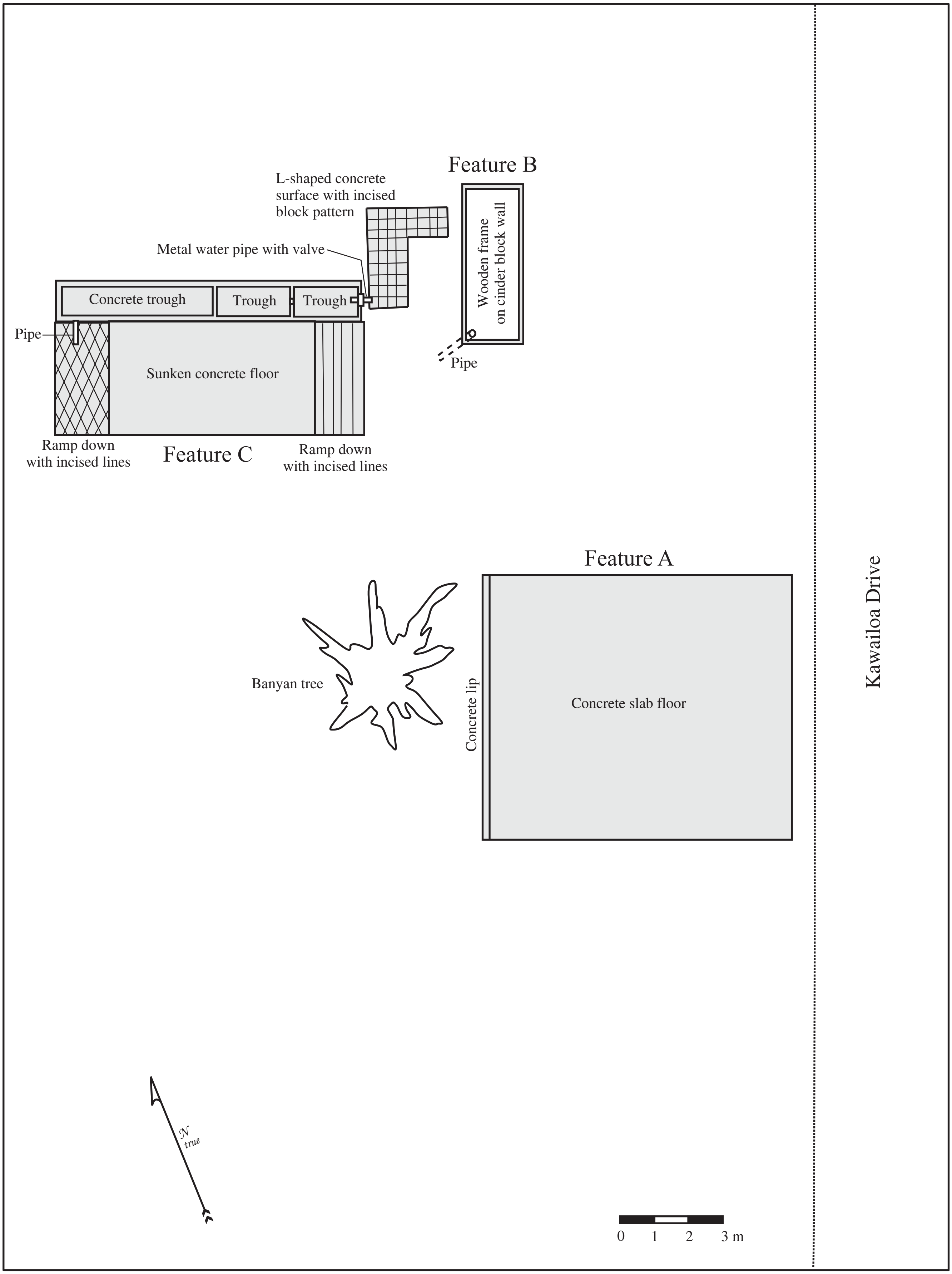

Figure 83. SIHP Site 7161, plan view.

Figure 84. Site 7161 Feature A, view to the north.

Figure 85. Site 7161 Feature B, view to the south.


Figure 86. Site 7161 Feature C, view to the southwest.

SIHP Site 50-80-04-7162

Site 7162 consists of a kerbstone alignment located along the *mauka* edge of Kawailoa Drive to the north of its intersection with Kawailoa Road (see Figures 36 and 44). The kerbstones consist of dressed basalt blocks (12-45 centimeters long by 12-17 centimeters wide) set end to end following the edge of the road alignment northeast/southwest for a distance of roughly 42 meters (Figure 87). The bottom edges of the kerbstones are buried in soil to a depth of 15-25 centimeters. The ground surface to the east (*mauka*) of the alignment is even with the top surfaces of the stones, and in some areas soil has spilled over the kerbing, completely burying some of the stones. The kerbstone alignment is interpreted as a historic construction related to the use of Kawailoa Drive and Kawailoa Camp. The exact date of construction for Site 7162 is unknown. This section of Kawailoa Drive was in use as early as 1901 (see Figure 30). The 1929 U.S.G.S. Haleʻiwa quadrangle (see Figure 4) shows houses, part of Kawailoa Camp # 2, lining the *mauka* edge of the road immediately inland of the kerbing.

Figure 87. Site 7162 kerbstone alignment, view to the northeast.

SIHP Site 50-80-04-7163

Site 7163, located on either side of the northeast/southwest aligned Hakina Bypass Road, almost 80 meters north of its intersection with Cane Haul Road (see Figures 36 and 44), is a culvert feature similar in design and construction to Sites 7165, 7166, and 7167. The concrete culvert has a diameter of 60 centimeters and extends under the road and serves as a drainage pipe for water from the Kawailoa Gulley. Both revetment walls are built from irregular-shaped basalt blocks that are joined together with cement. The *mauka* wall (Figure 88), which is concave-shaped in plan view, is almost six meters long by 2.1 meters high. The top of this wall is 2.5 meters below the level of the current road, indicating that a lot of fill was brought in to cross the gulch. The straight *makai* wall (Figure 89) is merely three meters long and 1.5 meters high. This wall appears to have been more carefully constructed than the *mauka* one, in that the basalt blocks have been laid down in four courses and the top of the wall is neatly capped with a cement layer. Guinea grass and *koa-haole* grow adjacent to both walls. Site 7167 appears to have been built during the early 1950s. Hakina Bypass Road was built after the railroad was dismantled (in ca. 1947-1950), and it is first depicted on the 1953 AMS Haleʻiwa quadrangle (see Genz and Hammatt 2011).


Figure 88. Site 7163 *mauka* revetment, view to the west.


Figure 89. Site 7163 *makai* revetment, view to the east.

Cane Haul Road Corridor

The Cane Haul Road Corridor follows the existing gravel/paved alignment of Cane Haul Road north/south between Hakina Bypass Road and Ashley Road (see Figure 1). The southern end of the Cane Haul Road Corridor is a portion of Alternative-2 of the Kawailoa Road Corridor (see above). This existing roadway, which will be used by First Wind to access Mid-Line Road and Ashley Road from Kawailoa Drive (Alternative-1 of the Kawailoa Road Corridor), runs at the base of the steep coastal escarpment and traverses portions of TMKs: 1-6-1-05: 019, 020, 021, and 022 (see Figure 2). Three of these parcels (020, 021, and 022) are former *kuleana* (LCA #s 7417:1, 8419:1, and 10364:2). All three have been recently grubbed and graded and lined with walls of stacked boulders to create lots for residential development. For most of its length, except at its northern end where it joins Ashley Road, Cane Haul Road follows the alignment of an older Waialua Sugar Company railway (see Figure 4). The current alignment of the road was built in ca. 1950 after the railroad shut down (in ca. 1947) and the tracks were dismantled. The road is shown in its present location on the 1953 U. S. Army Mapping Service (AMS) Haleʻiwa quadrangle (see Genz and Hammatt 2011). It is lined on either side, by a wire fence lines, and much of the land on both sides of the road was formerly used as pasture. With the exception of the recently developed area, vegetation along the edges of Cane Haul Road consists primarily of Guinea grass (*Panicum maximum*) and *koa-haole* (*Leucaena glauca*).

Five archaeological sites were recorded within the Cane Haul Road Corridor (Sites 7164, 7165, 7166, 7167 and 7168; see Table 7 and Figure 36). These sites, which are all fully or partially located within 20 feet of the existing roadway, include a portion of an old metal water line (Site 7164) that once carried water from Pump # 4 (*makai* of the Cane Haul Road Corridor) to a ditch along Kawailoa Drive (a portion of Site 7159; see above), three concrete culverts that run beneath Cane Haul Road (Sites 7165, 7166, and 7167), and a concrete bridge that connects Cane Haul Road to Ashley Road (Site 7168). Each of these sites is discussed in detail below.

In addition to the recorded archaeological sites the presence of several sites was noted nearby, but outside, the study area in the vicinity of the Cane Haul Road Corridor (see Table 8). These additional sites represent both Precontact and Historic use of the general project area. As part of the current study brief descriptions and sketch maps of the nearby sites were prepared, photographs were taken, and their locations were plotted on a map of the project area (see Figures 36 and 44). The nearby sites include a remnant enclosure/pavement (Site 50-80-04-3400) previously recorded by Hommon (1982) near the intersection of Cane Haul Road and Kawailoa Drive; a slab paved pathway (T-14) located east of the Cane Haul Road Corridor below the horseshoe in Kawailoa Drive; a section of old rail bed (T-35) located near the intersection of Cane Haul Road and Hakina Bypass Road; a complex of walls and other modifications at the location of Kohokuwelowelo (Site 240), the dwelling place of *kahuna* described by McAllister (1933), on an oval-shaped elevation inland of Cane Haul Road south of its intersection with Ashley Road; and an old WWII concrete bunker photographed by Beckett and Singer (1999:103) at the top of a hill within the Kohokuwelowelo complex. These sites will not be impacted by the proposed improvements to Cane Haul Road.

SIHP Site 50-80-04-7164

Site 7164 consists of a section of large water pipe elevated above the ground surface between Cane Haul Road and the *makai* end of Kawailoa Road (see Figure 44). Two separate portions of the pipe are visible above the ground surface in the vicinity of the current project area; an upper portion that extends from 10 meters *makai* of the end of Kawailoa Road to 20 meters *mauka* of a curve in Kawailoa Drive, and a lower portion (Figure 90) that extends from six meters *makai* of the curve in Kawailoa Drive to four meters *mauka* of Cane Haul Road. The comparatively steep terrain where the pipeline is visible on the surface is characterized by loose rocks, Guinea grass, *koa-haole* trees, banyan trees, and be-still trees (*Thevetia peruviana*). The 80-centimeter diameter pipe has an outer metal layer and an interior lining of ceramic-like material. The inner lining is roughly four millimeters thick. Aligned northwest/southeast, the pipe consists of seven-meter long sections that are bolted and/or welded together. North of the big pipe is small metal pipe with a diameter of seven centimeters (Figure 91).

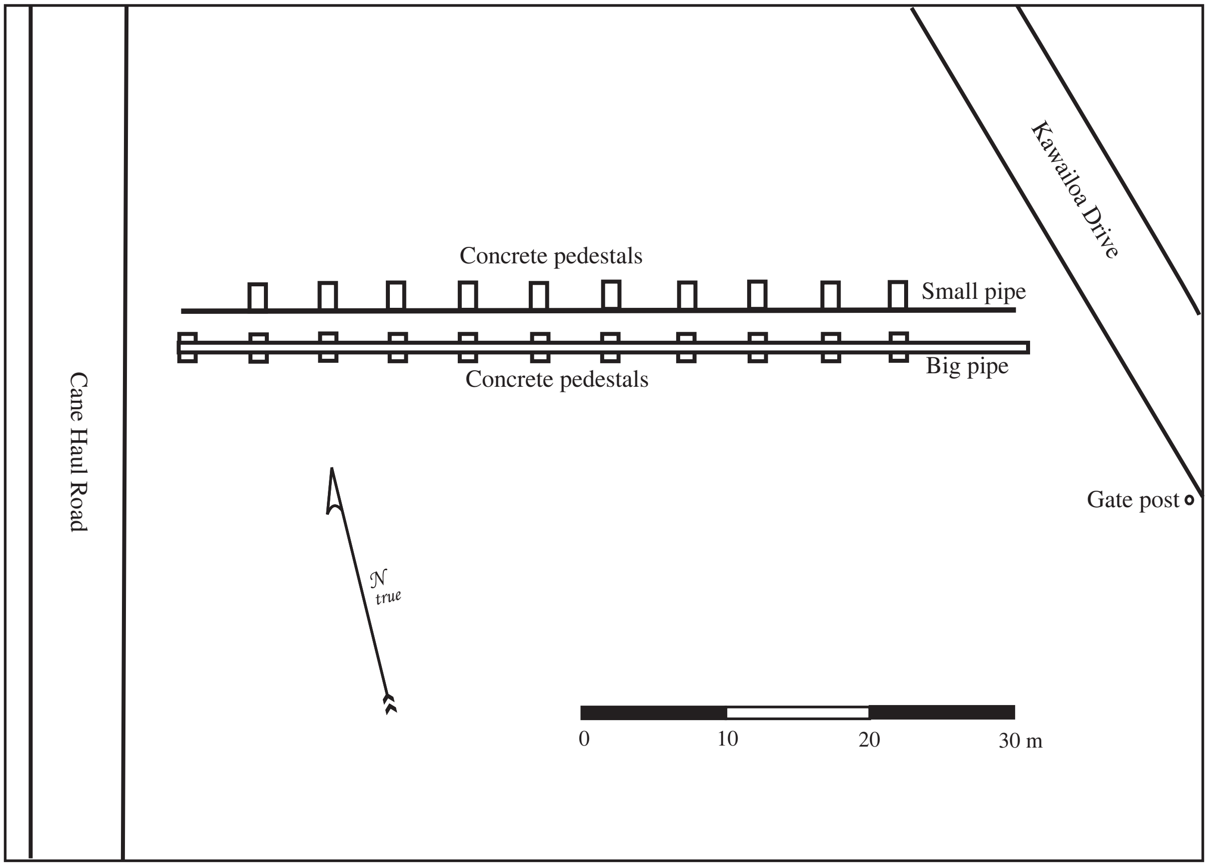

Figure 90. Site 7164 plan view of lower section.

Figure 91. Site 7164 lower portion, view to the southeast.

The 60-meter long exposed portion of the lower pipe, between Cane Haul Road and Kawailoa Drive, is supported by 11 concrete piers (see Figure 90). Parallel and 2.2 meters to the north of this line of piers is another line. Whereas the southern line of piers still supports the big pipe, the northern line now only has a small metal pipe attached to it via a bent metal bracket that connects to the upper southern edge of each pier (see Figure 91). The piers are made up of solid concrete that was poured into a wood-framed mold. The tallest pier is the fourth from *mauka*, on terrain *makai* of a steep slope. The rectangular-shaped pier is 1.87 meters high and tapers down towards the top. The *mauka* and *makai* edges of the pier are each 1.65 meters along the base and 90 centimeters along the top, whereas its north and south edges are each 119 centimeters along the base and 69 centimeters along the top. Only the tallest and second tallest piers have a step-like base, the rest have straight bases. Each of the shorter piers is 1.1 meters along the *mauka* and *makai* edges and 75 centimeters along the south and north edges. The upward-facing surfaces of all the piers are U-shaped, aligned *mauka*/*makai*. These U-shapes act as slots for the big pipe.

The approximately 250-meter long exposed portion of the upper pipe, between Kawailoa Drive and the *makai* end of Kawailoa Road, is supported by at least five stone and cement piers. Supporting two parallel large pipes down a steep slope, the piers in this section are fused into one. The basalt stones within the piers are neatly cut and dressed into rectangular blocks (Figure 92). The apex of each pier has two protrusions, each with a *mauka*/*makai*-oriented U-shape to nestle a pipe. The piers vary in height from two to five meters and are five meters long north/south by two meters wide east/west.


Figure 92. Site 7164 piers supporting the upper section of the pipes, view to the northeast.

This pipeline first appears on a 1901 map of the Kawailoa Section of the Waialua Agricultural Co.'s lands prepared by W. Wall (Hawai‘i Registered Map 2054; see Figure 30). It is shown stretching from Pump # 4 to a plantation ditch at roughly 560 feet above sea level. Pump # 4, which was used by the Waialua Agricultural Co. for irrigation purposes, was formerly located in the swampy area *makai* of Cane Haul Road and the current project area. Kawailoa Road follows the route of Site 7164 to the east, but no further sections of pipe are visible on the surface.

SIHP Site 50-80-04-7165

Site 7165 consists of a culvert located beneath Cane Haul Road, almost 100 meters south of its intersection with Kawailoa Drive (see Figures 36 and 44). On either side of the road are two vertical stone revetments and the ends of a concrete culvert with a diameter of 50 centimeters at the bottom center of each wall. The culvert extends for 14.5 meters under the road and serves as a drainage pipe for water from the upslope *mauka* side. Both walls are built from irregular-shaped basalt blocks that are joined together with cement. The *mauka* wall (Figure 93) is 3.6 meters long by 1.2 meters high, whereas the *makai* wall (Figure 94) is 3.5 meters long and 1.4 meters high. Trash and pieces of collapsed wall block the culvert opening at the bottom of the *mauka* wall. Guinea grass and *koa-haole* grow adjacent to the walls. The 1929 U.S.G.S. Hale'iwa quadrangle (see Figure 4) indicates that a railway once existed where the Cane Haul Road now extends. It is possible that this drainage control feature was originally built under the rail bed, but the fact that an almost identical feature (Site 7163) exists under a nearby roadway that did not exhibit prior use as a rail bed may indicate that Site 7165 was constructed when Cane Haul Road was built during the middle of the twentieth century, subsequent to the dismantling of the rail line. The current alignment of Cane Haul Road is first depicted on the 1953 AMS Hale'iwa quadrangle (see Genz and Hammatt 2011).

Figure 93. Site 7165 *mauka* revetment, view to the northwest.

SIHP Site 50-80-04-7166

Site 7166, located on either side of Cane Haul Road approximately 75 meters north of its intersection with Hakina Bypass Road (see Figures 36 and 44), is another culvert feature similar to Site 7165, with two vertical stone revetments and a 60 centimeter concrete culvert. The culvert extends under the road and serves as a drainage pipe for water from the upslope *mauka* side. Both revetment walls are built from irregular-shaped basalt blocks that are joined together with cement. The *mauka* wall (Figure 95) is covered with slumped soil and collapsed pieces of wall, so its original dimensions are difficult to determine. Nonetheless, judging from the intact pieces that are visible through the dirt and loose rock, the wall is probably similar in shape and size to the *makai* one. The *makai* wall (Figure 96), which is four meters long by 88 centimeters high, is capped by a neatly finished layer of cement. Guinea grass and *koa-haole* grow adjacent to both walls. The 1929 U.S.G.S. Hale'iwa quadrangle (see Figure 4) indicates that a railway once existed where the current Cane Haul Road now extends. It is possible that this drainage control feature was originally built under the rail bed, but the fact that an almost identical feature (Site 7163) exists under a nearby roadway that did not exhibit prior use as a rail bed may indicate that Site 7166 was constructed when Cane Haul Road was built during the middle part of the twentieth century, subsequent to the dismantling of the rail line. The current alignment of Cane Haul Road is first depicted on the 1953 AMS Hale'iwa quadrangle (see Genz and Hammatt 2011).


Figure 94. Site 7165 *makai* revetment, view to the southeast.


Figure 95. Site 7166 *mauka* revetment, view to the west.


Figure 96. Site 7166 *makai* revetment, view to the east.

SIHP Site 50-80-04-7167

Site 7167, located on either side of Cane Haul Road, approximately 550 meters south of its intersection with Mid-Line Road (see Figure 36), is another culvert feature similar to Sites 7165 and 7166, with two vertical stone revetments and a 60 centimeter concrete culvert. The culvert extends under the road and serves as a drainage pipe for water from the upslope *mauka* side. Both revetment walls are built from irregular-shaped basalt cobbles that are joined together with cement at the base of the wall on top of the culvert. The *mauka* wall is covered with slumped soil and grass (Figure 97), so its original dimensions are difficult to determine. It appears as though the *mauka* drainage channel has been somewhat recently re-excavated to expose the culvert opening. Judging from the visible section of the revetment immediately adjacent to the culvert, the wall is probably similar in shape and size to the *makai* one. The *makai* wall, which is ten meters long by 56-180 centimeters high, is covered by a layer of cement at the base (from 0-60 centimeters above ground surface), and then constructed of dry-stacked cobbles above (60-180 centimeters above ground surface) (Figure 98). It is highest at the center above the culvert, but tapers downward at each end as the ground surface slopes upward towards the road surface. Guinea grass and *koa-haole* grow adjacent to both walls. The 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4) indicates that a railway once existed where the current Cane Haul Road now extends. It is possible that this drainage control feature was originally built under the rail bed, but the fact that an almost identical feature (Site 7163) exists under a nearby roadway that did not exhibit prior use as a rail bed may indicate that Site 7167 was constructed when Cane Haul Road was built during the middle part of the twentieth century, subsequent to the dismantling of the rail line. The current alignment of Cane Haul Road is first depicted on the 1953 AMS Hale‘iwa quadrangle (see Genz and Hammatt 2011).


Figure 97. Site 7167 *mauka* revetment, view to the west.


Figure 98. Site 7167 *makai* revetment, view to the east.

SIHP Site 50-80-04-7168

Site 7168, located at the northeastern end of Cane Haul Road, where it meets Ashley Road (see Figure 36), is a concrete bridge that crosses an unnamed drainage channel. The bridge (Figure 99), which measures roughly 15 meters long by 7 meters wide, supports the asphalt surface of Cane Haul Road as it slopes up and turns to the east to join Ashley Road (Figure 100). The bridge span is made of poured, reinforced concrete that is 65-74 centimeters thick. The span sits (2 to 2.2 meters above the drainage basin) on poured concrete footings that abut either drainage embankment 3.1-3.6 meters distant from one another. Poured concrete wing walls, 2.5-4.5 meters long by 2.6-3.0 meters tall, extend for each side of both of the abutments, retaining the drainage edge and fill material on both sides of the span. The drainage basin beneath the span is covered with a slab of poured concrete. The *mauka* edge of the bridge span on the road surface (Figure 101) has dumped cobble, boulder, and soil material that acts as a kerb for the roadway. The *makai* edge of the bridge (Figure 102) has an iron I-beam railing, anchored in poured concrete at its northeastern end, and held up by two I-beam supports attached to the edge of the concrete span at its southwestern end. A metal gate, opening outward and upward to allow for debris carried by storm run-off to pass beneath it, but designed to keep livestock in the fenced paddock *makai* of Cane Haul Road, runs between the two wing walls on the *makai* side of the bridge. Guinea Grass, *haole-koa*, and a Banyan Trees are growing on either side of the bridge. The 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4) indicates that the old Waialua Agricultural Co.’s rail line deviated from the current alignment of Cane-Haul Road to the south of Site 7168, and that no road was present at this location as of yet. The bridge, based on its construction materials and condition, was likely built during the middle part of the twentieth century when Cane-Haul Road was built, subsequent to the dismantling of the rail line. The current alignment of Cane Haul Road is first shown on a 1953 AMS Hale‘iwa quadrangle (see Genz and Hammatt 2011). The concrete abutments have recently been covered with colorful, spray painted graffiti.

Figure 99. Site 7168 surface, view to the east.

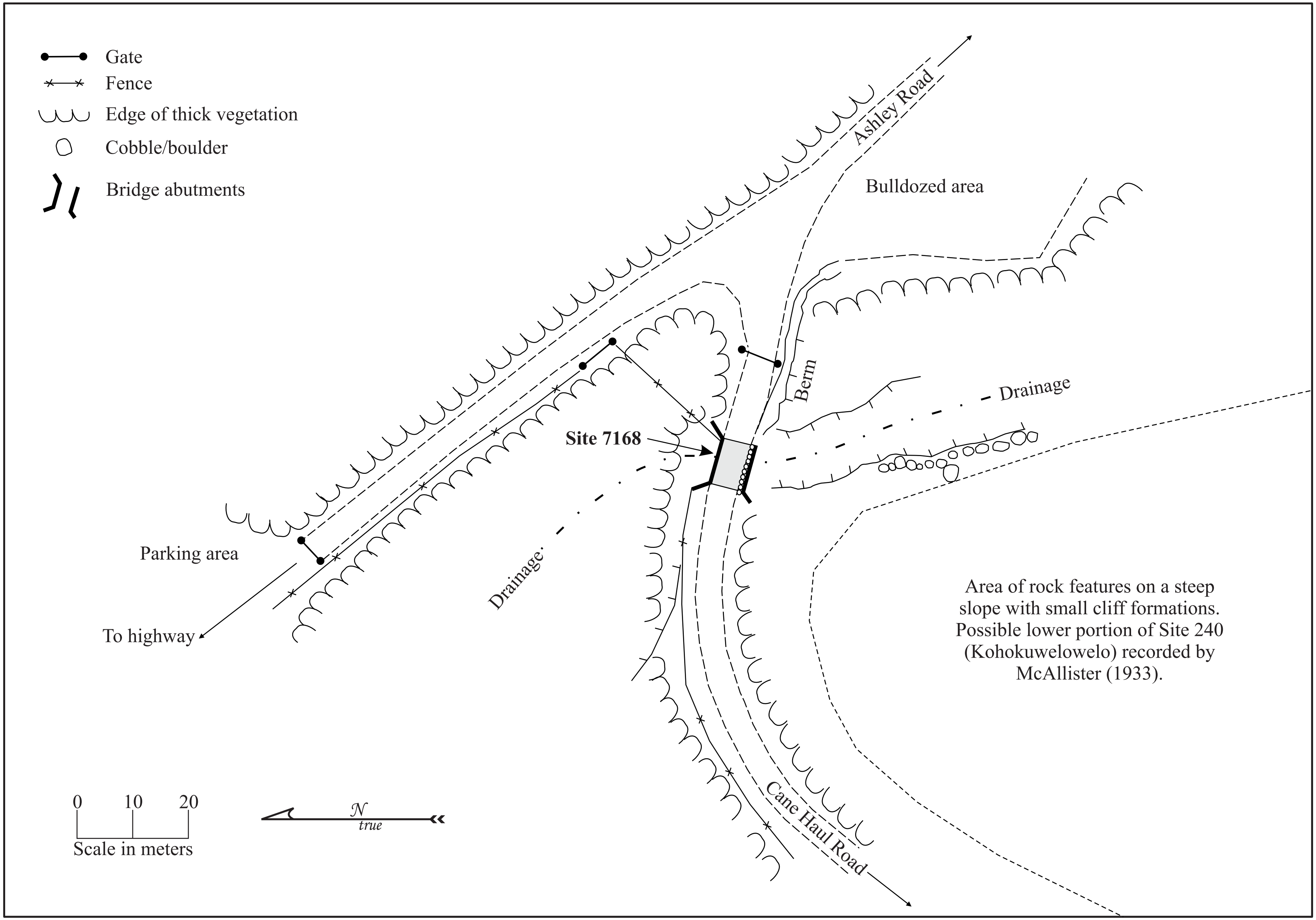

Figure 100. Site 7168 plan view.

RC-0660

Figure 101. Site 7167 *mauka* edge, view to the north.

Figure 102. Site 7168 *makai* edge, view to the southwest.

Mid-Line Road Corridor

The Mid-Line Road Corridor, which will be used by First Wind to access four turbine locations within the Western Tableland Array, follows the preexisting gravel/paved alignment of Mid-Line Road from Cane Haul Road to the middle survey area of the Western Tableland Array at an elevation of roughly 680 feet above sea level (see Figure 1). Mid-Line Road runs in a relatively straight line across portions of TMKs:1-6-1-05:001, 019 and 1-6-1-07:001 (see Figure 2). Only the western (*makai*) portion of this roadway (below the 440-foot contour), which passes through cultivated agricultural fields, is currently drivable. Above that elevation, which is marked by a crossroad, Mid-Line Road is completely overgrown and not drivable. Between the 440-foot contour and the 540-foot contour, which is marked by a second crossroad, the former road bed is lined by an earthen bank along its southern edge and a series of old power poles that follow its northern edge. Above the 540-foot contour the former route of Mid-Line Road is barely discernable through the thick growth of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and stands of albizia (*Acacia lebbek*).

The Mid-Line Road Corridor crosses the former Waialua Sugar Company’s fields Kawailoa-13, 14, and 15 (see Figure 9). Aerial photographs of the project area (see Figures 5-8) show that these fields were completely cultivated in sugarcane and pineapple during the second half of the twentieth century. The middle section of Mid-Line Road, between the 180-foot and 540-foot contours, appears to have been built first by the Waialua Agricultural Company, sometime prior to 1924 (see Figure 31). The upper section of the road, above the 540-foot contour, was added by 1929 (see Figure 4), and the lower section, between Cane Haul Road and the 180-fout contour, was added sometime prior to 1953, likely after the railway was dismantled in ca. 1947-1950. While the lower section of Mid-Line Road is shown on the 1953 AMS Hale‘iwa quadrangle (see Genz and Hammatt 2011), the upper section is not. Aerial photographs indicate that the upper section (above 540 feet in elevation) was planted in pineapple during the second half of the twentieth century, and that the road alignments through the pineapple fields, including Mid-Line Road, shifted frequently. The 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4) shows a ditch following the southern edge of the road between roughly the 340-foot and the 440-foot contours, and the north edge of the road between the 440-foot and 490-foot contours. That map also shows several ditches, a pipe line, and a railway crossing Mid-Line Road.

As a result of the current fieldwork two archaeological sites, both comprised of portions of former plantation ditches, were recorded within the Mid-Line Road Corridor (Sites 7169 and 7170; see Table 7 and Figure 36). Sites 7169 and 7170 are part of the Kamananui ditch system that was created by the Waialua Agricultural Co. during the early to mid-1900s. Site 7169 consists of a feeder ditch that follows the 540-foot contour across the Mid-Line Road Corridor. Site 7170 consists of a feeder ditch that crosses the corridor at the 440-foot contour and supplies a *mauka*/*makai* ditch that follows the southern edge of Mid-Line Road to a reservoir located near the 330-foot contour. Site 7170 also includes a short section of remnant ditch that follows the north edge of Mid-Line Road *mauka* from the 440-foot contour. Site 7169 no longer functions, but Site 7170 fills reseviors and retention ponds that water the existing agricultural fields along Mid-Line Road. Each of these sites is discussed in detail below.

SIHP Site 50-80-04-7169

Site 7169 designates an irrigation ditch that runs across the current project area at Mid-Line Road, following roughly the 540-foot contour (see Figure 36). This irrigation ditch is part of the Kamananui ditch system that was created by the Waialua Agricultural Co. during the early to mid-1900s. The ditch no longer carries water. For the purposes of description, this southwest/northeast trending irrigation ditch was subdivided into two sections separated by a buried pipe that runs beneath Mid-Line Road. Section 1 runs northeast of the road eventually feeding into a buried pipe and a reservoir, and Section 2 runs southwest of the road, once continuing to Site 7159 at Kawailoa Road (Figure 103). Starting with Section 1 at the northeast end, the following description highlights the main features of both sections.

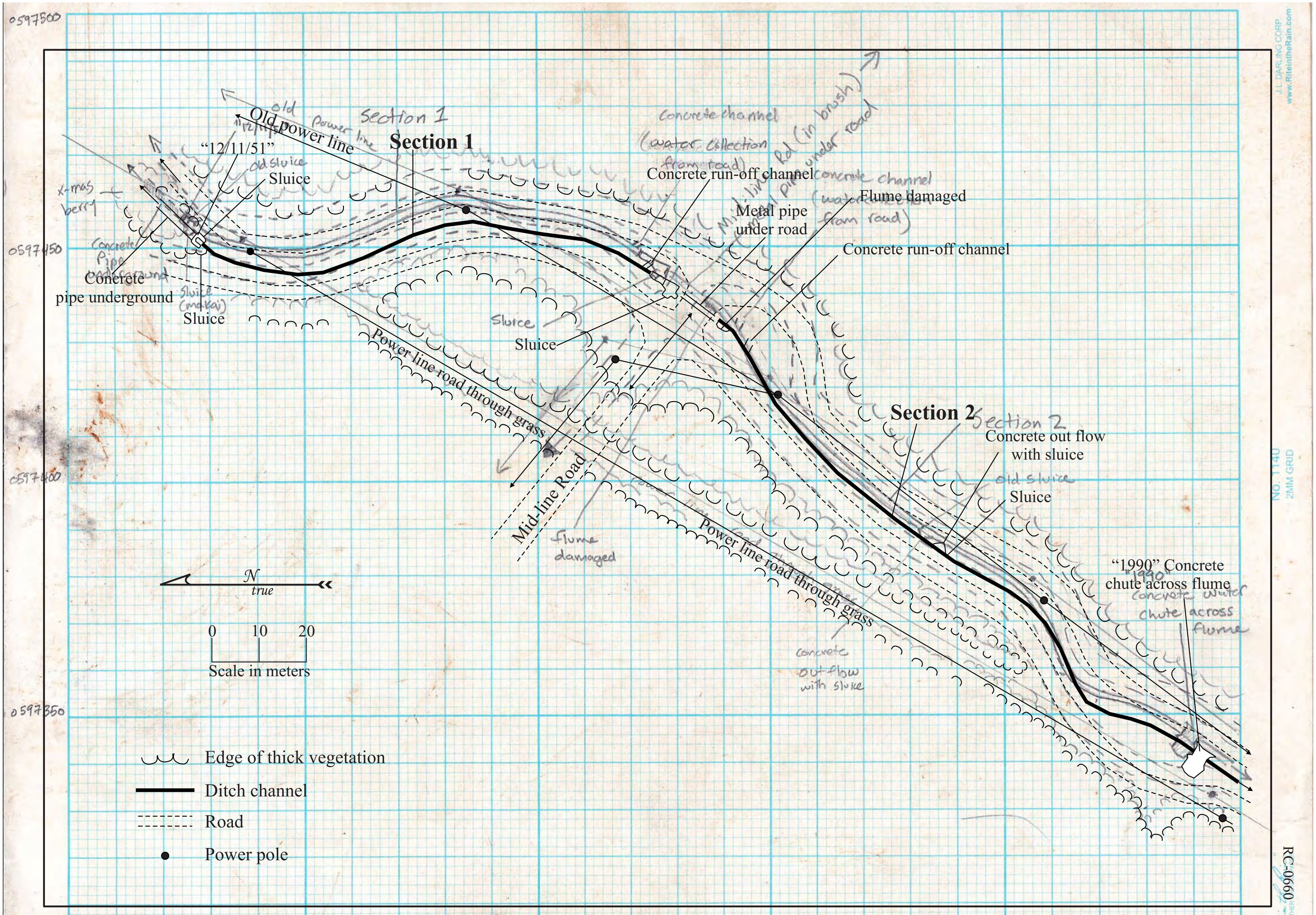

Figure 103. Site 7169 plan view.

Section 1 of Site 7169 originates roughly 100 meters north of the Mid-Line Road Corridor at a buried concrete pipe that runs down slope to the north to an old reservoir located outside of the project area. The pipe, which is labeled "siphon" on the U.S.G.S. Hale'iwa quadrangle (see Figure 1), has a diameter of 75 centimeters. Where the pipe joins Section 1 there is a dilapidated sluice complex that curves to the north with walls made up of four courses of neatly cut basalt blocks joined by cement and capped with cement (Figure 104). The walls are 1.1 meters distant from one another and the ditch has a depth of 1.2 meters, but it is silted in at the base and portions of the *makai* wall have collapsed. Incised into the cement capping of the wall above the pipe is the date "12/11/51" (Figure 105). Two sluice gates are present at this section; one directly in front of the pipe, and the other in the *makai* wall of the ditch that would have allowed water to flow out to the west. The gate in front of the pipe is missing, and the gate in the *makai* wall has been sealed with a slab of concrete.


Figure 104. Site 7169 Section 1 sluice gate complex at north end, view to the northeast.

Figure 105. Site 7169 Section 1 date incised into the cement above the pipe, overview.

Beyond the sluice complex, as Section 1 meanders north to Mid-Line Road (see Figure 103), it is made up of curved concrete side walls with a separate flat base in-between. The tubular-shaped ditch measures 120 centimeters across its widest central portion, with a 78-centimeter gap between its upper rims, and an 83-centimeter depth from rim to floor. The curved side walls are made-up of separately molded concrete sections, each measuring 92 centimeters long and 4 centimeters thick. Flat rectangular sections, each consisting of concrete and gravel, have been inserted between the curved side walls to form the base of the canal. Each basal section measures 92 centimeters long by 27 centimeters wide by 4.5 centimeters thick. The base sections are completely covered with a layer of soil, and not visible throughout most of Section 1. Joints between sections have been strengthened by adding patches of cement. Gravel roads follow each side of the ditch; a higher road on the *mauka* side, and a lower road on the *makai* side.

As Section 1 nears Mid-Line Road a second sluice complex is present. Just north of the complex, is a concrete surface channel that appears designed to collect run-off from the roadway *mauka* of the ditch (Figure 106). The U-shaped surface cannel slopes down toward the ditch. It measures 50 centimeters wide by 20 centimeters deep and 1.5 meters long. The sluice complex is rectangular-shaped and made up of irregular walls with four courses of neatly cut basalt blocks joined by cement. The first gate, which is no longer present, is 2 meters south of the surface channel (Figure 107). This gate would have slid between two sections of railroad track that are covered with cement. A third section of track also crosses the ditch at this location. The second gate, which is also gone, is roughly 4 meters south of the first, directly in front of (2 meters from) a pipe that leads beneath Mid-Line Road. South of this gate the ditch is lined with four courses of cinder block and there is an outflow sluice in the *makai* wall that is sealed with a slab of concrete. This sluice would have allowed water to flow west from Section 1 along the north edge of Mid-Line Road, although no ditch channel is present. The pipe beneath Mid-line Road, which marks the south end of Section 1, measures 75 centimeters in diameter. Its opening is nearly completely buried by soil.

<u>Section 2</u> of Site 7169 commences where the pipe beneath Mid-Line Road emerges ten meters south of Section 1's south end (see Figure 103). The pipe is nearly completely buried, and the ditch is virtually destroyed in this area (Figure 108), but is once again intact after a distance of 3 meters. From the pipe opening the ditch runs a meandering course southwest. It is the same construction as Section 1, made up of curved concrete side walls with a separate flat base in-between (Figure 109). The tubular-shaped ditch measures 120 centimeters across its widest central portion, with a 78-centimeter gap between its upper rims, and an 83-centimeter depth from rim to floor. The curved side walls are made-up of separately molded concrete sections, each measuring 92 centimeters long and 4 centimeters thick. Flat rectangular sections, each consisting of concrete and gravel, have been inserted between the curved side walls to form the base of the canal. Each basal section measures 92 centimeters long by 27 centimeters wide by 4.5 centimeters thick. The base sections are completely covered with a layer of soil, and not visible throughout most of Section 1. Joints between sections have been strengthened by adding patches of cement. Gravel roads follow each side of the ditch; a higher road on the *mauka* side, and a lower road on the *makai* side.

A concrete surface channel similar to the one on the north side of Mid-Line Road is present 10 meters from the north end of Section 2. This channel also appears designed to collect water run-off from the upper road. Seventy meters from the start of Section 2 a sluice complex is present with two former sluice gates; one across the main channel, and another in the *makai* wall (Figure 110). The wooden gate across the main channel is no longer present. The sluice in the *makai* wall consists of a 0.6 x 0.6 meter concrete slab with a 14 x 10 centimeter metal gate built into it near the top.

Beyond the sluice Section 2 continues a meandering course southwest for 70 meters to a poured concrete construction that crosses the ditch channel (Figure 111). The function of this construction, which slopes *makai* across the ditch is not clear, but it may have been intended to carry water from the upper road across the ditch to the lower road. Dates incised in the construction reveal that it was built in 1990. This feature marks the arbitrary end of Section 2, but Site 7169 continues to the south where it formerly connected to the ditch along Kawailoa Road (Site 7159) near the *makai* end of Section 3.

Figure 106. Site 7169 Section 1 surface drainage channel, view to the north.

Figure 107. Site 7169 Section 1 sluice complex at Mid-Line Road, view to the south.

Figure 108. Site 7169 Section 2 south end at Mid-Line Road, view to north.

Figure 109. Site 7169 Section 2, view to southwest.


Figure 110. Site 7169 Section 2 sluice gate, view to west.


Figure 111. Site 7169 Section 2 south end, view to southwest.

SIHP Site 50-80-04-7170

Site 7170 designates an irrigation ditch system that runs along the southern edge of Mid-Line Road for roughly 700 meters, extending from a water retention pond near the 440-foot contour to a reservoir near the 330-foot contour (see Figure 36). This irrigation ditch is part of the Kamananui ditch system that was created by the Waialua Agricultural Co. during the early to mid-1900s. It still carries water today. For the purposes of description, this southeast/northwest trending irrigation ditch has been subdivided into 14 sections, with culverts separating one section from the next (Figure 112). At the *mauka* end the Site 7170 ditch system is fed by a north/south running feeder ditch (Sections 1 and 2) that crosses the Mid-line Road Corridor near the 440-foot contour and supplies water to a *mauka*/*makai* ditch (Sections 4-12) that follows the southern edge of Mid-Line Road to another north/south feeder ditch (Sections 13 and 14) near the 330-foot contour that empties into a reservoir to the north of the Mid-Line Road Corridor. Site 7170 also includes a short section of remnant ditch (Section 3) that follows the north edge of Mid-Line Road *mauka* from the 440-foot contour for roughly 3 meters. Starting with Section 1 at the top end north of Mid-Line Road, and ending with Section 14 at the bottom end where it feeds into the reservoir, the following description highlights the main features of each section of Site 7170.

Section 1 of Site 7170 originates at an outflow pipe leading into a reservoir to the north of the project area at the 440-foot contour (see Figure 112). At the north end of the pipe there is a short section of joined, precast, u-shaped concrete spillway that directs water into the reservoir. On top of the pipe, at the south end of the spillway, is a cement capped cobble retaining wall that has broken in half lengthwise (Figure 113). The cement cap has been inscribed with two dates; the date on the more-intact western side reads “11-18-54,” and the date on the slumped eastern side reads “4-3-54.” The wall retains the edge of a roadway on top of the pipe that leads around the edge of the reservoir. The metal outflow pipe that runs under the roadway measures 75 centimeters in diameter. At the south end of the pipe is a sluice gate complex with two former gates; one directly in front of the pipe, and another in the *makai* edge of the ditch (Figure 114). The sluice gate complex is constructed of stacked basalt rocks joined and capped with cement. The wooden sluice gates are no longer present. The *makai* channel has been blocked with a concrete slab. This section of ditch measures 2 meters long by 1.4 meters wide by roughly 90 centimeters deep.

To the north of the sluice gate complex the Section 1 ditch runs a meandering course southwest to Mid-Line Road. It is made up of curved concrete side walls with a separate flat base in-between. The tubular-shaped ditch measures 120 centimeters across its widest central portion, with a 78-centimeter gap between its upper rims, and an 83-centimeter depth from rim to floor. The curved side walls are made up of separately molded concrete sections, each measuring 92 centimeters long and 4 centimeters thick. Flat rectangular sections, each consisting of concrete and gravel, have been inserted between the curved side walls to form the base of the canal. Each basal section measures 92 centimeters long by 27 centimeters wide by 4.5 centimeters thick. The base sections are covered by a layer of soil and the water running through the ditch, and are not visible. A gravel road follows the *mauka* side of the ditch.

Two meters from the south end of Section 1, where it joins a pipe that runs beneath Mid-Line Road, the ditch is once again lined with stacked basalt rocks. The almost vertical walls consist of four courses of basalt rocks, the biggest blocks being at the bottom (Figure 115). Cement has been used to join and cap the basalt blocks in the wall. The opposing *mauka/makai* basalt block and cement walls of the ditch are roughly 90 centimeters high and 140 centimeters apart. Two concrete over flow pipes (25 centimeters in diameter) are present in the *makai* wall of this section of the ditch. The pipes are set in the second course of cobbles above the waterline immediately adjacent to one another. The date “11-20-53” has been inscribed in the cement topping the wall situated parallel to Mid-Line Road directly above the pipe opening (see Figure 115). The concrete pipe is completely submerged beneath the water on this side of the road.

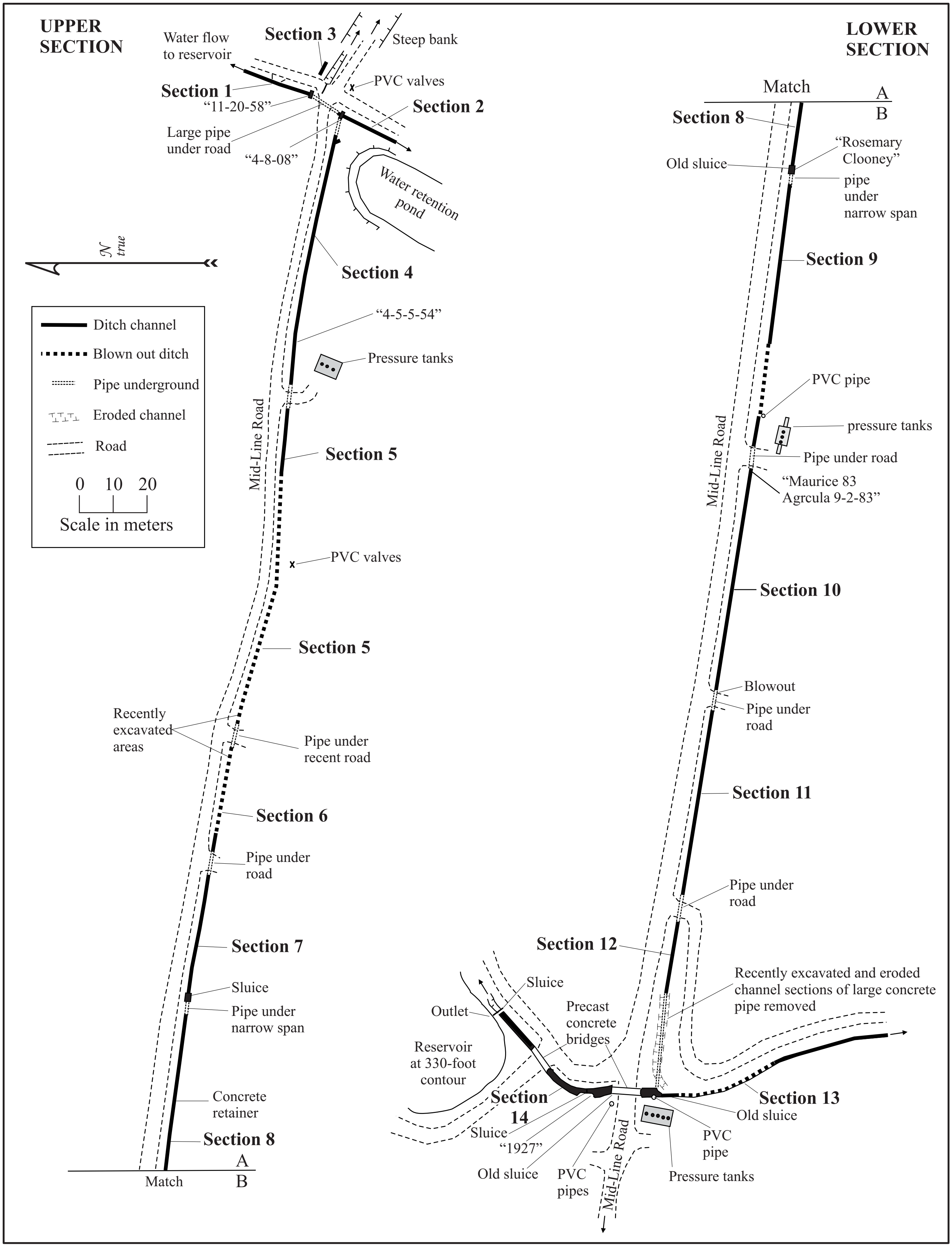

Figure 112. Site 7170 plan view.

Figure 113. Site 7170 Section 1 outlet to reservoir, view to the northeast.

Figure 114. Site 7170 Section 1 sluice complex at north end, view to the north.

Figure 115. Site 7170 Section 1 date inscribed in concrete at south end, view to the northeast.

Section 2 of Site 7170 starts on the south side of Mid-Line Road at the southern end of the pipe that run under the road from Section 1 (see Figure 112). Where the pipe enters Section 2 a sluice complex with three former gates is present (Figure 116). The ditch at this end of Section 2 is lined with stacked basalt rocks. The almost vertical walls consist of four courses of basalt rocks, the biggest blocks being at the bottom. Cement has been used to join and cap the basalt blocks in the wall. The opposing *mauka/makai* basalt block and cement walls of the ditch are roughly 90 centimeters high and 140 centimeters apart. The former wooden sluice gates are located (1) in front of the pipe that runs under Mid-Line Road, (2) in front of a pipe that leads *makai* to Section 4, and (3) to the north of the other two where the cement and basalt ditch transitions to a concrete sectional ditch. All three of the gates are absent, but wooden slats are present in front of the pipe that leads *makai* to Section 4, and a piece of narrow-gauge rail is held in place by cement on top of the ditch near the opening of the pipe beneath Mid-Line Road. A patch of concrete at the ditch corner between the pipe under Mid-Line Road and the *makai* sluice contrains the inscription “4-8-08”, suggesting that it was repaired in 2008.

Beyond the third sluice gate the Section 2 ditch runs a meandering course southwest along the *mauka* edge of a small water retention pond (Figure 117), and continues well out of the current project area. South of the sluice complex the ditch is made up of curved concrete side walls with a separate flat base in-between. The tubular-shaped ditch measures 120 centimeters across its widest central portion, with a 78-centimeter gap between its upper rims, and an 83-centimeter depth from rim to floor. The curved side walls are made-up of separately molded concrete sections, each measuring 92 centimeters long and 4 centimeters thick. Flat rectangular sections, each consisting of concrete and gravel, have been inserted between the curved side walls to form the base of the canal. Each basal section measures 92 centimeters long by 27 centimeters wide by 4.5 centimeters thick. The base sections are covered by a layer of soil and the water running through the ditch, and are not visible. Joints between sections have been strengthened by adding patches of cement. A gravel road follows the *mauka* side of the ditch.

Adjacent to the water retention pond two concrete over flow pipes (25 centimeters in diameter) are present in the *makai* wall of Section 2 (Figure 118). The pipes sit above the waterline. Both have been blocked with metal disks, but one of the disks has partially corroded away. Roughly 40 meters from Mid-Line Road, outside of the project area corridor, another sluice gate is present in the Section 2 ditch with a channel that leads *makai* into the water retention pond(Figure 119). To the south of this former sluice gate Section 2 of Site 7170 continues to the southwest, eventually connecting with the *mauka* end of Section 11 of Site 7159.

Figure 116. Site 7170 Section 2 sluice gate complex at Mid-Line Road, view to the northwest.

Figure 117. Site 7170 Section 2 water retention pond, view to the southwest.

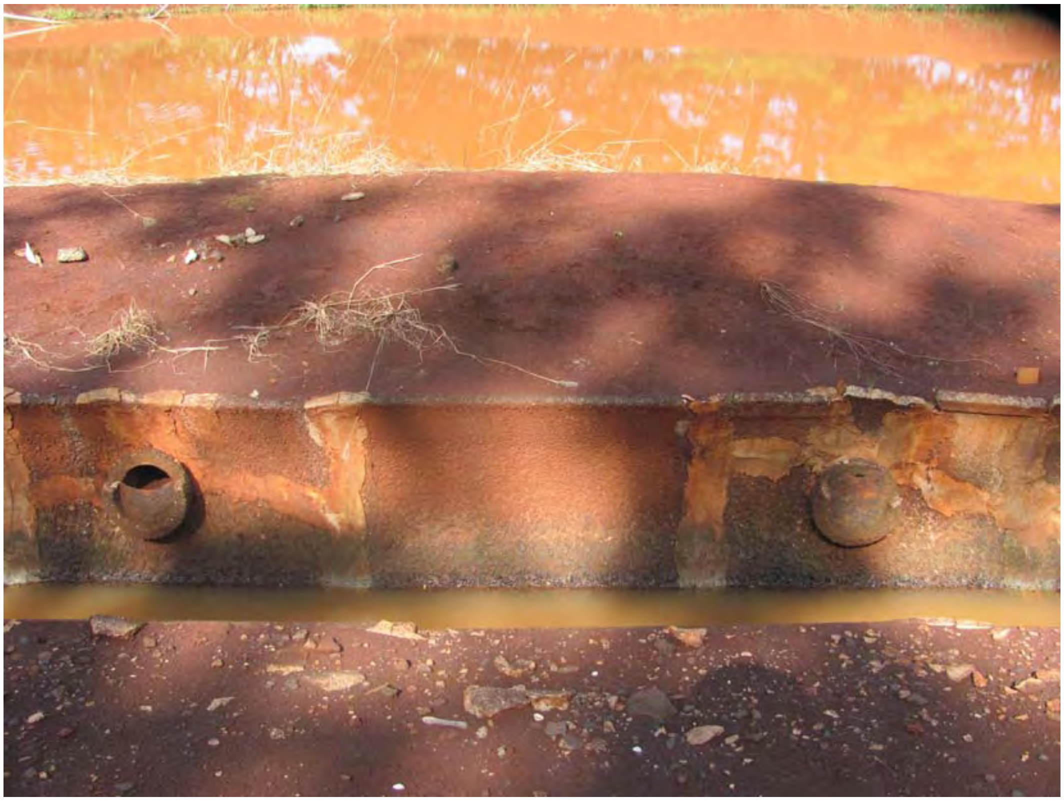
Figure 118. Site 7170 Section 2 concrete overflow pipes, view to the west.


Figure 119. Site 7170 Section 2 sluice and channel leading to the water retention pond, view to the west.

Section 3 of Site 7170 consists of two parallel alignments of basalt rocks (Figure 120) located along the north edge of Mid-Line Road, *mauka* of the crossroad that parallels Sections 1 and 2 (see Figure 112). This section appears to represent the top edge of a former ditch that once ran along Mid-Line Road between Section 1 of Site 7170 and the 490-foot contour (see Figure 4). It is completely filled in with soil and gravel, however, and only a three meter long portion of the ditch is visible on the surface. Section 3 consists of two parallel lines of basalt rocks set 95 centimeter apart from one another. Each line contains five rocks that are visible on the surface. To the south of Section 3 a PVC pipe runs beneath the roadway that follows the *mauka* edge of Sections 1 and 2, directing water that flows through a natural water channel adjacent to Mid-Line Road beneath the crossroad. The expected route of the Section 3 ditch was thoroughly inspected between Sites 7169 and 7170, but no additional sections of constructed ditch were observed (Mid-Line Road, *mauka* of Site 7170, is no longer maintained and is overgrown with thick brush).

Figure 120. Site 7170 Section 3, view to the southeast.

Section 4 of Site 7170 runs along the south edge of Mid-Line Road (see Figure 112). This section starts at the exit of the concrete pipe that runs *makai* from the Section 2 sluice complex, six meters distant from that section. Where the pipe exits the ditch walls are constructed of four courses of stacked basalt cobbles held together and capped with cement (Figure 121), and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 4 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and 70 centimeters deep at its *mauka* end. Immediately adjacent to the exit of the pipe at this end, along the south side of the ditch, is a short segment of U-shaped concrete sectional flume that once acted as a spillway leading from the small water retention pond adjacent to Section 2 into the ditch. The spillway is now buried beneath soil.

Section 4 runs for a total distance of 75 meters. Approximately 60 meters from the *mauka* end of Section 4 a date is inscribed in the cement capping the northern wall of the ditch (Figure 122). The date reads “4-5-5-54”, which may mean that this section was constructed between April and May 5, 1954. Section 4 becomes deeper (as much as 1 meter deep) and more neatly constructed at its *makai* end. Where this section terminates the ditch splits in two (Figure 123) with the main channel continuing *makai* through a pipe along the southern edge of Mid-Line Road to Section 5, and a branch channel diverging to the south, parallel to the main channel. The branch channel is filled in and no longer carries water. The base of the branch channel sits 15 centimeters above the base of the main channel. A sluice gate was formerly present across the main ditch channel at the opening to the pipe. Where Section 4 enters the pipe at its *makai* end a road crosses the ditch channel leading to a concrete slab surrounded by chain link fence that contains four pressure tanks along the route of more modern irrigation pipes. The road appears to have been the cause of the destruction of the branch channel at the *makai* end of Section 4.

Figure 121. Site 7170 Section 4 *mauka* end, view to east.

Figure 122. Site 7170 Section 4 date inscribed in cement capping the northern wall, view to south.

Figure 123. Site 7170 Section 4 *makai* end, view to the west.

Section 5 of Site 7170 begins at the exit of the metal pipe that runs *makai* under the short spur road leading to the modern pressure tanks, six meters from the end of Section 4 (see Figure 112). Section 5 runs along the south edge of Mid-Line Road for a total distance of 135 meters, but only the *mauka* 20 meters are actually intact with stacked basalt and cement walls (Figure 124). Where the pipe exits from beneath the road the ditch walls are constructed of five courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 5 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and 100 centimeters deep at its *mauka* end. The ditch quickly becomes shallower, however, with an average depth of 50 to 70 centimeters. The remainder of the ditch, although formerly lined with basalt and cement, is currently an earthen ditch with water flowing through it. The earthen ditch measures approximately 90 centimeters wide by 50 centimeters deep. The *makai* end of Section 5 terminates at a metal culvert capped with concrete that runs beneath what appears to be a recently constructed or repaired roadway. The ditch is wider (roughly 2 meters) for the final 4 meters of Section 5, and appears to have been somewhat recently cleared of sediment using a backhoe. The culvert beneath the roadway, despite the relatively recent clearing, is once again nearly buried beneath sediment.


Figure 124. Site 7170 Section 5 intact *mauka* end, view to the east.

Section 6 of Site 7170 begins six meters from Section 5 at the exit of the metal culvert that runs beneath the roadway (see Figure 112). Section 6 runs along the south edge of Mid-Line Road for a total distance of 30 meters. Only the *makai* end of this section, for 15 meters along the southern ditch wall and 5 meters along the northern ditch wall, is actually intact with stacked basalt and cement walls. The rest of Section 6, like much of the previous section, consists of an earthen ditch that measures approximately 90 centimeters wide by 50-85 centimeters deep. Section 6 is widest (roughly 2 meters wide) at its *mauka* end, and appears to have been somewhat recently cleared of sediment using a backhoe (Figure 125). The intact portion of Section 6 at the *makai* end is constructed of four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement (Figure 126). The 15 meter long south wall is fairly vertical and straight, but the 5 meter long section of the north wall bows outward to the north, giving the *makai* end of Section 6, where it enters a concrete pipe under a roadway, a width of 1.3 meters. The pipe is held in cement at the base of the 75 centimeter deep ditch channel and is also capped with cement. A wooden sluice gate was formerly present across the ditch channel at the opening to the pipe.

Figure 125. Site 7170 Section 6 recently excavated *mauka* end, view to the west.

Section 7 of Site 7170 runs along the south edge of Mid-Line Road for a total distance of 37 meters (see Figure 112). This section starts at the exit of the concrete pipe that runs *makai* from Section 6 beneath a roadway, six meters distant from that section. Where the pipe exits, the ditch walls are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 7 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. The walls are relatively intact with only minimal collapse. At the *makai* termination of Section 7, where the ditch enters a concrete pipe, a sluice gate complex is present. At this end, for the final 2 meters, the stacked cobble walls are covered and capped with a smooth layer of cement, the ditch narrows to 53 centimeters, and becomes 1 meter deep with vertical walls. Two sets of matching vertical slots in the concrete, one 36 centimeters from the pipe and a second immediately in front of the pipe, are present that formerly housed wooden sluice gates (Figure 127). The pipe at the *makai* end of Section 7 runs under a narrow dirt path (2.4 meters wide) that is blocked by boulders placed on its surface. The path is not wide enough for a vehicle, and may have been intended only for foot traffic.

Figure 126. Site 7170 Section 6 intact south wall, view to the south.

Figure 127. Site 7170 Section 7 *makai* sluice complex, over view to the north.

Section 8 of Site 7170 runs along the south edge of Mid-Line Road for a total distance of 67 meters (see Figure 112). This section starts roughly 2.5 meters distant from Section 7 at the exit of the concrete pipe that runs beneath the narrow pathway. Where the pipe exits, the ditch walls are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 8 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. The walls are mostly intact with a few areas of collapse. Along the southern wall of Section 8, 25 meters from the *mauka* end near an area of collapse a concrete retainer has been placed in the ditch wall (Figure 128), perhaps to prevent further erosion or to block a former side channel that is no longer present.

At the *makai* termination of Section 8, where the ditch enters a concrete pipe, a sluice gate is present. At this end, for the final 2 meters, the stacked cobble walls are covered and capped with a smooth layer of cement, the ditch narrows to 53 centimeters, and becomes 1 meter deep with vertical walls. A set of vertical slots in the concrete, 30 centimeters from the pipe opening formerly housed a wooden sluice gate. The name "Rosemary Clooney" is written in the cement capping the pipe construction (Figure 129). This cement appears to have been added after the original construction, as section of narrow gauge rail, meant to block debris from entering the pipe, runs at an angle from the base of the ditch up to it, and is held in place by it. A second rail was once present to the south of this one, but it broke free of the cement and has been removed. The pipe at the *makai* end of Section 8 runs under a narrow dirt path (2.4 meters wide). The path is not wide enough for a vehicle, and may have been intended only for foot traffic.

Figure 128. Site 7170 Section 8 concrete retainer in south wall of ditch, view to the southwest.

Section 9 of Site 7170 runs along the south edge of Mid-Line Road for a total distance of 80 meters (see Figure 112). This section starts roughly 2.5 meters distant from Section 8 at the exit of the concrete pipe that runs beneath the narrow pathway. Where the pipe exits, the ditch walls are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 9 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. The walls are mostly intact with a few areas of collapse. One long section of collapse, where the ditch walls become earthen embankments with the cobble and cement material strewn about them, is present between 50 and 70 meters from the *mauka* end.

Figure 129. Site 7170 Section 8 *makai* end with the inscription “Rosemary Clooney”, overview to the east.

Following the section of collapse, the final ten meters of Section 9 are fairly intact. At the *makai* termination of the section, where the ditch enters a metal pipe, a sluice gate is present. At this end, for the final 2 meters, the stacked cobble walls are covered and capped with a smooth layer of cement, the ditch narrows to 53 centimeters and becomes 1 meter deep, and two sections of rusted narrow gauge rail prevent debris from entering the pipe. An angled channel of thick cement covering cobbles is present in the north wall of the sluice complex 80 centimeters from the pipe, and two sets of matching vertical slots in the concrete, one 36 centimeters from the pipe and a second immediately in front of it, are present that formerly housed wooden gates (Figure 130).

The angled channel, which is 40 centimeters wide by 60 centimeters deep, runs a short distance northwest towards Mid-Line Road before terminating at a 13-centimeter deep slot in the cement cap that is wider than the channel at each end. A pipe that was sealed off at a later date may have once run beneath Mid-Line Road at this location. The cement wall opposite the channel is much more eroded than the smooth walls throughout the rest of the sluice complex, suggesting that water may have flowed against it more aggressively. Similar channels (sluices) with pipes running from them were recorded at Site 7159 along Kawailoa Road (see description above), but no pipe opening or ditch was observed within the survey corridor on the opposite side of Mid-Line road at this location.

Where Section 9 enters the pipe at its *makai* end a road crosses the ditch channel leading to a concrete slab surrounded by chain link fence that contains two pressure tanks along the route of more modern irrigation pipes. A PVC pipe runs from the tanks emptying back into the ditch ten meters to the east (Figure 131). The metal pipe beneath the road is fairly corroded, and the concrete capping it at the *makai* end has broken apart causing the roadway to erode.

Figure 130. Site 7170 Section 9 *makai* sluice complex, view to the west.

Section 10 of Site 7170 runs along the south edge of Mid-Line Road for a total distance of 68 meters (see Figure 112). This section starts roughly six meters distant from Section 9 at the exit of the metal pipe that runs beneath the roadway. In the cement cap at the *mauka* end of this section of the ditch, above where the pipe exits, the name “MAURICE AGRILULA 83” and the date “9-2-83” are inscribed. The ditch walls, like previous sections, are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance (Figure 132). Section 10 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. The walls are mostly intact with a single area of severe collapse along the north wall at the *makai* end, where the ditch once had a sluice complex. At this end the north wall becomes an earthen embankment with cement and cobble rubble strewn about. Where the ditch once entered a metal pipe that ran beneath a roadway the soil has eroded, a section of pipe is missing, and the eastern third of the roadway has collapsed into the pipe channel and been swept away.

Section 11 of Site 7170 runs along the south edge of Mid-Line Road for a total distance of 55 meters (see Figure 112). This section starts roughly six meters distant from Section 10 at the exit of the metal pipe that runs beneath the roadway (Figure 133). The ditch walls, like the previous sections, are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. Section 11 measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. The walls are mostly intact with only small areas of collapse. At its *makai* end, where the ditch enters a metal pipe beneath a relatively wide roadway that is well used, the end is capped with an extra layer of cement that holds in place three angled sections of narrow gauge rail meant to keep debris from entering the pipe (Figure 134).


Figure 131. Site 7170 Section 9 PVC pipe and nearby pressure tanks, view to the south.


Figure 132. Site 7170 Section 10 *mauka* end, view to the east.


Figure 133. Site 7170 Section 11 *mauka* end, view to the east.


Figure 134. Site 7170 Section 11 *makai* end, view to the east.

Section 12 of Site 7170 runs along the south edge of Mid-Line Road for roughly 50 meters (see Figure 112). This section starts roughly eight meters distant from Section 10 at the exit of the metal pipe that runs beneath a relatively wide, well traveled roadway (Figure 135). The open ditch is only intact for a distance of 24 meters. Beyond that point Section 12 once entered a buried cement pipe that has been removed, and the ditch channel now consists of an eroded channel that meets with Section 13 near its northern end (Figure 136). The intact ditch walls, like the previous sections, are constructed of three to four courses of stacked basalt cobbles held together and capped with cement, and the ditch floor is covered with a layer of cement. The walls of the ditch are sloped outwards giving it a V-shaped appearance. The ditch channel measures 60 centimeters wide at the base, 90 centimeters wide at the top, and averages 70 centimeters deep. Beginning 24 meters from the *mauka* end, where Section 12 formerly entered the cement pipe, the sluice has been removed and the ditch becomes a somewhat recently excavated channel with earthen embankments. A section of the large diameter cement pipe has also been removed from this channel and deposited on top of the southern embankment. Another section of the pipe is visible at the base of the earthen channel, and a third section is still in place and covered with soil where the pipe entered Section 13. This section of pipe is blocked, however, and water travelling through Site 7170 has eroded a new channel that meets Section 13 two meters south of where the pipe opening is visible in the side wall of that section.

Figure 135. Site 7170 Section 12 from the *makai* end of Section 11, view to the west.

Section 13 of Site 7170 is a portion of a north/south running feeder ditch on the south side of Mid-Line Road (see Figure 112). The ditch runs a meandering course south following the 330-foot contour from a pre-cast concrete bridge that is located underneath the road (Figure 137), out of the Mid-Line Road Corridor, eventually connecting with Site-7159 (at the *mauka* end of Section 11; see description above). Section 13 was not carrying water at the time of the current study, but contained puddles, and may have carried water recently. With the exception of one short section of precast cement panels joined with cement lining the western edge, within the survey corridor, the ditch is constructed of stacked basalt cobbles (3-4 high) held together and capped with cement. It has nearly vertical walls that are 1.5 meters distant from one another and 60 centimeters tall. The floor of the ditch is covered by a layer of sediment and not visible. Four meters from its north end, the pipe from Section 12 enters Section 13. Just beyond where the pipe enters the ditch an old sluice is present that once housed a wooden gate (Figure 138). The gate is missing, but wooden slats are present within grooves in the cement covered walls on either side of the ditch.

Opposite the Section 12 pipe opening, a PVC pipe that runs from a concrete slab surrounded by chain link fence that contains five pressure tanks along the route of more modern irrigation pipes to the ditch. Twelve meters from its north end the east wall of Section 13 is missing and the ditch is lined with an earthen embankment. The west wall remains intact as the ditch exits the survey corridor.


Figure 136. Site 7170 Section 12 eroded *makai* end, view to the east.

Section 14 of Site 7170 begins eight meters north of Section 13 at the outlet of pre-cast concrete bridge that runs under Mid-Line Road (see Figure 112). Section 14 runs a curvilinear path northeast for twenty meters to a second precast concrete bridge beneath a roadway that runs along the edge of a reservoir (Figure 139). At the outset the ditch measures 1.7 meters wide by 70 centimeters deep. The vertical walls are constructed of stacked basalt cobbles (3-4 high) held together and capped with cement. A sluice is present in the west wall immediately adjacent to Mid-Line Road, but it has been blocked with a cement panel and filled in behind with soil. Seven meters from Mid-Line Road an old sluice complex is present (140). At this location the ditch narrows to 1.04 meters wide and the basalt stones are covered with a smooth layer of cement. Three indentations of various sizes and shapes are present in the west wall of the complex that likely once housed wooden gates or associated wooden components. The date "1927 is etched into the smooth cement cap on top of the west wall at the south end of the sluice complex. The east wall consists of smooth cement, with some collapse, but no indentations. Beyond the complex the ditch widens to 1.28 meters as it continues northeast to the precast concrete bridge. It is once again constructed of stacked basalt cobbles held together and capped with cement. Just prior to the bridge, in the east wall of Section 14, two metal pipes are present near the upper edge of the ditch (Figure 141). These pipes may have been for out flow to help control the level of the water travelling beneath the bridge.


Figure 137. Site 7170 Section 13 north end at Mid-Line Road, view to the northwest.


Figure 138. Site 7170 Section 13 where concrete pipe enters from Section 12 and an old sluice is present, view to the east.


Figure 139. Site 7170 Section 14, view to the north.

North of Section 14 (see Figure 112) Site 7170 runs under the roadway and enters an earthen ditch that carries water into a reservoir near the 330-foot contour (Figure 142). This last section of ditch and the reservoir fall out side the Mid-Line Road Corridor and were not recorded in detail. It appears that the overall Site 7170 ditch system once carried water to this reservoir watering sugarcane fields along the way. The reservoir is currently used to water diversified agricultural fields that begin immediately below Sections 13 and 14 of Site 7170. This old irrigation infrastructure in the vicinity of Mid-Line Road has largely been replaced by more modern plantation infrastructure consisting of buried irrigation pipes with pressure tanks to control the water flow.


Figure 140. Site 7170 Section 14 sluice complex in the west wall, view to the west.


Figure 141. Site 7170 Section 14 metal pipes near the northeast end, view to the northeast.


Figure 142. Site 7170 Section 14 northeast end and reservoir beyond, view to the northeast.

Ashley Road Corridor

The Ashley Road Corridor, which will be used by First Wind to access the northwestern most portions of both the Eastern and Western Tableland Arrays, follows the existing gravel/paved alignment of Ashley Road from the northern end of Cane Haul Road to the Eastern Tableland Array at an elevation of roughly 1,000 feet above sea level (see Figure 1). Beginning at the northern end of Cane Haul Road, Ashley Road runs northeast as it traverses the steep coastal cliff formation. At the top of the cliff Ashley Road turns east and runs in a relatively straight line east as it crosses the northwestern portion of the Western Tableland Array, accesses the proposed location of the O & M building and *mauka* point of interconnection, and continues on to northwestern portion of the Eastern Tableland Array near Drum Road. The Ashley Road Corridor crosses TMKs:1-6-1-05:001, 015 and 019, and 1-6-1-06:001 (see Figure 2). Vegetation along the existing roadway consists primarily of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), albizia (*Acacia lebbek*), and a thick growth of non-native vines near its upper reaches.

The Ashely Road Corridor runs through the former Waialua Sugar Company's fields Waimea-1, 2, 6, 8 and 25 (see Figure 9), and passes by the location of the former Hawaiian Pineapple Company's (H. P. Co.) Waimea Camp. Aerial photographs of the project area (see Figures 5-8) show that these fields were completely cultivated in sugarcane and pineapple during the second half of the twentieth century. The current alignment Ashely Road, which was built by the Waialua Agricultural Co. during the early twentieth century, is shown on the 1924 HTS Plat 2069 (see Figure 31). On the 1929 U.S.G.S. Hale‘iwa quadrangle (see Figure 4) a ditch, a railway line, and a pipe are shown crossing the road alignment, and a second dich is shown terminating near its southern edge. Waimea Camp, which is located along Ashley Road at an elevation of 600 feet above sea level where a spur road diverges from it and runs southeast across a gulch, is shown on the 1929 U.S.G.S. Hale‘iwa quadrangle, but was not depicted on the 1924 HTS Plat 2069, suggesting that it may have been constructed during the intervening time period. During WWII four 75mm guns, part of Battery Waimea, were emplaced at the Waimea Camp. The camp was removed in ca. 1960, and the camp area was later planted in pineapple. No surface evidence of the camp or the gun emplacements was observed within the Ashley Road Corridor.

A single archaeological site, consisting of a north/south running ditch line (Site 7171) following the 410-foot contour was recorded within the Ashley Road Corridor (see Figure 36). This ditch part of the Kamananui ditch system that was created by the Waialua Agricultural Co. during the early to mid-1900s. In addition to the recorded archaeological site, a rectangular-shaped asphalt pad with a sunken side road along its western edge that is lined with a cinderblock wall was noted within the survey corridor immediately north of Ashley Road, near the 380-foot contour (Figure 143). A review of aerial photographs revealed that these features were of modern origins, constructed sometime between 1977 and 1993 (see Figures 7 and 8). Thirty meters *mauaka* of the pad is a rectangular fenced area that contains five pressure tanks that are connected with pipes. This enclosed area, which also contains an electrical box, is where the upslope power lines originate. Slightly upslope of this pump facility is a machinery storage depot with a utility shed (Figure 144). Judging from the age of the abandoned tractors and combine harvesters, the depot probably does not pre-date the 1980s.

In the vicinity of the coastal escarpment formation nearby, but outside the study area, reconnaissance level survey of the accessible sections of the cliff face inland of Ashley Road revealed the presences of several areas of cobble modification (T-37; see Table 8 and Figure 37). The modification consisted of low walls, cobble alignments, leveled areas, filled areas, and cobble stacking. Some of this modification appears to be modern and is associated with plastic grow pots and wire fencing, but some may be older, dating to the Historic or Precontact Periods. Genz and Hammatt (2011) note that locally transmitted oral traditions relate that the area of the *makai* escarpment below Ashley Road stretching to Waimea Bay was a favored place for burial during Precontact and early Historic times. None of the proposed improvements to the existing road within the Ashley Road Corridor will impact the cliff face. Site 7171 is described in detail below.

Figure 143. Sunken road and cinderblock wall noted below an asphalt pad within the Ashley Road Corridor, view to the northeast.

Figure 144. Machinery storage depot with a utility shed noted within the Ashley Road Corridor, view to the northwest.

SIHP Site 50-80-04-7171

Site 7171 designates an irrigation ditch that runs northeast/southwest across the Ashley Road Corridor following the 410-foot contour (see Figure 36). South of the road the basalt and cement walls of the ditch can be seen sticking out above re-deposited red soil (Figure 145), while north of the road the entire canal has been covered by soil (Figure 146). Judging from the exposed canal rims, the two-meter wide ditch is constructed from carefully cut basalt blocks joined together and capped with cement. The ditch widens to three meters where it abuts a buried culvert beneath Ashley Road (Figure 147). An elongated water retention pond occurs southwest of the intersection between the ditch and the road. Linking this pond with Site 7171 is a sluice gate complex. This complex, which is 50 meters southwest of Ashley Road and outside the project area, contains two sluice gates, with the wooden gate slots and a slot for a plank still visible in one. On the cement capping of the sluice gate is incised, partly in picture writing, "Victor [arrow and heart symbol] Patience DEC. 3 1987-88." Cross-hatched incisions frame the top end of the writing. A dirt road follows the *mauka* edge of Site 7171 across the survey corridor. This irrigation ditch is part of the Kamananui ditch system that was created by the Waialua Agricultural Co. during the early to mid-1900s. To the south the ditch once connected with the Mid-Line Road ditch system (Site 7170; see above), and to the south the ditch continued nearly to the Eastern Tableland Array, carrying water the northernmost portion of the Wailua Sugar Co.'s lands (see Figure 4).

Makai Interconnection Facility Corridor

The Makai Interconnection Facility Corridor consists of a proposed switch building (*makai* point of interconnection) and associated infrastructure located on TMK:1-6-1-05:001 at an elevation of roughly 160 feet above sea level with an access road that leads to it from Ashley Road beginning at an elevation of 280 feet above sea level (see Figures 1 and 2). The entire survey area falls within the former Waialua Sugar Company's field Waimea-1 (see Figure 9), and the access road mostly follows a former field road that is shown on maps in 1901 and 1929 (see Figures 4 and 31) as a road with a rail line next to it. Aerial photographs of the general project area (see Figures 5-8) show that this field was completely cultivated in sugarcane during the second half of the twentieth century. The entire area is overgrown with Guinea grass (*Panicum maximum*), but was mowed prior to the fieldwork. No archaeological sites were identified within the Makai Interconnection Facility Corridor.


Figure 145. Site 7171, view to the south.


Figure 146. Site 7171, view to the north.

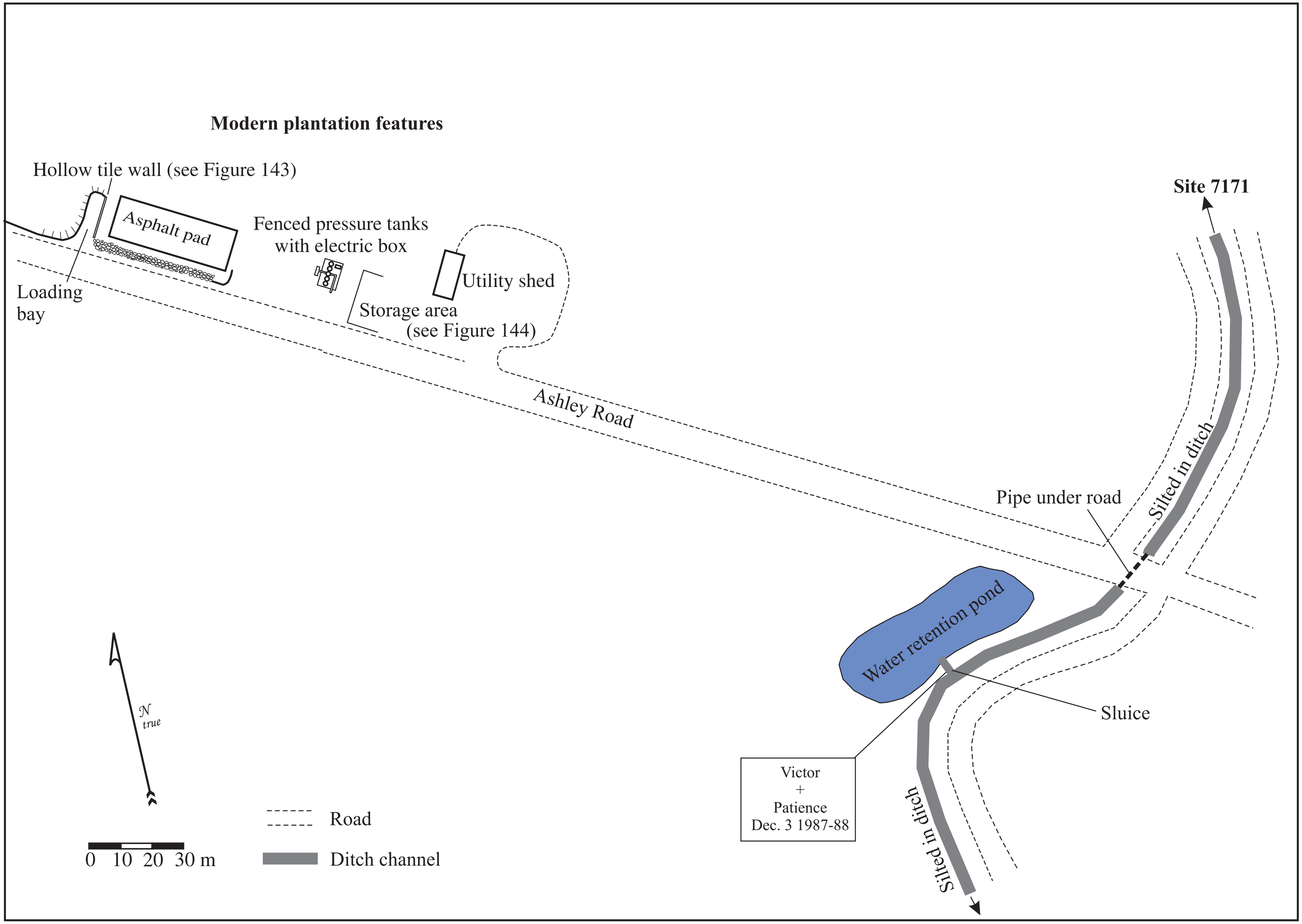

Figure 147. Site 7171 plan view.

In the vicinity of the coastal escarpment formation nearby, but outside the study area, reconnaissance level survey of the accessible sections of the cliff face between Ashley Road and the *makai* point of interconnection, revealed the presences of several areas of cobble modification (T-37; see Table 8 and Figure 37). The modification consisted of low walls, cobble alignments, leveled areas, filled areas, and cobble stacking located on the rocky precipice well below the Makai Interconnection Facility Corridor. Some of the modification appears to be modern and is associated with plastic grow pots and wire fencing, but some may be older, dating to the Historic or Precontact Periods. Genz and Hammatt (2011) note that locally transmitted oral traditions relate that the area of the *makai* escarpment below Ashley Road stretching to Waimea Bay was a favored place for burial during Precontact and early Historic times. Construction of the *makai* interconnection facility, which is located within a former sugarcane field well above T-37, will not impact the cliff face or any of the observed modifications.

Overhead Collector Line Corridor

The Overhead Collector Line Corridor consists of a 50-foot wide corridor that stretches across a tableland formation (at an elevation of roughly 600 feet above sea level) between the gulches bordering the Eastern and Western Tableland Arrays (see Figure 1). Within this corridor poles will placed that will hold an overhead power line connecting the Eastern Tableland Array with the *mauka* point of interconnection. The corridor crosses TMK:1-6-1-06:001 (see Figure 2) and passes through the former Waialua Sugar Company's field Waimea-26 (see Figure 9). Aerial photographs (see Figures 5-8) indicate that this area was cultivated in pineapple during the second half of the twentieth century. Currently vegetation, within this mechanically disturbed area, consists of a thick growth of Guinea grass (*Panicum maximum*), *koa-haole* (*Leucaena glauca*), and stands of albizia (*Acacia lebbek*). Old plastic drip-line and sheets of weed mating were noted on the surface of the survey area. No archaeological sites were observed within or nearby the narrow Overhead Collector Line Corridor.

SUMMARY OF ARCHAEOLOGICAL FINDS

No Precontact sites were found within the study area. Of the seventeen Historic Period sites recorded within the study area, five are associated with the irrigation of sugarcane. Sites 7159 (Kawailoa Ditch Complex), 7169 (Upper Mid-Line Road Ditch Complex), 7170 (Lower Mid-Line Road Ditch Complex), and 7171 (Ashley Road Ditch Complex) are ditch and pond complexes, and Site 7164 is a water pipe system that connected the Kawailoa ditch complex (Site 7159) with Pump House 4 (an existing facility situated on private land *makai* of the project area). A sixth site (Site 7157) is a possible concrete field marker identifying the location of one of the *mauka*-most agricultural plots within the project area.

Historical documentation (e.g., see Dorrance and Morgan 2000; Wilcox 1996) indicates that plantation agricultural may have began impacting the Kawailoa landscape as early as 1898, and that by the late 1920s irrigated fields and associated infrastructure (formal and informal ditches, pipes, tunnels, a few pump houses, several reservoirs, roads, and railway lines) covered vast portions of the study area and was identified as the Kamananui Ditch System. Beginning in ca. 1939 gun emplacements and a military command and fire control communication system were established at key locations in and around the study area (along the shore near Kawailoa Drive and Ashley Road, at Kawailoa and Waimea Camps, and along the upper ridges of the Waimea River catchment) as part of O‘ahu's coastal defenses (Bennett 2002; Gaines 2002; Sugimoto 1996; Takamura 1995). The defenses were mostly dismantled immediately following World War II (in ca. 1945). By the middle twentieth century the plantation railway system was defunct and was replaced by roads for trucks to haul cane. Within the study area the formal plantation activities persisted until 1996.

Dates incised into the cement capping of ditch and sluice gate walls of the four defined ditch complexes (Sites 7159, 7169, 7170, and 7171) (Figure 148) suggest that the Kamananui Ditch System existed by at least 1913, and dates incised in other concrete features suggest that by 1926 and 1927 the main channels were well established. Dates between 1935 and 1943 indicate ongoing maintenance activities. Based on the increased occurrence of the incised dates, a spurt of activity occurred between 1950 and 1954, and further maintenance and update activities occurred between 1981 and 1990. Even though sugarcane cultivation was terminated at the end of 1996, the ditch complex continued to be used and maintained along certain sections, as attested by the 2008 and 2009 dates incised on portions of the lower Mid-Line Road and the main Kawailoa Road ditches.

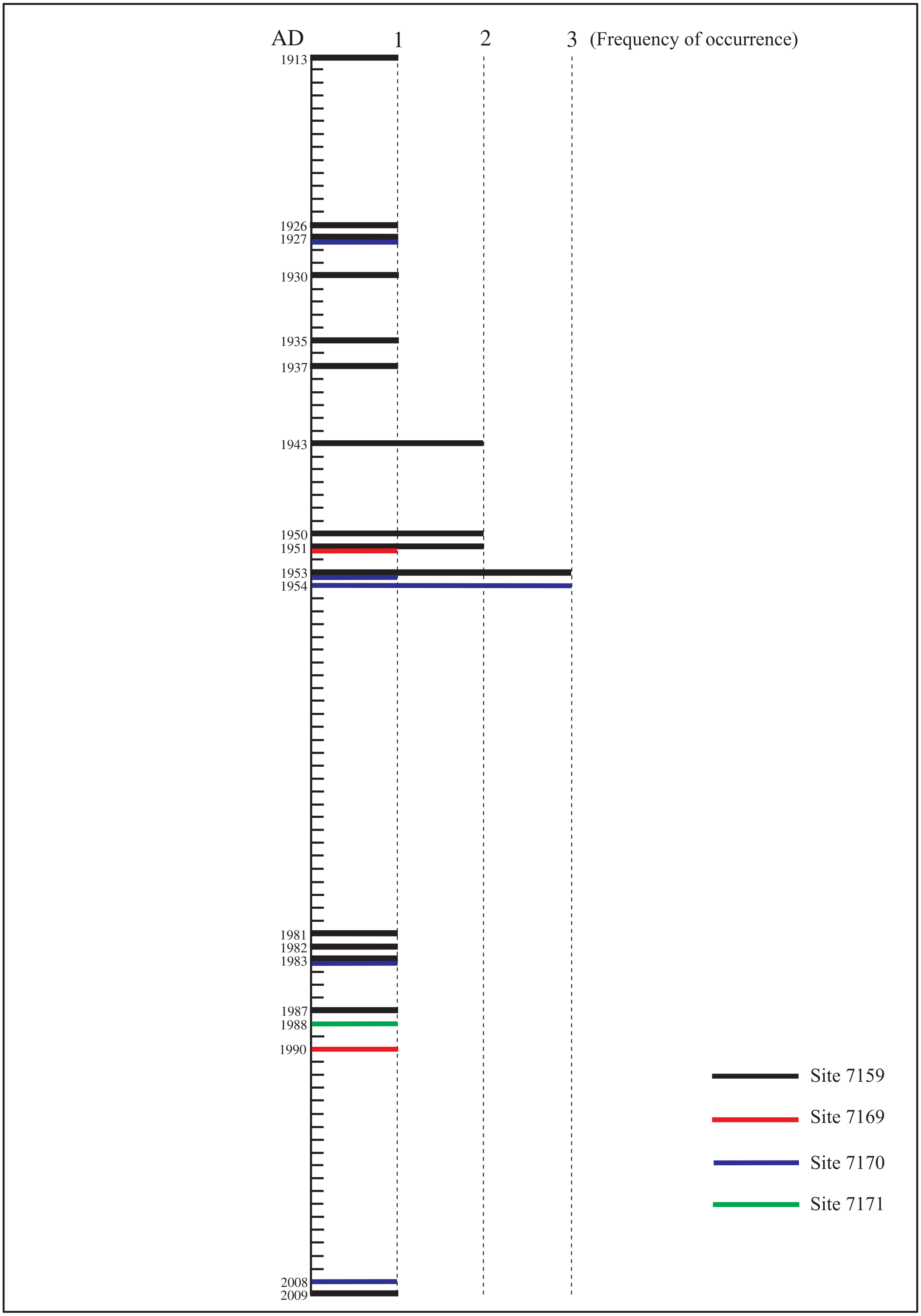

Figure 148. Diagrammatic representation of etched dates within the Kamananui Ditch System.

Features associated with the transport of sugarcane within the study area include the concrete bridge along Cane Haul Road (Site 7168), the four stone-walled road culverts (Sites 7165, 7166 and 7167 on Cane Haul Road, and Site 7163 on Hakina Bypass Road), and stone abutments (Site 7160) and kebstone alignment (Site 7162) within the Kawailoa Road corridor. An additional plantation-related site (Site 7161) recorded within the Kawailoa Road Corridor appears to be the location of a former stable.

Sites seemingly associated with World War II era (or slightly earlier) military activities include three separate concrete pillar foundations (Sites 7155, 7156, and 7158) along the northern *mauka*-most ridge within the study area. These three related sites are most probably remnants of a military communication and fire control network. These sites, along with Site 7157, are the only sites that were found in the vicinity of any of the proposed wind turbines tower locations.

SIGNIFICANCE EVALUATION AND TREATMENT RECOMMENDATIONS

The sites recorded during the current study are assessed for their significance based on criteria established and promoted by the DLNR-SHPD and contained in the Hawaiʻi Administrative Rules 13§13-284-6. This significance evaluation should be considered as preliminary until DLNR-SHPD provides concurrence. For a resource to be considered significant it must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

- A Be associated with events that have made an important contribution to the broad patterns of our history;
- B Be associated with the lives of persons important in our past;
- C Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;
- D Have yielded, or is likely to yield, information important for research on prehistory or history;
- 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 significance and recommended treatment for the seventeen recorded sites are discussed below and presented in Table 9.

Table 9. Site significance and treatment recommendations.

Site #	*Description*	*Association*	*Significance*	*Treatment*
7155	Concrete pillar	Military	A, D	No further work
7156	Concrete pillar	Military	A, D	No further work
7157	Concrete marker	Plantation	D	No further work
7158	Metal pole/concrete base	Military	A, D	No further work
7159	Ditch complex	Plantation	D	No further work
7160	Stone abutments	Plantation	D	No further work
7161	Concrete foundations	Plantation	D	No further work
7162	Kerbstone Alignment	Plantation	D	No further work
7163	Stone/concrete culvert	Plantation	D	No further work
7164	Metal pipeline	Plantation	D	No further work
7165	Stone/concrete culvert	Plantation	D	No further work
7166	Stone/concrete culvert	Plantation	D	No further work
7167	Stone/concrete culvert	Plantation	D	No further work
7168	Concrete Bridge	Plantation	D	No further work
7169	Ditch complex	Plantation	D	No further work
7170	Ditch complex	Plantation	D	No further work
7171	Ditch complex	Plantation	D	No further work

Sites 7155, 7156, and 7158 are likely interrelated elements associated with a WWII (or slightly older) military communication and fire control network that was established as a warning and response system in the event of a foreign invasion. Although the integrity of the overall system no longer exists, the locational and contextual integrity of these elements are intact, and as such these sites are considered significant under Criteria A and D.

Sites 7157, 7159, 7160, 7161, 7162, 7163, 7164, 7165, 7166, 7167, 7168, 7169, 7170, and 7171, although either non-functional (7161, 7162, 7164, 7169, 7171) partly functional (7157, 7159, 7170) or fully functional (7160, 7163, 7165, 7166, 7167, 7168), do retain sufficient integrity to be considered significant under Criterion D for the historical information they have yielded relative to the development of the plantation industry on the north shore of O‘ahu.

It is suggested however, that a reasonable and adequate amount of information has been collected from and about all of these sites as a result of the current study to warrant a no further work recommendation; and thus, a no historic properties affecting determination for these sites with respect to the proposed Kawailoa Wind Power project.

It is further recommended that a program of archaeological monitoring be maintained during the construction activities associated with the Kawailoa Wind Power project. Such a program will help to ensure that any inadvertently discovered resources would receive immediate attention and protection, while their ultimate disposition is being determined by DLNR-SHPD. A monitoring plan in compliance with HAR 13§13-279 should be prepared and submitted to DLNR-SHPD for review and approval.

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APPENDIX A – Archaeological Assessment of Off-Site Communication Facilities at Mount Kaʻala

Introduction and Project Area Description

As part of the Kawailoa Wind Farm Project, and in compliance with the U.S. Department of Energy and HECO, First Wind will be required to establish a high-speed communications system using microwave radio technology in order to protect the electrical grid in case of outages. The microwave communication system will involve the placement of line of sight microwave dishes and signal repeater antennae at existing facilities on two small parcels with the same Tax Map identifier (TMK:1-6-7-03:024) near the summit of Mount Kaʻala, Kamanaui Ahupuaʻa, Waialua District, Island of Oʻahu (Figures A-1, A-2, and A-3).

Both locations are sites of existing Hawaiian Telcom facilities, and the co-location of First Wind infrastructure at these sites will not result in new ground disturbance. One location, the existing Hawaiian Telcom Building (Figure A-4) is located at an elevation of roughly 3,600 feet (1,097 meters) directly along the Mount Kaʻala access road (Figure A-5). The other tower location (Figure A-6) is situated along a finger ridge at an elevation of 3,200 feet (975 meters) and is reached via an improved concrete step (Figure A-7) and dirt foot trail (Figure A-8) (Dupont Trail) extending for roughly 1,600 feet to the west from the Mount Kaʻala access road.

Background

Mount Kaʻala is the highest peak on Oʻahu and as such for decades has been a locus of modern governmental and public utility radar and communication activity, with several developed facilities. From a traditional Hawaiian perspective, Mount Kaʻala is revered and honor as a sacred place. As McGrath et al. (1973) relate, "this peak stand 4,040 feet high, the tallest on Oʻahu. Ancient Kahunas spoke of Mount Kaʻala as being clothed in the golden cloak of Kāne, the first deity of the Hawaiian pantheon. Kaʻala was the guardian of the road to the west, the path of the sun, the resting place on that great road to death where spirits of the dead return to their homeland." The cultural significance of Mount Kaʻala and any potential cultural impacts that would result from the Kaiwailoa Wind Project are discussed in the cultural impact assessment prepared by Cultural Surveys Hawaii (Genz and Hammatt 2011) for this project.

A review of the records on file at DLNR-SHPD indicates that no archaeological studies have been conducted at the upper elevations on Mount Kaʻala, and that no sites are known to exist in the vicinity of the study area. However, there was one Section 106 consultation/determination made for the existing Hawaiian Telcom facility located along Mount Kaʻala access road, which is one of the two facilities that is the subject of the current study. In May 2005, the SHPO (DLNR-SHPD Doc. No. 1005RS47) concurred with an applicant determination that the proposed co-location of cellular communication antennae and a 100 square foot ground sublease would not affect historic properties.

Fieldwork Findings and Conclusion

A field inspection of both of the existing facility locations was conducted by Rechtman Consulting, LLC on July 16, 2010. There were no archaeological resources observed at either location. Given the negative findings of the field investigation coupled with the fact that the proposed communication system will be installed at previously developed facilities, it is our conclusion that no archaeological resources will be affected by the establishment of the First Wind microwave communication system.

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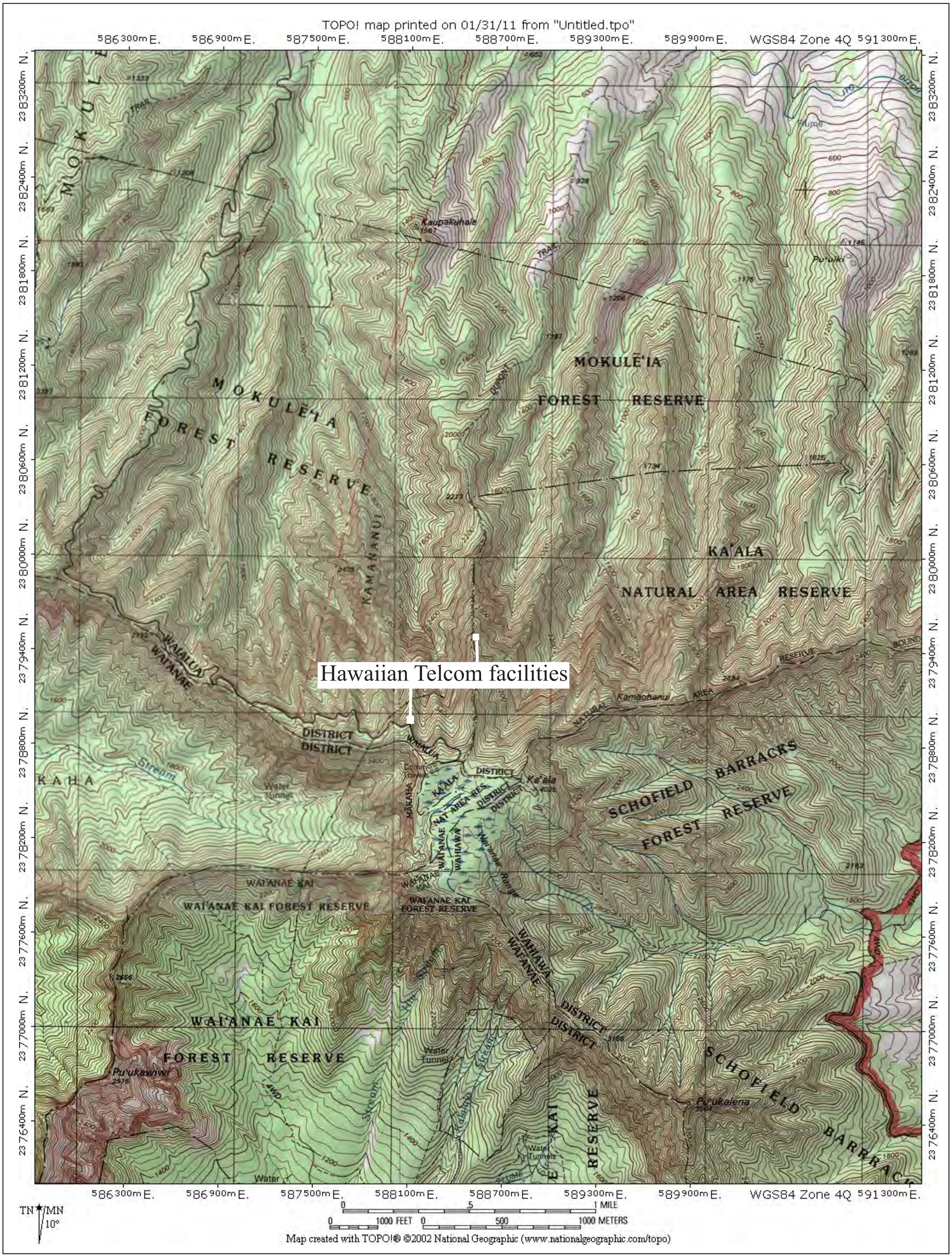

Figure A-1. Mount Ka'ala project location.

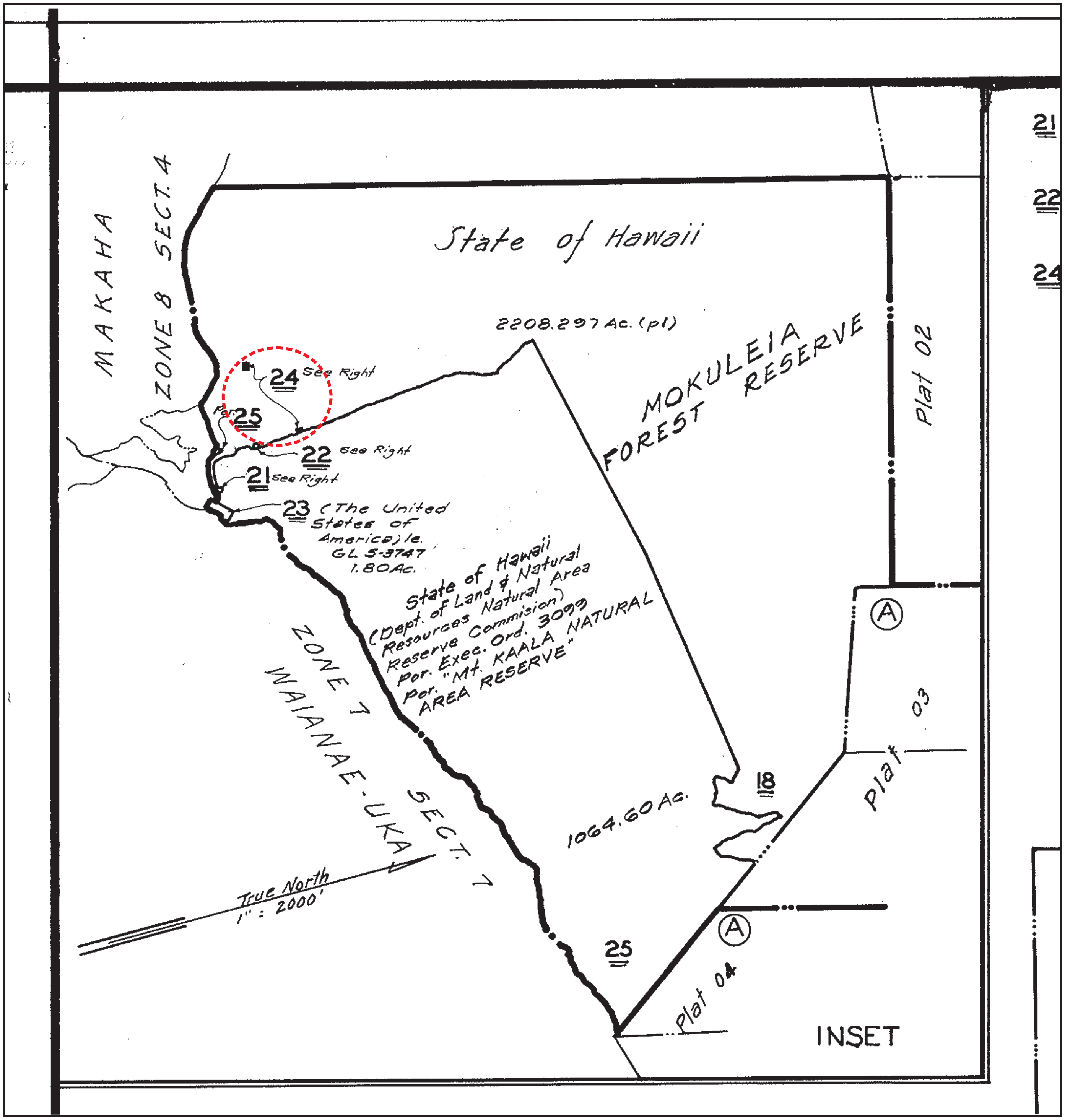

Figure A-2. Inset portion of Tax Map Key1- 6-7-03 showing existing Hawaiian Telcom lease lots, Parcel 24.

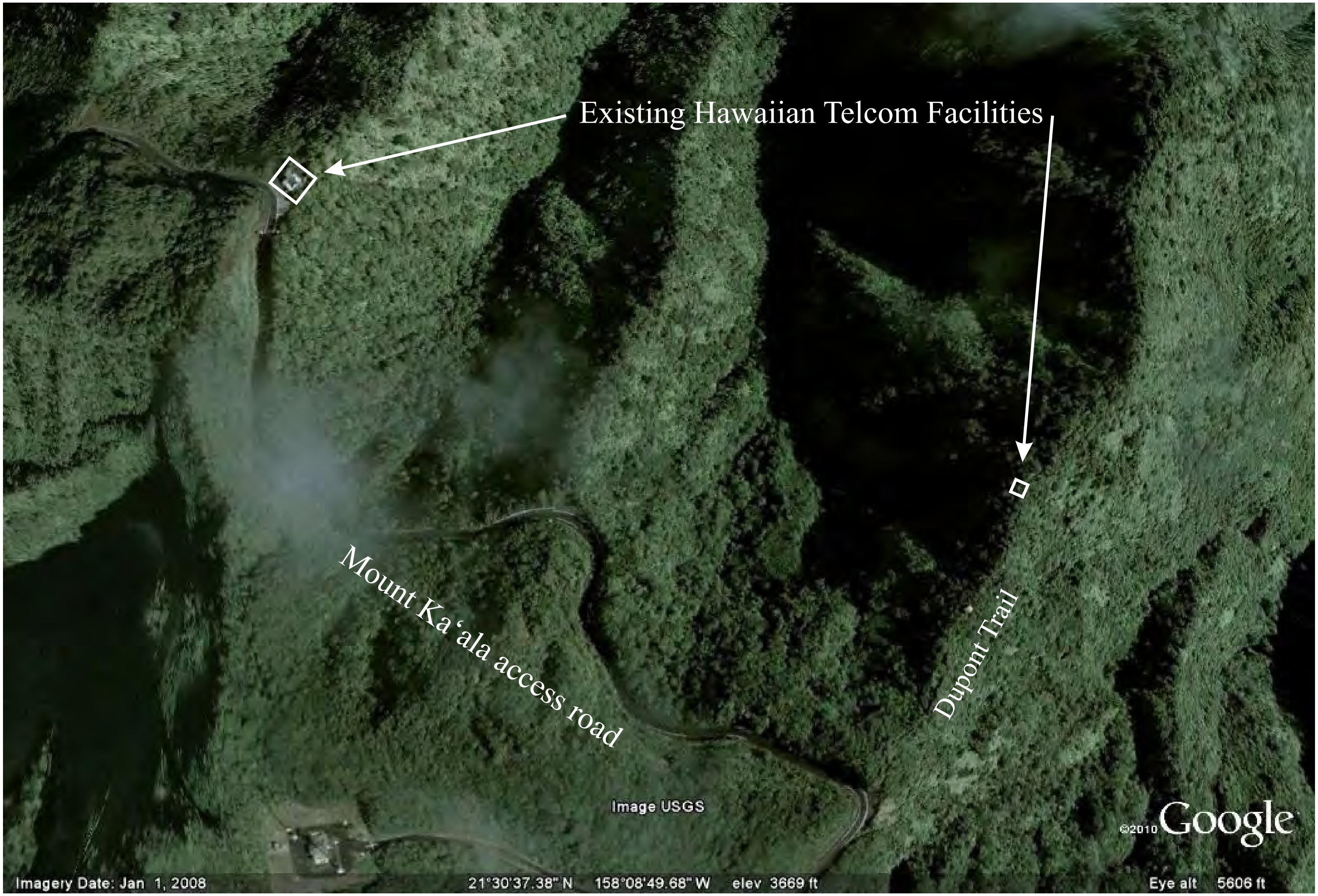

Figure A-3. Google image of Mount Ka‘ala project area.

Figure A.4. Existing Hawaiian Telcom communication building along Mount Ka‘ala access road.

Figure A-5. Mount Ka‘ala access road.

Figure A-6. Existing tower location along trail where First Wind plans to co-locate microwave dishes.


Figure A-7. Concrete steps at trail head.


Figure A-8. Dirt foot path along finger ridge.

APPENDIX B: Environmental Noise Assessment Report for Kawailoa Wind Farm

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

Environmental Noise Assessment Report
Kawailoa Wind Farm
Haleiwa, Oahu, Hawaii

June 2011

DLAA Project No. 09-39A

Prepared for:
CH2M Hill / First Wind Energy, LLC
Honolulu, Hawaii

970 N. KALAHEO AVE. • SUITE A311 • KAILUA, HAWAII 96734
808/254-3318 • FAX 808/254-5295
www.dlaa.com • hawaii@dlaa.com

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1.0 EXECUTIVE SUMMARY

1.1 The proposed Kawailoa Wind Farm project is located between Haleiwa and Waimea Bay on the north shore of Oahu, Hawaii. Thirty wind turbines are planned, along with other key components such as electrical substations, operations and maintenance buildings, communications and meteorological towers, and communication facilities. The wind turbines selected for use at the proposed Kawailoa Wind Farm project are the Siemens SWT-2.3-101, which have 332 foot (101 meter) diameter three-blade rotors and a hub height of 326 feet (99.5 meters).

1.2 The proposed project site is located on the Kawailoa Plantation lands, and is zoned primarily as an agricultural district (AG-1), with a small area zoned as preservation (P-1). As such, there are no residential dwellings within 4,000 feet (1220 meters) from the project site or noise sensitive land uses within 1,000 feet (300 meters) from the project site. Sound from the wind turbines must comply with the State Department of Health (HDOH) maximum permissible sound levels for any location at or beyond the First Wind project area. These sound limits may be enforced at nearby residences or along the boundary of the project site. Therefore, project noise must comply with the limits specified for all HDOH zoning districts (Residential, Preservation, Commercial, and Agriculture).

1.3 Ambient noise level measurements and wind speed data was collected to assess the existing acoustical environment in the community surrounding the project site and on the proposed Kawailoa Wind Farm project site. The range of equivalent sound levels, L_{eq}, during the day (7:00 a.m. to 10:00 p.m.) and during the night (10:00 p.m. to 7:00 a.m.) and average calculated day-night level, L_{dn}, were reported for 13 locations. The average calculated L_{dn} ranged from 43 to 69 dBA on the project site and 42 to 63 dBA in the surrounding community. Contributing noise sources included environmental noise sources such as wind and birds, vehicular traffic, community noises, landscaping or grading equipment, and aircraft flyovers.

1.4 A sound propagation model of the proposed Kawailoa Wind Farm project was developed to predict wind turbine sound in the areas surrounding the project site. To assess potential sound impacts and compliance with associated regulations, the results of the sound propagation model were compared to the State of Hawaii Department of Health Community Noise Rule's maximum permissible noise limits. To assess community reaction to project noise, the results were compared to the ambient sound levels that were measured in the community surrounding the project site.

1.5 Based on the results of the sound propagation model and comparisons to the measured ambient sound levels, wind turbine sound is expected to increase the ambient noise environment by less than 3 dB, an insignificant amount, at the closest noise sensitive receptor (Waimea Valley). This means that during the day, turbine sounds will be fully masked by ambient noise sources such as birds and wind. At night, turbine sounds will just barely be perceptible. The other nearby residential communities are located at a sufficient distance from the Kawailoa Wind Farm project site that wind turbine sounds are predicted to be lower than the existing ambient noise environment. This means that wind turbine noise will not be audible at these residences. Therefore, the Kawailoa Wind Farm project noise would be unlikely to create a disturbance to sensitive noise receptors or generate complaints from the surrounding residences.

1.6 The predicted wind turbine sound levels from the Kawailoa Wind Farm project are not expected to exceed the HDOH maximum permissible noise limit in the areas to the west of the project site that are zoned for agriculture. However, sounds from the wind turbines are expected to exceed the HDOH nighttime maximum permissible noise limit where the project borders preservation land. Although the property line locations are not easily accessible or commonly occupied locations, any requirements for a noise variance should be confirmed with the HDOH.

1.7 Sounds from the wind turbines are also not expected to exceed the HDOH maximum permissible noise limit at the residential communities or commercial properties closest to the project site. Since the project noise complies with the HDOH Community Noise Rule, a noise impact is not expected at these nearby residences and businesses.

2.0 PROJECT DESCRIPTION

The proposed Kawailoa Wind Farm project is located between Haleiwa and Waimea Bay on the north shore of Oahu, Hawaii. The project site is located on the Kawailoa Plantation lands, and is zoned primarily as an Agricultural District (AG-1), with a small area zoned as Preservation (P-1). As such, there are no residential dwellings within 4,000 feet (1220 meters) from the project site or noise sensitive land uses within 1,000 feet (300 meters) from the project site.

Thirty wind turbines are planned, along with other key components such as electrical substations, operations and maintenance buildings, communications and meteorological towers, and communication facilities. The wind turbines selected for use at the proposed Kawailoa Wind Farm project are the Siemens SWT-2.3-101, which have 332 foot (101 meter) diameter three-blade rotors and a hub height of 326 feet (99.5 meters). The turbines will be located at varying elevations, primarily in the north-eastern portion of the Kawailoa Plantation lands where the wind profile is favorable. The turbines are generally activated when wind speeds reach approximately 8 miles per hour (mph) or 4 meters per second (mps) and shut down when winds exceed 55 mph (25 mps), as high wind speeds can damage the equipment. The wind turbines are expected to have a nominal output of 2.3 MW each.

The environmental noise assessment consists of two phases: a survey of the existing ambient noise environment and an analysis of future wind turbine sound levels with computer modeling software. Long-term ambient sound level measurements were conducted to monitor existing sound levels at the project site and in the surrounding areas. A sound propagation model of the site and the surrounding areas was developed in order to assess the potential sound impacts of the selected wind turbines. The results of the sound propagation model and the measurements will confirm whether sound from the wind turbines will be audible over the existing ambient environment.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. It is our understanding that the only local noise regulation that applies to the proposed project is the State of Hawaii Community Noise Control Rule. However, other guidelines may be used to assess the community response to the proposed project as it relates to noise. A brief description of common acoustic terminology used in the regulation and in this report is presented in Appendix A.

3.1 State of Hawaii Department of Health, Community Noise Control

The State of Hawaii Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to *stationary* sound sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc. The Community Noise Control Rule does not address most *moving* sources, such as vehicular traffic noise, air traffic noise, or rail traffic noise. However, it does regulate noise related to agricultural, construction, and industrial activities, which may not be stationary. The proposed wind turbines are considered stationary sound sources and would be subject to the Community Noise Control Rule.

The maximum permissible sound levels are enforced by the State Department of Health (HDOH) for any location at or beyond the First Wind project area and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 1. With respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. For enforcement purposes, sound levels are typically measured at the property line or on the property of the complainant, and the maximum permissible sound level corresponds with the zoning of the complainant's property.

While the HDOH Community Noise Rule is generally enforced at the property line boundary between two adjoining lands, the maximum permissible noise levels can apply to any excessive noise source "emanating at any point at or beyond the property line." Therefore, wind turbine sound levels must also meet the HDOH maximum permissible noise limit at all zoning districts outside of the First Wind project area, including residential or commercial zones.

3.2 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 2]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

4.1 Noise Measurement Procedure

Ambient noise level measurements and wind speed data was collected to assess the existing acoustical environment in two areas which will be referred to as "Community" and "Project Site". Noise monitoring stations were set up in seven locations in the community surrounding the project site. The project site measurements were conducted at six locations in the vicinity of the proposed Kawailoa Wind Farm project area. The locations of the noise monitoring stations are shown in Figures 2 and 3 and described below.

The data collection took place during the months of January, February and March 2011. Continuous, one-hour, statistical sound levels were recorded for approximately two weeks at each location. Calibration was checked before and after the measurements. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. The microphone was mounted on a tripod, generally about 5 feet above grade, and covered by a windscreen. The sound level meter was secured in a weather resistant case.

Simultaneous weather data (wind speed, direction, temperature, etc.) was also collected in 15 minute intervals. The anemometer was mounted on a tripod near the sound level meter, generally about 6 feet above grade. A handheld Garmin GPS was used to adjust the wind vane to accurately measure wind direction. The wind speed measurements were validated using a handheld Kestrel 3000 Pocket Weather Meter. The Weather Console and Weatherlink were secured in a weather resistant case.

The measurement equipment is described in Table 1 below. Photographs of the various measurement equipment setups can be seen in Appendix B.

Table 1. Noise Monitoring Station Equipment List

Equipment Type	Manufacturer, Model
Type 1 Sound Level Meter	Larson Davis Model 820
	Larson Davis Model 831
Type 1 Microphone	Gras Model 40AQ
	PCB Model 377B20
Calibrator	Larson Davis CAL200
Windscreen	Larson Davis 001
	Larson Davis EPS2106
Weather Station	Davis Instruments Weather Wizard III, Product 7425
	Davis Instruments, Vantage VUE Integrated Sensor Suite Model 6357, Console Model 6351
	Larson Davis Model 831, Weather Module
WeatherLink	Davis Instruments WeatherLink, Model 7866
	Davis Instruments WeatherLink, Model 6510USB
Anemometer	Davis Instruments Model 7911

4.2 Community Noise Measurement Locations and Results

Ambient noise measurements were conducted at seven locations between the communities of Whitmore Village and Pupukea, as shown in Figure 2. The existing conditions and ambient noise environment for each location are described below. The results from these long-term noise measurements are graphically presented in Figures 4 through 10, which show the measured equivalent sound level, L_{eq}, in A-weighted decibels (dBA) and the measured wind speed as a function of the measurement date and time. The results are also summarized for each location in Table 2 below.

Table 2. Community Noise Measurement Results

ID	Measurement Location	Daily Avg. Sound Level $L_{eq\ (Day)}$[1]	Daily Avg. Sound Level $L_{eq\ (Night)}$[2]	Daily Avg. Day-Night Level L_{dn}[3]
C3	Pu'u O Mahuka Heiau	41 - 47 dBA	36 - 51 dBA	44 - 56 dBA
C4	Pupukea	38 - 48 dBA	35 - 51 dBA	42 - 57 dBA
C8	Waimea Valley	45 - 50 dBA	42 - 50 dBA	49 - 56 dBA
C11	Punalau/Pohaku Loa Area	55 - 61 dBA	51 - 57 dBA	59 - 63 dBA
C13	Papailoa/Kawailoa Area	55 - 61 dBA[4]	47 - 49 dBA[4]	56 - 60 dBA[4]
C14	Haleiwa – JPL Hwy Property	50 - 56 dBA	45 - 52 dBA	53 - 58 dBA
C15	Dole Plantation	48 - 60 dBA	39 - 58 dBA	49 - 64 dBA

Notes:

1. $L_{eq(day)}$ is an average of the hourly equivalent sound levels during the daytime hours only (between 7:00 am and 10:00 pm) within a 24-hour measurement period. The range represents the quietest and noisiest day measured within the 14 day measurement period.
2. $L_{eq(night)}$ is an average of the hourly equivalent sound levels during the nighttime hours only (between 10:00 pm and 7:00 am) within a 24-hour measurement period.. The range represents the quietest and noisiest night measured within the 14 day measurement period.
3. The L_{dn} represents the lowest and highest calculated average day-night level from the 14 day measurement period.
4. Peaks caused by meter malfunctions were removed from the from the $L_{eq(day)}$, $L_{eq(night)}$, and L_{dn} calculations.

4.2.1 Pu'u O Mahuka Heiau (C3)

Pupukea Ranch was chosen for one of the sound level meter locations due to its proximity to the Pu'u O Mahuka Heiau. The sound level meter was set up approximately 1000 feet south-east of the Heiau near the edge of the ridge overlooking Waimea Valley (GPS Coordinates: 21°38'19.15"N, 158° 3'21.23"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 4. Noise sources at this site include wind, birds, rain and thunder, frequent military aircraft flyovers, tsunami sirens, ATVs, horses, and sounds from the Waimea Valley parking lot below.

4.2.2 Pupukea - Maulukua Rd Property (C4)

The sound level meter was set up on private property at the edge of the ridge overlooking Waimea Valley and had a direct line-of-sight to the proposed project site on the opposite ridge (GPS Coordinates: 21°38'13.43"N, 158° 2'9.64"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 5. Noise sources at this site include wind, birds, rain and thunder, landscaping equipment, and occasional aircraft flyovers.

4.2.3 Waimea Valley (C8)

The sound level meter was set up on the southern edge of the valley near the back of the botanical gardens area (GPS Coordinates: 21°37'48.13"N, 158° 2'52.58"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 6. Noise sources at this site include wind, birds, landscaping equipment, pedestrians, and occasional aircraft flyovers.

4.2.4 Punalau/Pohaku Loa Area - Ashley Road Residence (C11)

It was necessary to assess noise levels in an area between the residential neighborhoods of Punalau and Papailoa. Therefore, the sound level meter was located at a private residence adjacent to Ashley Road, approximately 300 feet east of Kamehameha Highway (GPS Coordinates: 21°37'20.70"N, 158° 4'48.25"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 7. The ambient noise levels are dynamic and depend significantly on the vehicular traffic patterns of Kamehameha Highway. Noise sources at this site include vehicular traffic, frequent military aircraft flyovers, chickens, landscaping equipment, wind, and birds.

4.2.5 Papailoa/Kawailoa Area - Alluvion Ranch (C13)

In order to assess sound levels in the agricultural neighborhoods mauka of Kamehameha Highway, a sound level meter was located near Kawailoa Ranch (GPS Coordinates: 21°36'49.60"N, 158° 5'7.19"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 8. There were many instances of equipment malfunctions, as indicated in the figure and the affected data points were removed from the L_{eq}(day), L_{eq}(night), and L_{dn} calculations. Noise sources at this site include agricultural and/or landscaping equipment, wind, birds, and occasional aircraft flyovers.

4.2.6 Haleiwa - Joseph P. Leong Highway Residence (C14)

It was also necessary to assess noise levels near Haleiwa town, which is zoned for residential, commercial and agricultural uses. The sound level meter was located at the north end of Haleiwa on an agricultural lot approximately 300 feet east of Joseph P. Leong Highway (GPS Coordinates: 21°35'51.06"N, 158° 5'54.95"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 9. The ambient noise levels are dynamic and depend significantly on the vehicular traffic patterns of Joseph P. Leong Highway. Noise sources at this site include vehicular traffic, frequent military aircraft flyovers, agricultural and/or landscaping equipment, wind, and birds.

4.2.7 Dole Plantation (C15)

The sound level meter was located at Dole Plantation near the plantation garden, approximately 950 feet east of Kamehameha Highway (GPS Coordinates: 21°31'34.57"N, 158° 2'9.52"W). A graphical representation of the results from the long-term noise measurements at this location are shown in Figure 10. Noise sources at this site include vehicular traffic, rain and thunder, tsunami sirens, noise from the train tour, agricultural and/or landscaping equipment, wind, and birds.

4.3 Project Site Measurement Locations and Results

Ambient noise measurements were also conducted on the proposed Kawailoa Wind Farm project site. Six sound level meters were set up at various locations within the project area, as shown in Figure 3. The results from these long-term noise measurements are graphically presented in Figure 12 through 16, which show the measured equivalent sound level, L_{eq}, in A-weighted decibels (dBA) and the measured wind speed as a function of the measurement date and time. The results are summarized in Table 3 below.

Table 3. Project Site Noise Measurement Results

ID	GPS Coordinates	Daily Avg. Sound Level $L_{eq\ (Day)}$[1]	Daily Avg. Sound Level $L_{eq\ (Night)}$[2]	Daily Avg. Day-Night Level L_{dn}[3]
L1	N21° 37.355', W158° 04.422'	58 - 64 dBA	55 - 63 dBA	62 - 69 dBA
L2	N21° 37.693', W158° 03.836'	47 - 50 dBA[4]	35 - 45 dBA[4]	46 - 53 dBA[4]
L3	N21° 37.426', W158° 03.422'	43 - 49 dBA[4]	27 - 55 dBA[4]	43 - 60 dBA[4]
L4	N21° 37.510', W158° 02.619'	41 - 52 dBA	36 - 57 dBA	48 - 63 dBA
L5	N21° 36.999', W158° 01.841'	44 - 48 dBA[4]	43 - 44 dBA[4]	49 - 50 dBA[4]
L6	N21° 35.476', W158° 02.312'	41 - 50 dBA	24 - 48 dBA	43 - 53 dBA

Notes:

1. $L_{eq(day)}$ is an average of the hourly equivalent sound levels during the daytime hours only (between 7:00 am and 10:00 pm) within a 24-hour measurement period. The range represents the quietest and noisiest day measured within the 14 day measurement period.
2. $L_{eq(night)}$ is an average of the hourly equivalent sound levels during the nighttime hours only (between 10:00 pm and 7:00 am) within a 24-hour measurement period.. The range represents the quietest and noisiest night measured within the 14 day measurement period.
3. The L_{dn} represents the lowest and highest calculated average day-night level from the 14 day measurement period.
4. Peaks caused by meter malfunctions or due to birds or other unknown noise sources were removed from the $L_{eq(day)}$, $L_{eq(night)}$, and L_{dn} calculations.

The proposed Kawailoa Wind Farm site is located on undeveloped land that was previously utilized for the cultivation of sugarcane. As shown in Figure 11 through 16, ambient noise levels on the project site are dynamic and depend significantly on environmental noise sources. The measurements are fairly consistent for all measurement locations (except Location L1), which indicates a uniform ambient noise environment throughout the project site. Noise sources on the project site include wind, birds, rain, and frequent military aircraft flyovers. At Location L3, there were several occurrences of bird sounds near the microphone. These events and other unknown noise sources caused sound levels to spike. At Locations L2 and L5, there were instances of equipment malfunctions. While these anomalies are indicated in the figure, the affected data points were removed from the L_{eq}(day), L_{eq}(night), and L_{dn} calculations. Peaks due to various events such as military aircraft flyovers and rain are also indicated in the figures.

4.4 Wind Speed Measurement Results

4.4.1 Atmospheric Conditions at Hub Height and Ground Height

In an attempt to address atmospheric conditions at various times of the day, wind speed data was collected from the two First Wind meteorological (MET) stations corresponding to Location L5 on the project site. Figure 17 shows the hourly averaged wind speed measured over a two week period at the MET station at a height of approximately 200 ft (59.5) for Location L5. The figure also shows the wind speed at Location L5 measured during the same time period at ground level (5 ft).

As shown in the figure, the wind data from the MET station fluctuates significantly over time. But on average, the wind speed only varies from 8 mph to 12 mph indicating that wind speed at a high altitude is not dependent on time of day. However, a general pattern in the data indicates that wind speed at ground level is highest during the daylight hours and tends to be minimal at night. This phenomenon occurs during periods of stable nighttime atmospheric conditions, when calm ground level winds become decoupled from winds at a higher altitude. Under this "worst case" condition, wind turbine noise could be perceived as louder and more perceptible if wind speeds at hub height are sufficient to drive the turbine but the lack of wind closer to the ground causes low ambient sound levels that are not effective at masking other noise sources.

4.4.2 Windscreen Induced Self Noise

During unmonitored environmental noise measurements, there is a possibility that the measured ambient noise is actually due to self induced wind noise generated by flow around and through the windscreen. The contamination of ambient noise by the self induced wind noise depends on the porosity of the windscreen and the wind speed itself. Self induced noise levels of 35 to 40 dBA generally occur at wind speeds of 12 mph or greater. Based on the measurements at the various community and project site measurement locations, wind speeds at ground level were insufficient to create self-induced noise.

5.0 SOUND PROPAGATION MODEL

5.1 Model Overview

To evaluate the sound impact of each wind turbine in each direction, the DataKustik CadnaA (version 4.0) software program [Reference 3] was used to create a sound propagation model. The software program uses the calculation procedures of International Standard ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* [Reference 4]. The model is a three dimensional representation of the propagation of wind turbine sound throughout the project site and the surrounding areas. It includes the effect of ground cover and terrain and also considers environmental parameters, such as temperature, humidity, and wind direction.

The Kawailoa Wind Farm sound propagation model was developed using the wind turbine coordinates, sound power data, and a site plan provided by First Wind and CH2M Hill. The following paragraphs describe the input parameters used to develop the sound propagation model relative to the Kawailoa Wind Farm.

5.2 Wind Turbine Sound Data

The proposed wind turbines are Siemens SWT-2.3-101 turbines which have 332 ft (101 m) diameter three-blade rotors and a hub height of 326 ft (99.5 m). The current standard for measuring and reporting the sound power of wind turbines is the International Standard IEC 61400-11:2006 *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* [Reference 5]. The sound power levels were presented with reference to IEC 61400 requirements based on a hub height of 262 ft (80 m) and a roughness length of 0.16 ft (0.05 m). The data used in the sound propagation model is based on 18 mph (8 m/s) wind speed referenced to a height of 33 ft (10 m) above ground level.

5.3 Project Site Topography

The elevation of the Kawailoa Wind Farm project site ranges from 200 feet above sea level (ASL) at the makai (western) edge to 1,280 feet ASL. Furthermore, the site encompasses a range of topographical conditions from relatively flat and moderately sloping agricultural lands to steep gullies and intermittent streams. As such, the irregular terrain may play a significant role in the attenuation of sound where the line-of-sight from receptor to the wind turbines is broken. Digital geometric data of topographic contours (at 40 ft intervals) were imported into the software. Topographic maps of the island of Oahu were available on the City and County of Honolulu Department of Planning and Permitting Land Information System website [Reference 6].

5.4 Meteorological Conditions

Over large distances, meteorological conditions (i.e., wind, temperature, and humidity) play a large role in the attenuation of sound. Standard practice for calculating sound attenuation at long ranges is to restrict attenuation to atmospheric conditions that are favorable for sound propagation, consistent with the methodology described in ISO 9613-2. Therefore, although physically impossible, every receiver was assumed to be simultaneously downwind of the source in the presence of a well developed temperature inversion. The model also assumes an average temperature of 68° Fahrenheit and relative humidity of 70%, based on software settings that are closest to the average climate on the north shore of Oahu.

The software program does provide the means to model other meteorological conditions including predominant wind speeds and directions. However, the methodology described above is not only standard practice, but also a conservative approach to predicting wind turbine sound. This means that the actual sound levels due to wind turbine sound propagation should be equal to or less than the predicted levels.

5.5 Ground Attenuation Coefficient

The ground attenuation coefficient is another condition used in the sound propagation model that can influence the predicted sound levels. A ground attenuation coefficient of 1.0 indicates that the ground is porous or acoustically very absorptive (e.g., ground covered by grass, trees or other vegetation). A coefficient of 0.0 indicates that the ground is hard or acoustically reflective (e.g., water, pavement, or other low porosity ground surfaces). The project site and surrounding terrain is currently heavily vegetated by various grass species and trees. Therefore, the model assumes a ground attenuation coefficient of 1.0 to represent the absorptive nature of the existing and future ground cover or the project area. For the developed and residential areas (such as Pupukea, Haleiwa, and the Kamehameha Highway corridor), a conservative ground absorption coefficient of 0.0 was used to represent the paved and other reflective surfaces.

5.6 Receiver Height

Wind turbine sound levels have been calculated at the receiver locations at 13 ft (4 m) above ground. This height represents a worst case scenario of a listener on a second story balcony or in a second story bedroom with an open window. This also provides a safety factor when considering shadowing due to terrain features, in case there are slight inaccuracies in the topographical data used in the model. Typically, measurements would most often be made at 5 ft (1.5 m) above ground if testing for compliance with the Community Noise Control Rule. However, the regulation does allow measurements to be made higher on the vertical plane of the property line, or within the complainant's property. In almost all cases, predicted sound levels at 5 ft would be equal to or slightly less than at 13 ft.

5.7 Predicted Wind Turbine Sound Levels

The results of the sound propagation model have been presented in both tabular and graphical formats. Again, various conservative assumptions have been made in developing the model to ensure that actual project noise does not exceed the predicted levels. Table 4 summarizes the predicted wind turbine sound levels at the measurement locations described in Sections 4.2 and 4.3 above. Figures 18 and 19 are graphical representations of the predicted sound level contours due to the wind turbines in the vicinity of the project site and in the North Shore region, respectively. The sound contour lines range from 30 dBA to 60 dBA

Table 4. Predicted Wind Turbine Sound Levels at Various Locations

ID	Name	Distance[1]	Predicted Sound Level[2]	DOH Nighttime Sound Limit[3]
L1-L3	W Site Boundary	1300 - 5000 ft	30 – 43 dBA	70 dBA
L4-L6	**N, E, S Site Boundary**	**200 - 900 ft**	**52 – 55 dBA**	**45 dBA[4]**
C3	Pu'u O Mahuka Heiau	4,100 ft	30 dBA	45 dBA
C4	Pupukea	5,300 ft	30 dBA	45 dBA
C8	Waimea Valley	750 ft	42 dBA	45 dBA
C11	Punalau/Pohaku Loa	7,320 ft	< 30 dBA	45 dBA
C13	Papailoa/Kawailoa	9,390 ft	< 30 dBA	45 dBA
C14	Haleiwa	> 10,000 ft	< 30 dBA	45 dBA
C15	Dole Plantation	> 10,000 ft	< 30 dBA	50 dBA

Notes:
1. Approximate distance from indicated location to closest wind turbine.
2. The predicted sound levels are based on the conditions indicated in Sections 5.2 – 5.6.
3. The nighttime sound limits are based on the zoning of the indicated location and the corresponding HDOH maximum permissible limits, as discussed in Section 3.1.
4. The predicted wind turbine sound levels will exceed the DOH nighttime sound limit at the northern, eastern, and southern boundaries of the project site which are zoned for preservation land. This impact is discussed in more detail in Section 7.1.

6.0 COMMUNITY RESPONSE TO PROJECT

6.1 Community Response Guidelines

The average ability of an individual to perceive changes in noise levels is well documented and has been summarized in Table 5 [Reference 7, 8]. These guidelines permit direct estimation of an individual's probable perception of changes in noise levels.

Table 5. Average Ability to Perceive Changes in Noise Level

Sound Level Change (dB)	Human Perception of Sound
0	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	Two times (or 1/2) as loud
20	Four times (or 1/4) as loud

A commonly applied criterion for estimating a community's response to changes in noise level is the 'community response scale' proposed by the International Standards Organization (ISO) of the United Nations [Reference 9]. The scale shown in Table 6 relates changes in noise level to the degree of community response and allows for direct estimation of the probable response of a community to a predicted change in noise level.

Table 6. Community Response to Increases in Noise Levels

Sound Level Change (dB)	Category	Response Description
0	None	No observed reaction
5	Little	Sporadic Complaints
10	Medium	Widespread Complaints
15	Strong	Threats of Community Action
20	Very Strong	Vigorous Community Action

Human perception to changes in noise level is subjective by its very nature. All people do not respond to noises in the same manner or with the same threshold for tolerance. Tables 5 and 6 above summarize the human perception and response to noise level changes for most people (the general public). These tables are based on a summary of results and research by many different organizations, and they are commonly referenced when determining the perceived annoyances due to changes in sound levels. The values stated in Tables 5 and 6 should not be considered regulatory requirements because they are not associated with a specific governing document for this project. However, these tables are very useful in assessing the human perception to changes in sound levels and they are considered to be supplemental information to the governing State of Hawaii Community Noise Control Rule, which does not discuss community response to changes in noise levels.

A change in sound level of 6 dB or more is commonly used as a threshold for determining the when an adverse reaction from the community can be expected. Based on the information provided in Tables 5 and 6, a 6 dB change in sound level will be easily noticeable and generate complaints from most communities. Many studies support the 6 dB change as a common threshold. Examples of this threshold being applied as a guideline can be found in the 2008 Noise Impact Assessment Report completed for the St. Lawrence Wind Farm Project [Reference 10], and the New York State Department of Environmental Conservation (NYSDEC) program policy (Section V B(7)c) [Reference 11]. Therefore, this 6 dB change in noise level was used as the threshold for determining adverse community response for the Kawailoa Wind Farm project. For clarification, this criteria is based on the change in noise level and is supplemental to the criteria regarding the overall noise level limits regulated by the Hawaii Department of Health.

6.2 Predicted Community Response to Wind Turbine Sound

As described above, a change in noise level of 6 dB or more is the threshold for predicting adverse community response regarding the cumulative change in sound level due to the wind turbines. The cumulative change includes both the wind turbine noise and the existing ambient noise and can be determined by logarithmically combining the existing ambient sound (based on the measurement results) with the predicted wind turbine sound, as shown in Table 7 below.

Table 7: Predicted Change in Sound Level and Community Response

ID	Name	Predicted Sound Level[1]	Measured Min. Average $L_{eq(Night)}$[2]	Combined Sound Level[3]	Δ due to Wind Turbines[4]	Response Category[5]
C3	Heiau	30 dBA	36 dBA	37 dBA	+ 1 dB	Little to None
C4	Pupukea	30 dBA	35 dBA	36 dBA	+ 1 dB	Little to None
C8	Waimea Valley	42 dBA	42 dBA	45 dBA	+ 3 dB	Little to None
C11	Punalau	<30 dBA	51 dBA	51 dBA	+ 0 dB	None
C13	Kawailoa	<30 dBA	47 dBA	47 dBA	+ 0 dB	None
C14	Haleiwa	<30 dBA	45 dBA	45 dBA	+ 0 dB	None
C15	Dole Plantation	<30 dBA	39 dBA	39 dBA	+ 0 dB	None

Notes:

1. Sound levels were predicted from the sound propagation model described Section 5.7 and do not include ambient sound.
2. $L_{eq(night)}$ is an average of the hourly equivalent sound levels during the nighttime hours only (between 10:00 pm and 7:00 am) within a 24-hour measurement period. The minimum represents the quietest night measured within the 7 day measurement period and is a conservative noise descriptor to which the predicted turbine noise can be compared.
3. Combined sound level is the logarithmic addition of the predicted sound level plus the measured ambient sound level.
4. The predicted change (in dB) due to wind turbines is the amount by which the ambient sound environment is expected to increase with the addition of the Kawailoa Wind Farm project.
5. The response category is based on the information provided in Table 6.

The largest increase is expected to be 3 dB at Waimea Valley (C8). This increase is well below the 6 dB threshold and is likely to generate little to no noise complaints. Furthermore, the residential areas surrounding are expected to experience a cumulative increase of less than 1 dB. Therefore, a negative response to wind turbine noise from the communities surrounding the project site due is not expected.

The same cumulative threshold concept can be applied to the noise contour map, where homes outside of the 40 dBA sound contour will experience an increase in sound level that is less than the 6 dB threshold. In other words, homes located outside of this noise contour line are not expected to have an adverse response to the wind turbines. This estimate is a conservative approach that is based on the quietest area surrounding the project site, which was measured to be 35 dBA. The reason this approach is conservative is because other areas experience higher ambient sound levels that would more effectively mask wind turbine sounds. Even taking this conservative approach, there are no residences located within the 40 dBA sound contour line. Please refer to the blue contour line shown in Figures 18 and 19.

7.0 POTENTIAL SOUND IMPACTS

A sound impact may occur if the sound levels generated by the project exceed applicable standards and regulations. However, the sound level alone cannot determine if a sound impact occurs. The "sound receiver" or typical listener must also be considered, along with the land use, to determine the compatibility of the sound and sound receiver. Even if the sound level complies with all standards and regulations, the sound generated by the project may still be audible at the sound receiver. However, most regulations regarding sound levels are written with the intent to limit excessive sound levels for which the general public may be adversely affected.

7.1 Construction Noise

The areas adjacent to the proposed Kawailoa Wind farm are primarily zoned for agricultural and preservation uses. The Hawaii Community Noise Control Rules state that the primary land use designation shall be used to determine the applicable zoning district class. Maximum permissible noise levels are specified by the State for daytime and nighttime hours, but ambient noise levels are also taken into account. Construction noise levels are expected to exceed the daytime limits and a permit must be obtained from the State DOH to allow the operation of construction equipment.

The Kawailoa Wind Farm project boundaries are not easily accessible due to the terrain in the area. Furthermore, much of the project area is not considered noise sensitive and does not represent typical listener locations. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 9. The mitigation measures discussed in Section 7.1 may not be necessary due to the remote locations of the wind turbines.

7.2 Compliance with State of Hawaii Community Noise Control Rule

7.2.1 Preservation Zone

Sound from the wind turbines must meet the nighttime HDOH maximum permissible noise limit for zoning district Class A at the northern, eastern, and southern boundaries where the project site is adjacent to preservation land. The results of the sound propagation model show that project noise will not comply with the 45 dBA nighttime noise limit at this adjacent land zoned for preservation. Although the property line locations are not easily accessible or commonly occupied locations, the Hawaii Department of Health should be contacted to determine if a noise variance is needed for this adjacent land.

7.2.2 Agriculture Zone

Sound from the wind turbines must meet the nighttime HDOH maximum permissible noise limit for zoning district Class C at the western boundary where the project site is adjacent to land zoned as agriculture. The results of the sound propagation model show that project noise will comply with the 70 dBA nighttime noise limit.

7.2.3 Residential/Commercial Zones

The results of the sound propagation model show that project noise will not exceed the 45 dBA nighttime noise limit at the residences closest to the project site. In addition, project noise will not exceed the 55 dBA nighttime noise limit at commercial properties closest to the project site. Since the project noise complies with the HDOH Community Noise Rule, a noise impact is not expected at the nearby residences and businesses.

Furthermore, most residential communities along the North Shore are located at a sufficient distance from the Kawailoa Wind Farm project site that wind turbine sounds are predicted to be lower than the existing ambient noise environment. Wind turbine noise will not be audible at these residences. Even at the closest noise receptors (i.e., Waimea Valley), sounds from the turbines are expected to increase the ambient noise environment by less than 3 dB, which is not considered a significant increase. During the daytime hours, wind turbine sound at Waimea Valley will be fully masked by environmental noises such as birds and wind blowing through the landscape. During periods of stable atmospheric conditions, sounds from the wind turbines may just barely be perceptible at night.

7.3 Compliance with EPA Noise Guidelines

The EPA has an existing design goal of $L_{dn} \leq 65$ dBA and a future design goal $L_{dn} \leq 55$ dBA for exterior noise levels. It is important to note that the EPA noise guidelines are design goals and not enforceable regulations. However, these guidelines and design goals are useful tools for assessing the noise environment.

The results from the long-term ambient noise measurements conducted in the community surrounding the project site show calculated day-night noise levels, L_{dn}, that range from 42 to 64 dBA. After completion of the project, ambient noise levels are not expected to increase when the wind turbines are in operation.

8.0 MITIGATION OF NOISE IMPACTS

8.1 Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State's maximum permissible property line noise levels [Reference 1], a permit must be obtained from the HDOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit sound levels in excess of the "maximum permissible" levels.

In order for the HDOH to issue a construction noise permit, the Contractor must submit a noise permit application to the HDOH, which describes the construction activities for the project. Prior to issuing the noise permit, the HDOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The HDOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engines, using properly tuned and balanced machines, etc. However, the HDOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, and chain saws are restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday. In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers [Reference 1].

The construction of the proposed turbines may include blasting and on-site rock crushers. Although these types of construction activities are not individually delineated in the noise permit documentation, they would fall under the restricted construction hours of 9:00 a.m. to 5:30 p.m., Monday through Friday.

The HDOH noise permit does not limit the sound level generated at the construction site, but rather the times at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

8.2 Wind Turbine Noise at Project Boundaries

The predicted wind turbine sound levels will not comply with the HDOH maximum permissible nighttime noise limit at the project site boundaries adjacent to preservation land. Because there are no inhabitants in these areas, it is unlikely that there would be noise complaints near the boundaries of the project site. However, to comply with the Community Noise Rule, any requirements for a noise variance should be confirmed with the Department of Health.

8.3 Wind Turbine Noise in the Community

The predicted wind turbine sound levels complies with the HDOH maximum permissible noise limits in the communities surrounding the proposed Kawailoa Wind Farm project site. Therefore, a noise impact due to wind turbine noise is not expected and mitigation should not be required.

REFERENCES

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3. *DataKustik CadnaA software program*, Version 4.0; DataKustik GmbH, 2010.

4. International Standard ISO 9613-2:1996, *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of Calculation,* Geneva, Switzerland, 1996.

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6. Honolulu Land Information System, USGS 40 ft Contour Map, Retrieved on January 4, 2011, from ftp://gisftp.hicentral.com/layers/elevation/.

7. M. David Egan, *Architectural Acoustics*, McGraw-Hill Book Company, 1998

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11. New York State Department of Environmental Conservation (NYSDEC), *Program Policy - Assessing and Mitigating Noise Impacts,* Albany, New York, October 6, 2000

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 µPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 µPa, then SPL = 0 dB
If P = 200 µPa, then SPL = 20 dB
If P = 2000 µPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the

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[1] D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

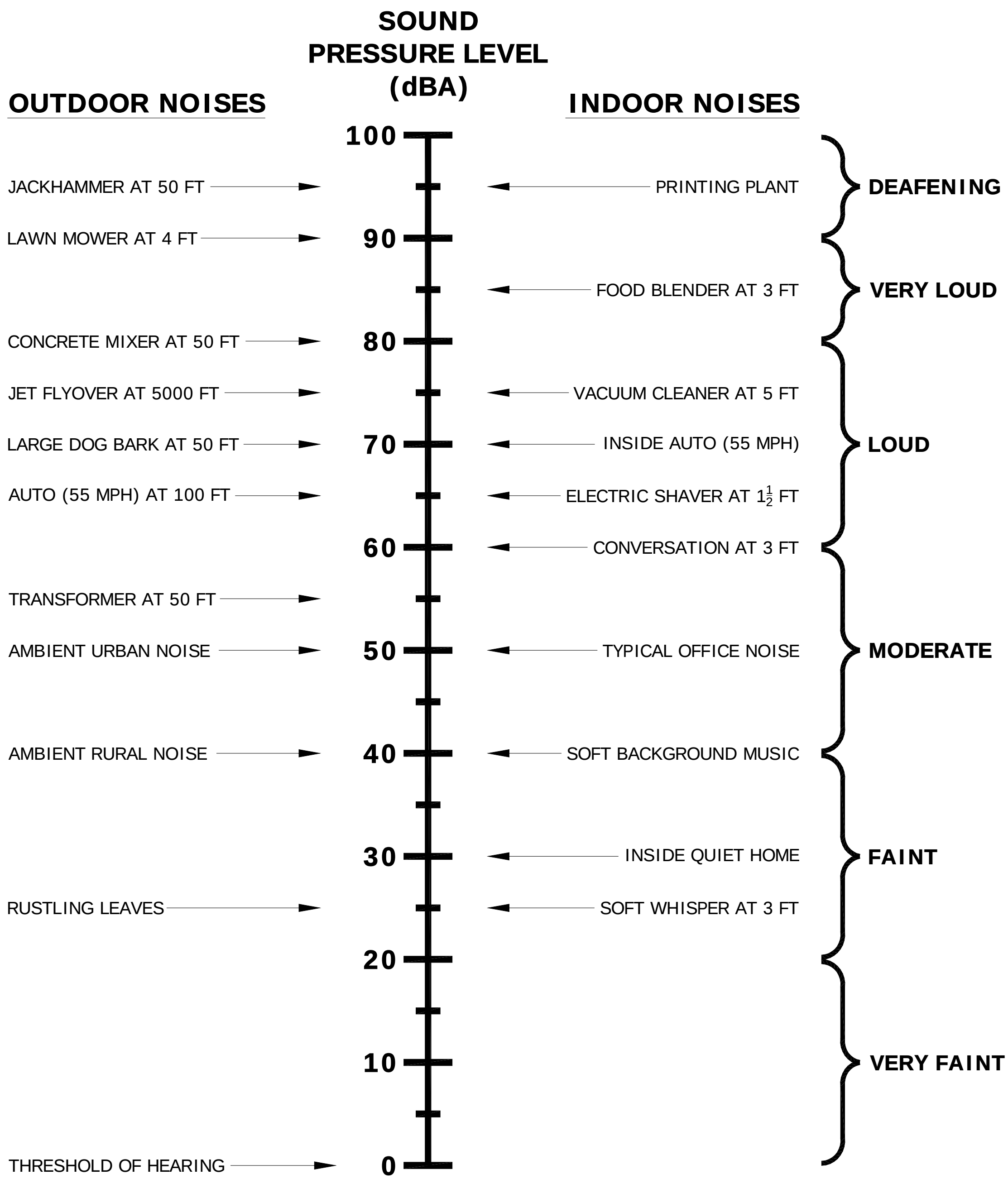


Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

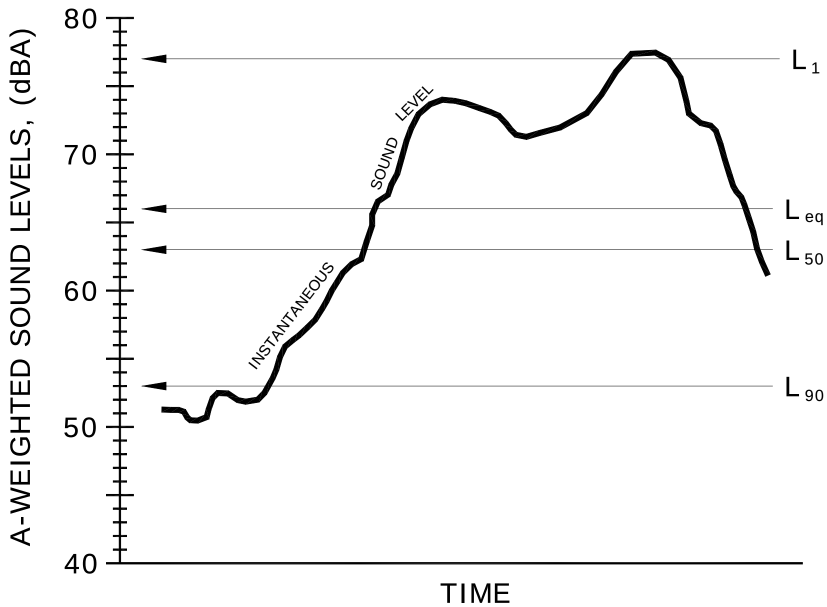


Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

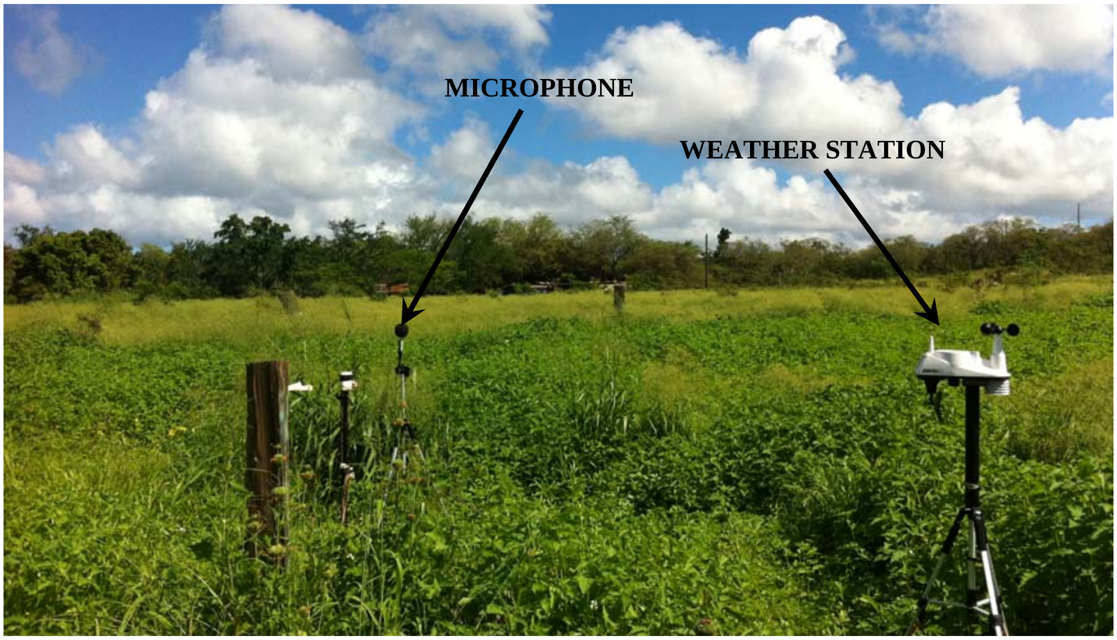
The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

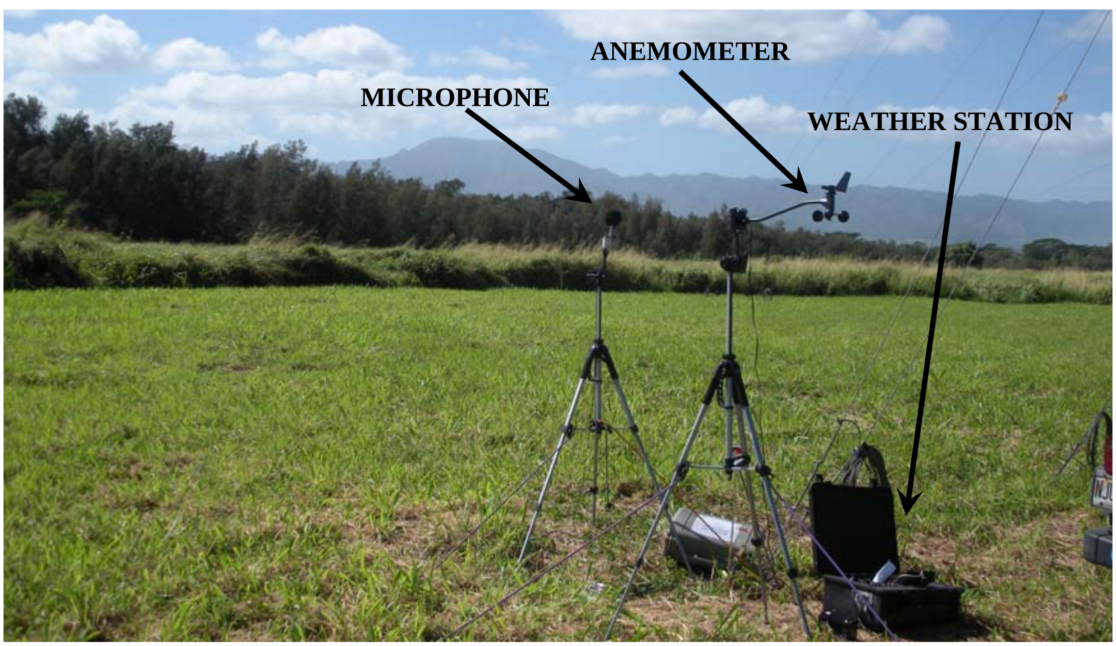
The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

APPENDIX B

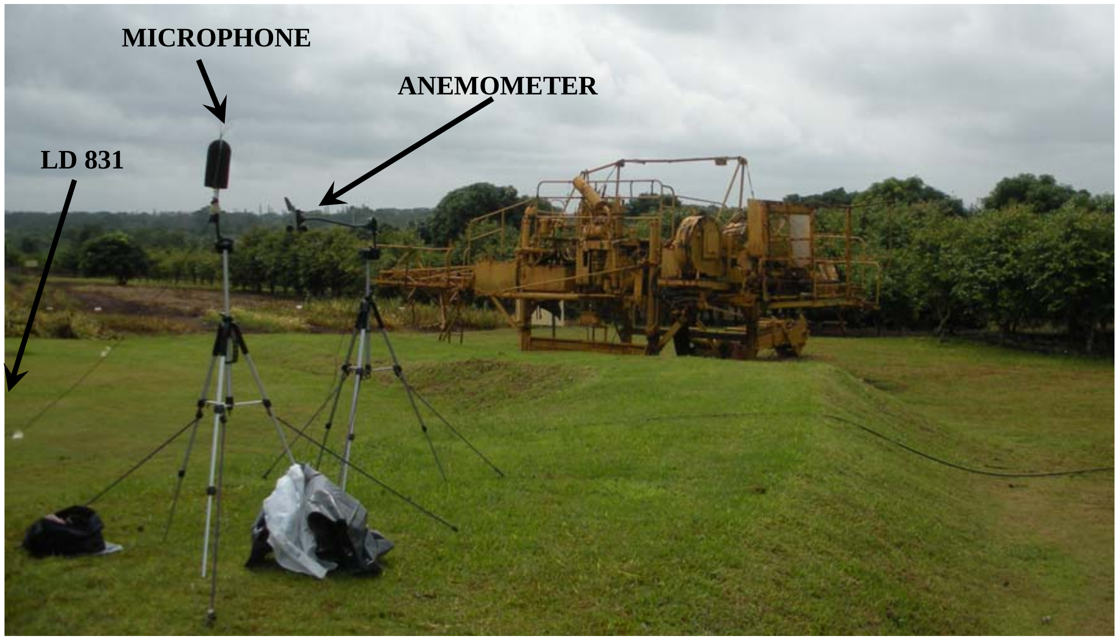
Photographs at Project Site



Equipment Setup A:
Larson Davis 820 Sound Level Meter with Davis Vantage Vue Weather Station

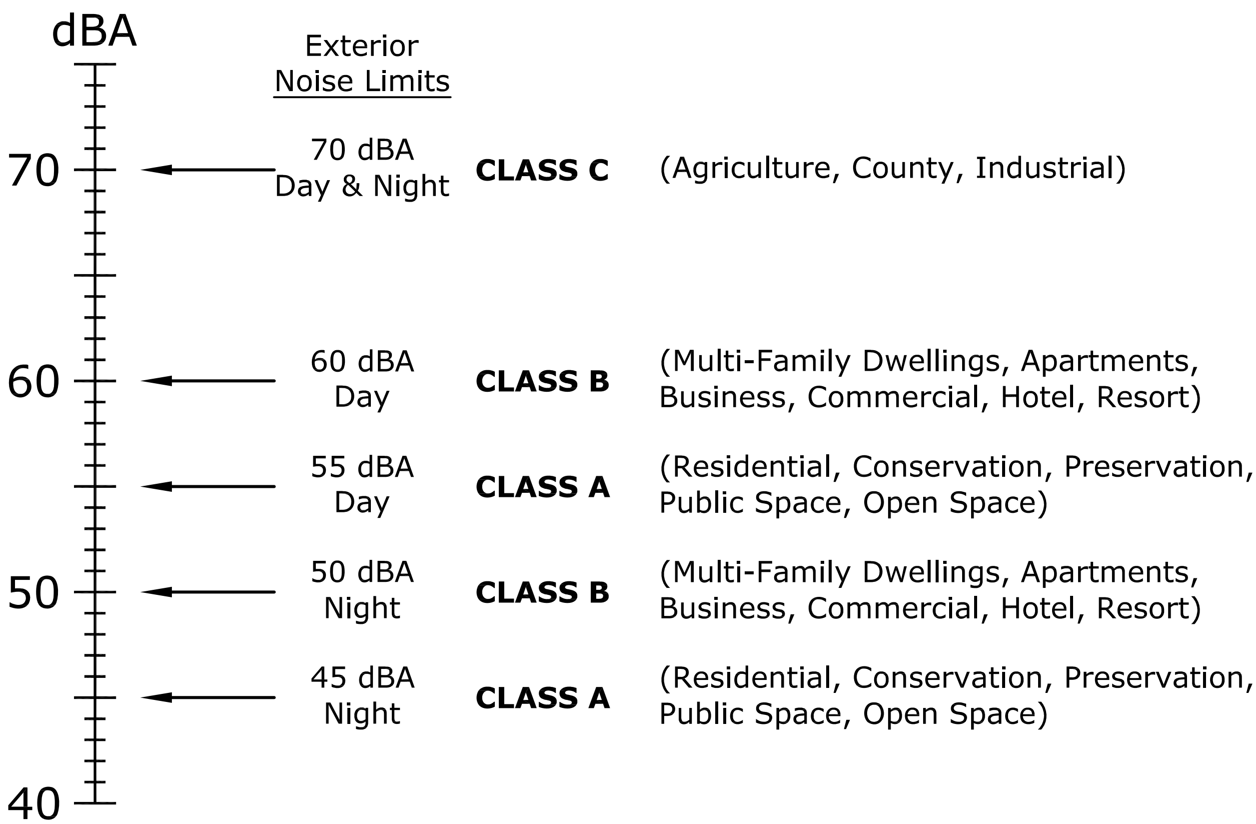


Equipment Setup B:
Larson Davis 820 Sound Level Meter with Davis WeatherLink Weather Station



Equipment Setup C:
Larson Davis 831 Sound Level Meter with Weather Module

Zoning District	**Day Hours** (7 AM to 10 PM)	**Night Hours** (10 PM to 7 AM)
CLASS A Residential, Conservation, Preservation, Public Space, Open Space	55 dBA (Exterior)	45 dBA (Exterior)
CLASS B Multi-Family Dwellings, Apartments, Business, Commercial, Hotel, Resort	60 dBA (Exterior)	50 dBA (Exterior)
CLASS C Agriculture, Country, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



D. L. ADAMS ASSOCIATES, LTD.
970 N. KALAHEO AVE, A-311
KAILUA, HAWAII 96734
808/254-3318 FAX 808/254-5295

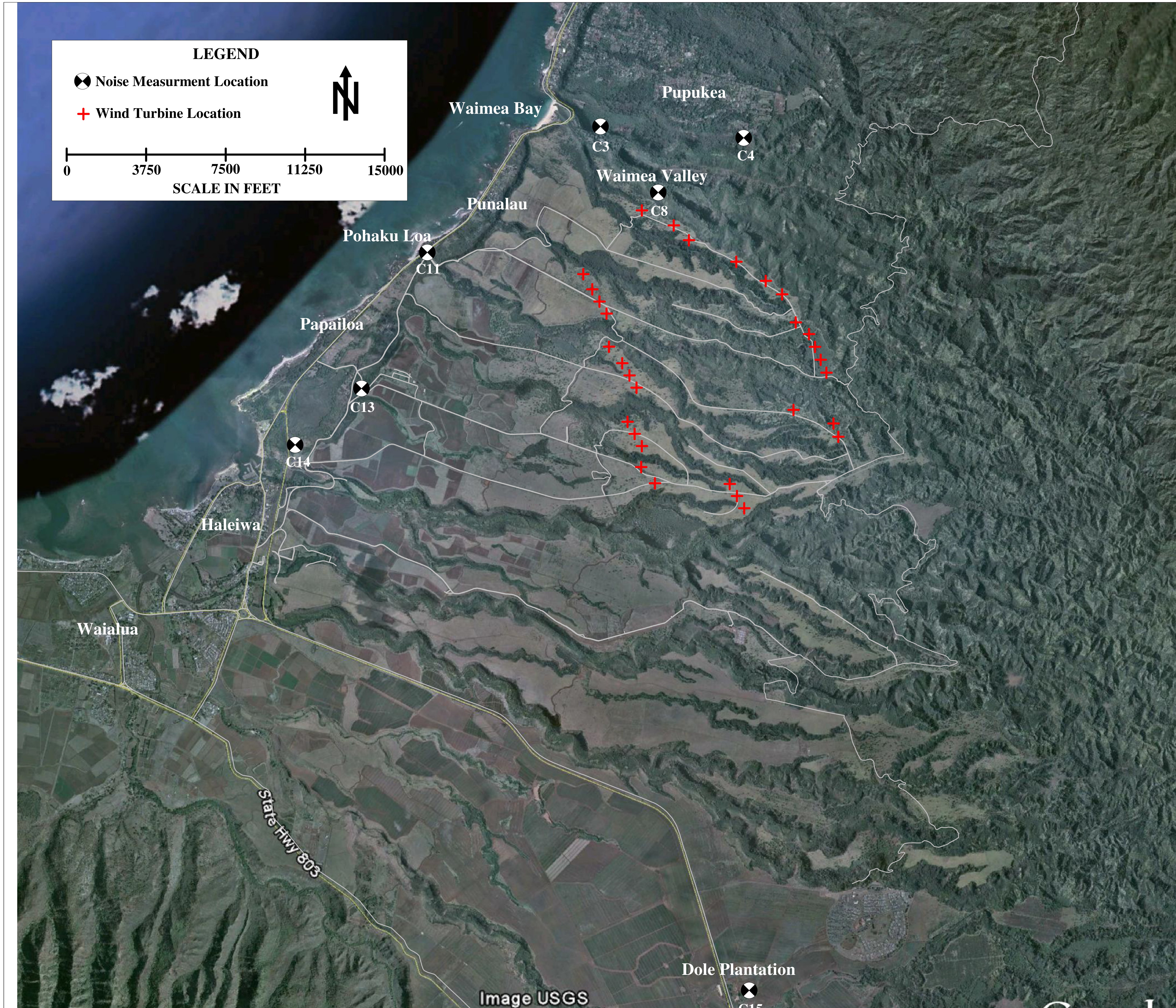
Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

Kawailoa Wind Farm Project

Not to Scale

Figure No 1

Date	Project No.	Drawn By
April 2011	09-39A	TRB



Kawailoa Ridge Wind Farm

Haleiwa, Oahu, Hawaii

February 2011

Figure 2

Community Long Term Measurement Locations

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KAILUA, HI 96734
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Kawailoa Wind Farm Project

Haleiwa, Oahu, Hawaii

April 2011

Figure 3

Project Site
Long Term Measurement Locations

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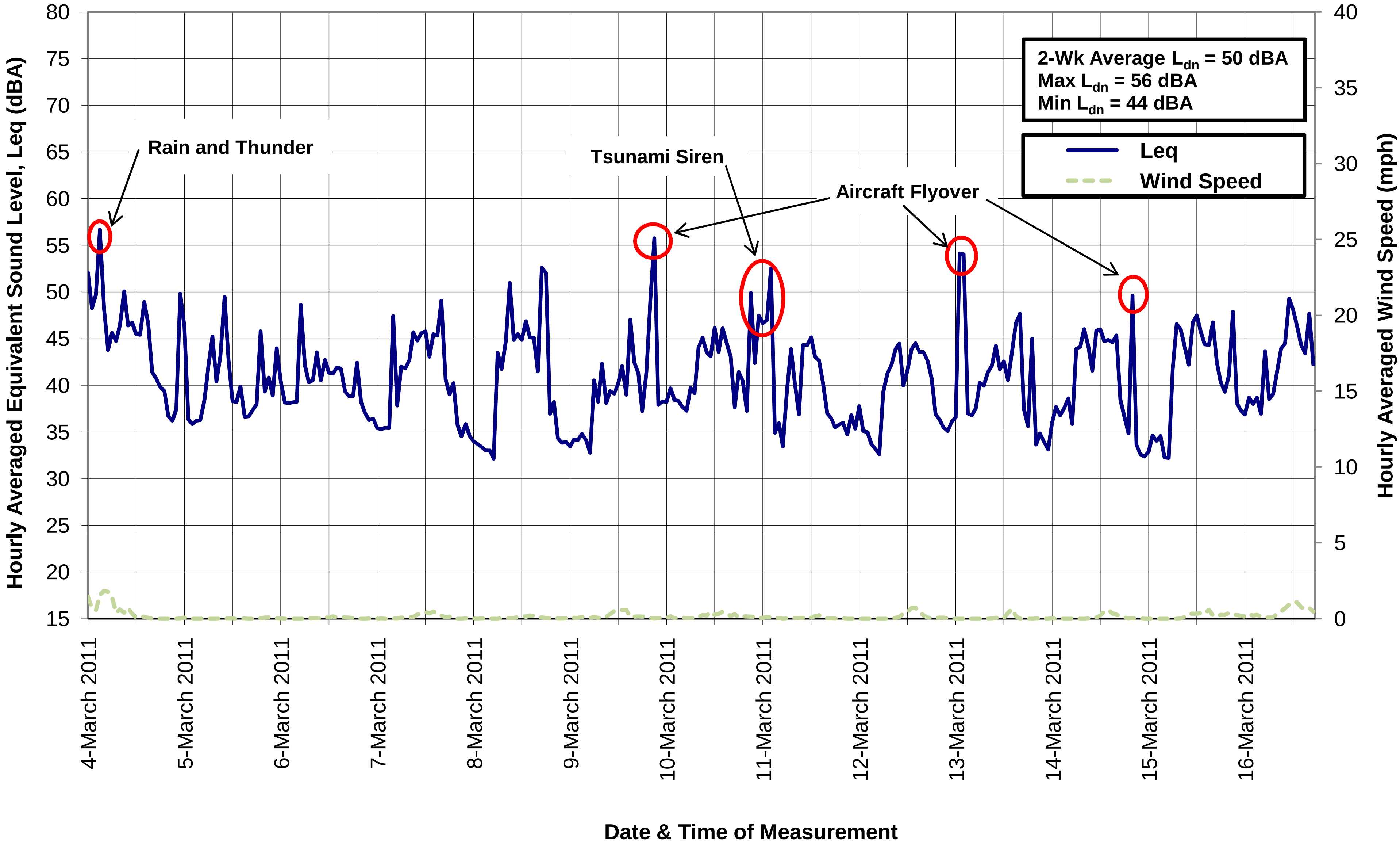

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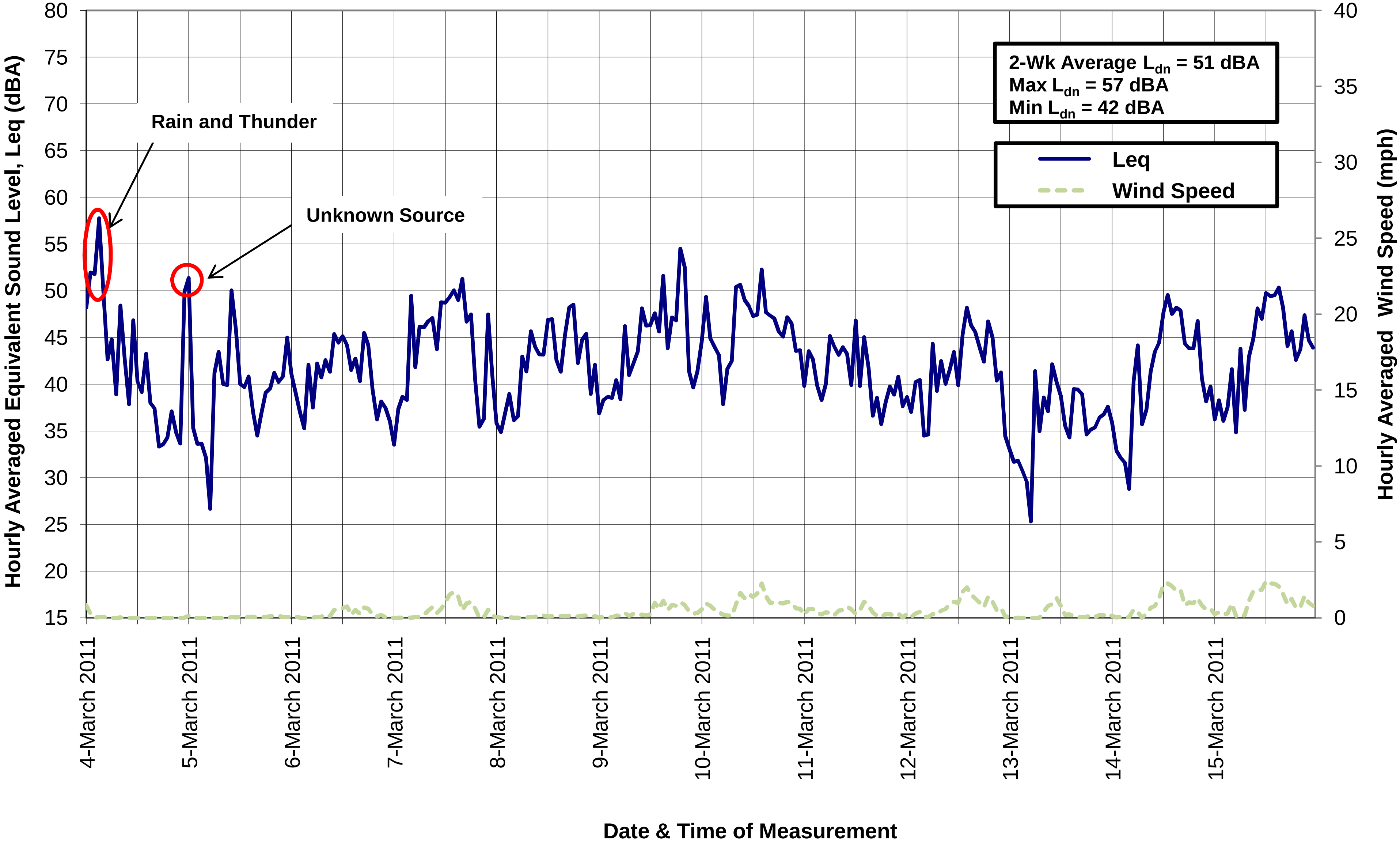
Community Noise Measurement Results - Pu'u O Mahuka Heiau (C3)

Date	Project No.	Drawn By	Figure No
March 2011	09-39A	APD	4



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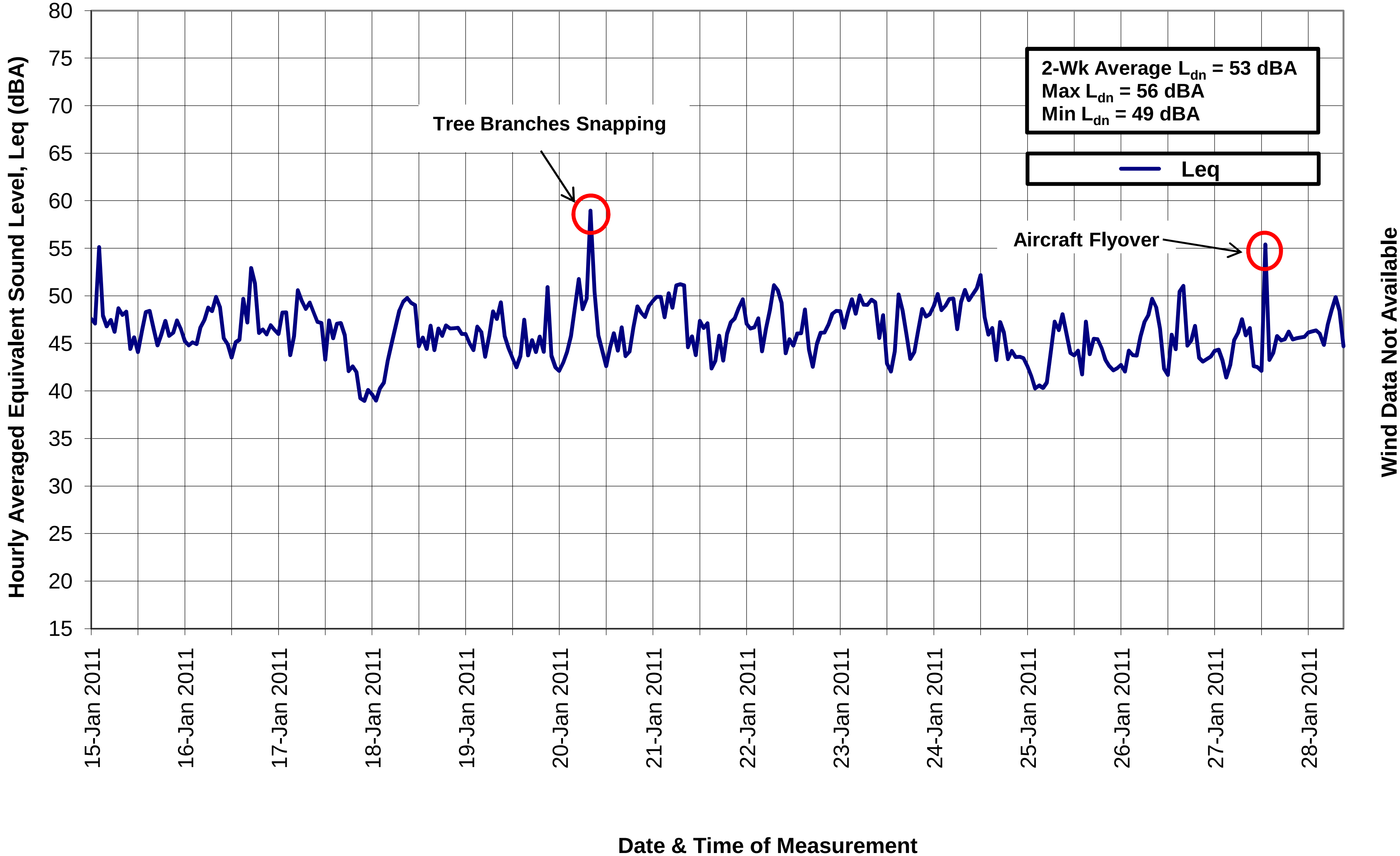
Community Noise Measurement Results - Pupukea (C4)

Date	Project No.	Drawn By	Figure No
March 2011	09-39A	APD	5



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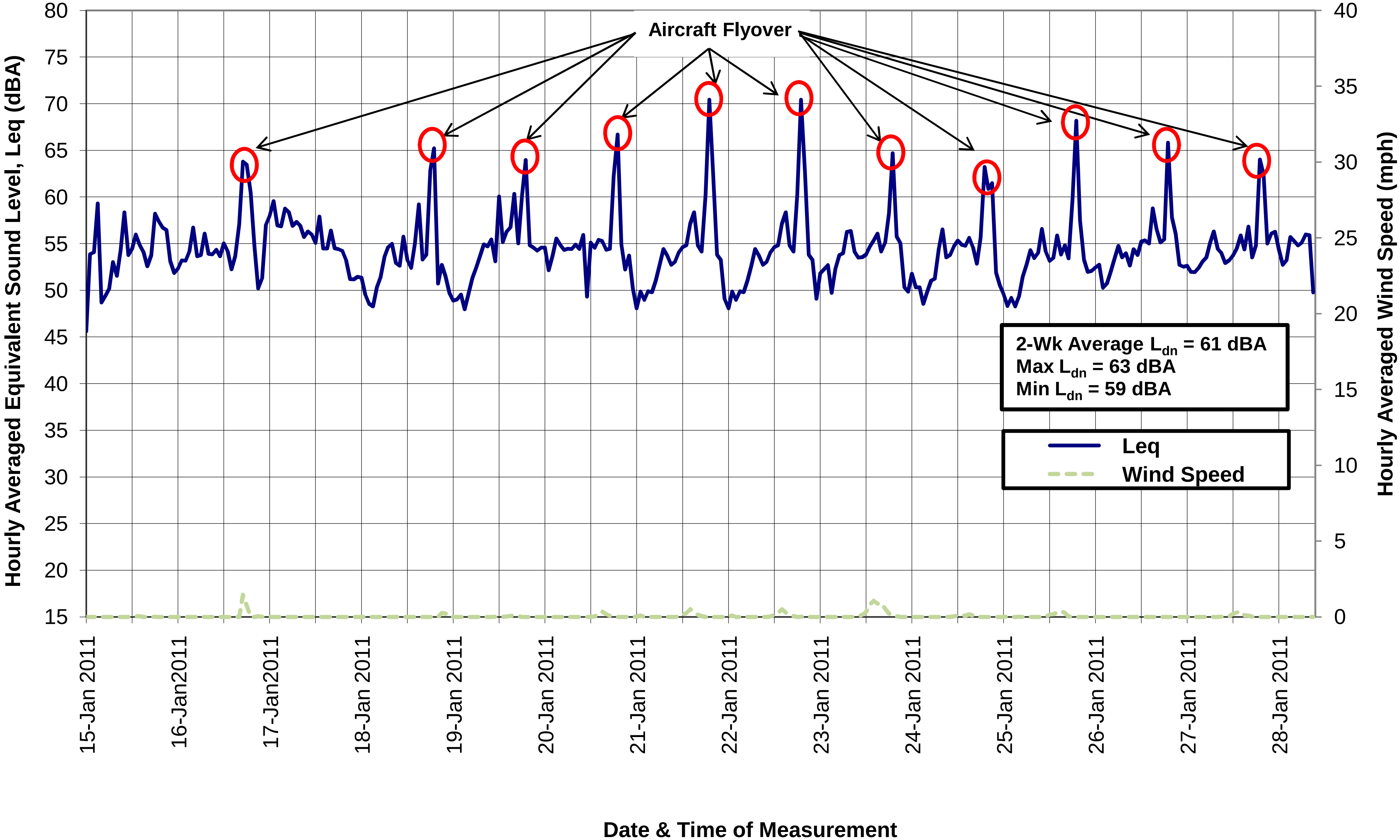
Community Noise Measurement Results - Waimea Valley (C8)

March 2011	09-39A	APD	Figure No 6
Date	Project No.	Drawn By	



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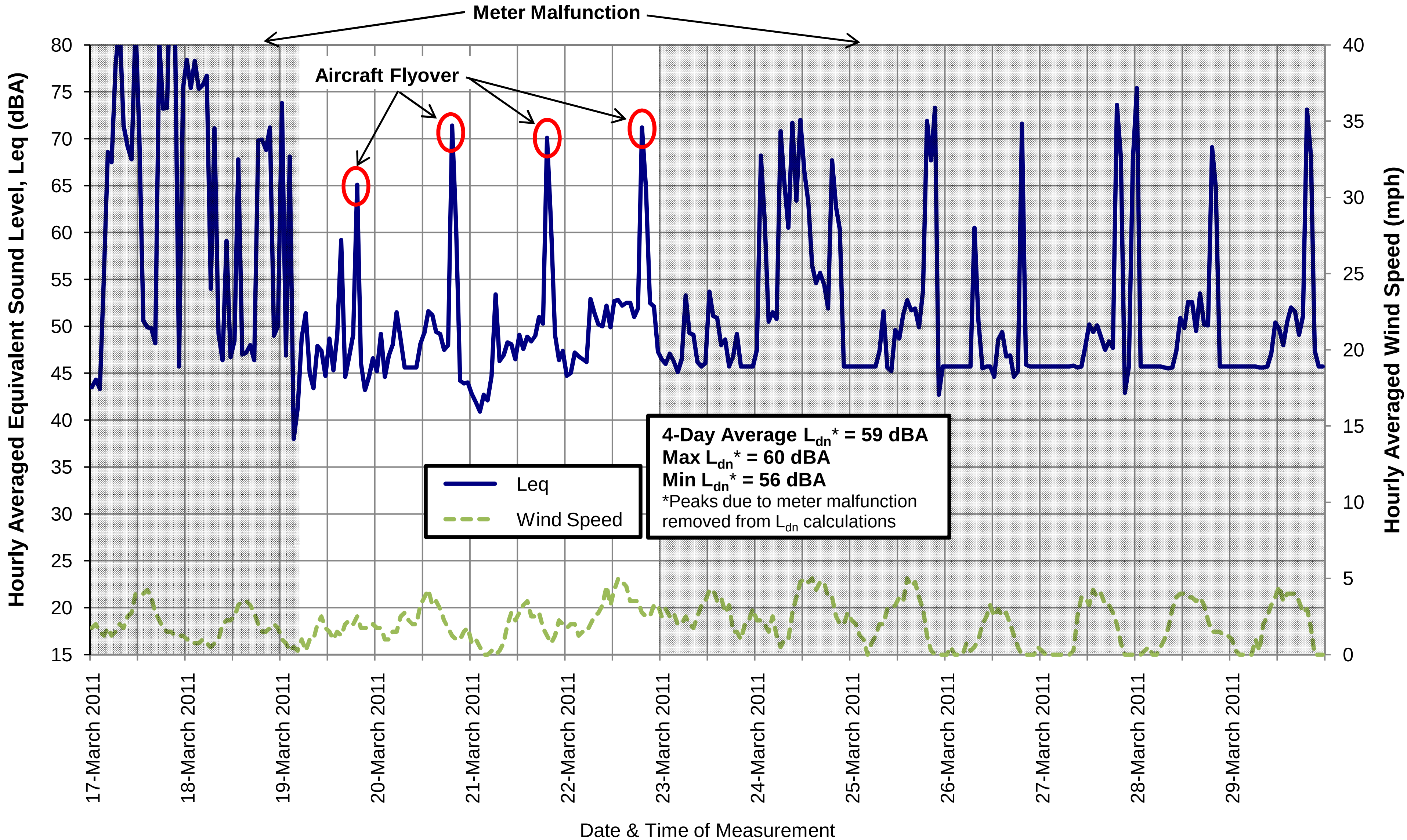
Community Noise Measurement Results - Punalau/Pohaku Loa Area (C11)

March 2011	09-39A	APD	Figure No 7
Date	Project No.	Drawn By	



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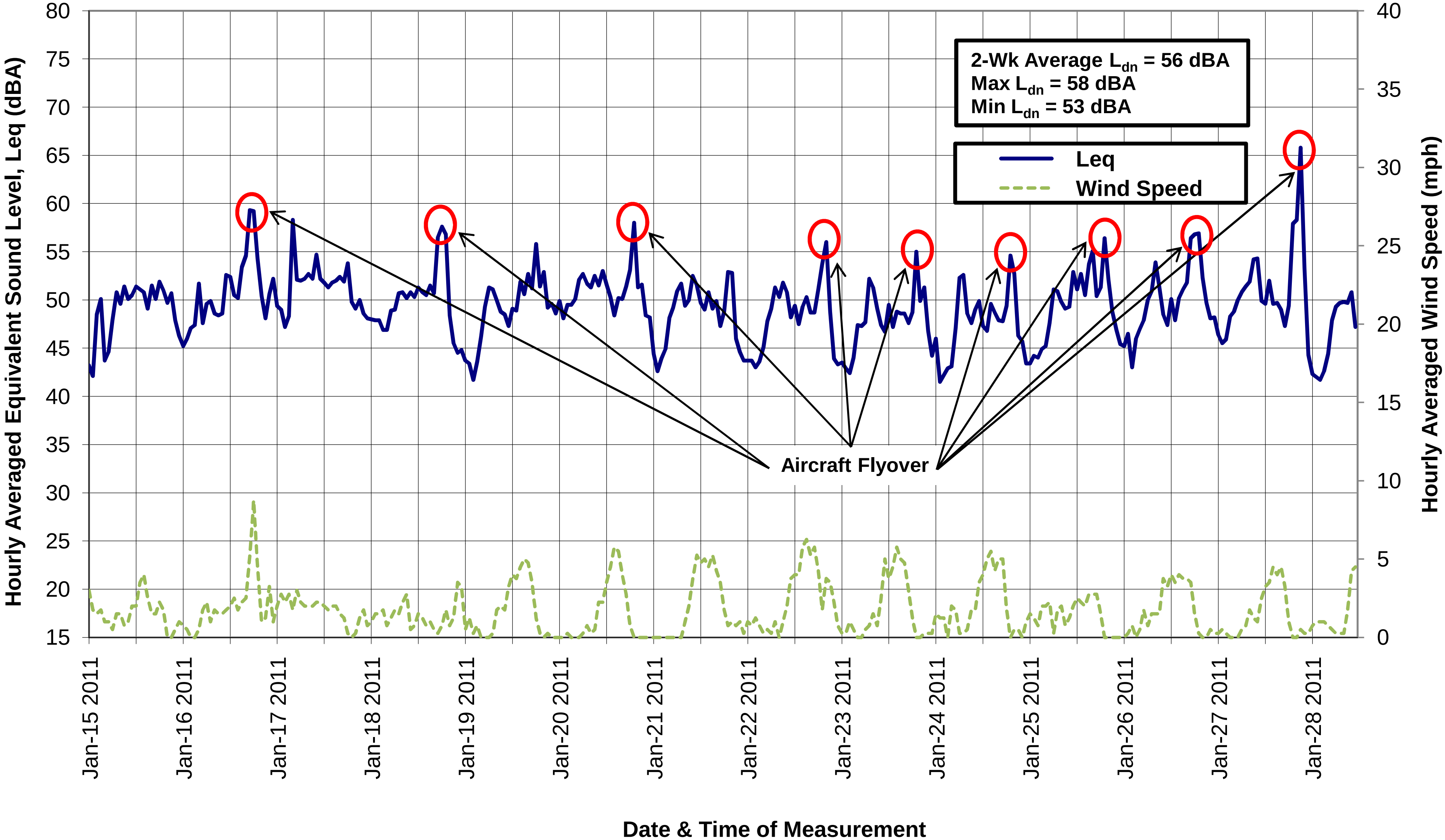
Community Noise Measurement Results - Papailoa/Kawailoa Area (C13)

March 2011	09-39A	APD	Figure No 8
Date	Project No.	Drawn By	



Community Noise Measurement Results - Haleiwa (C14)

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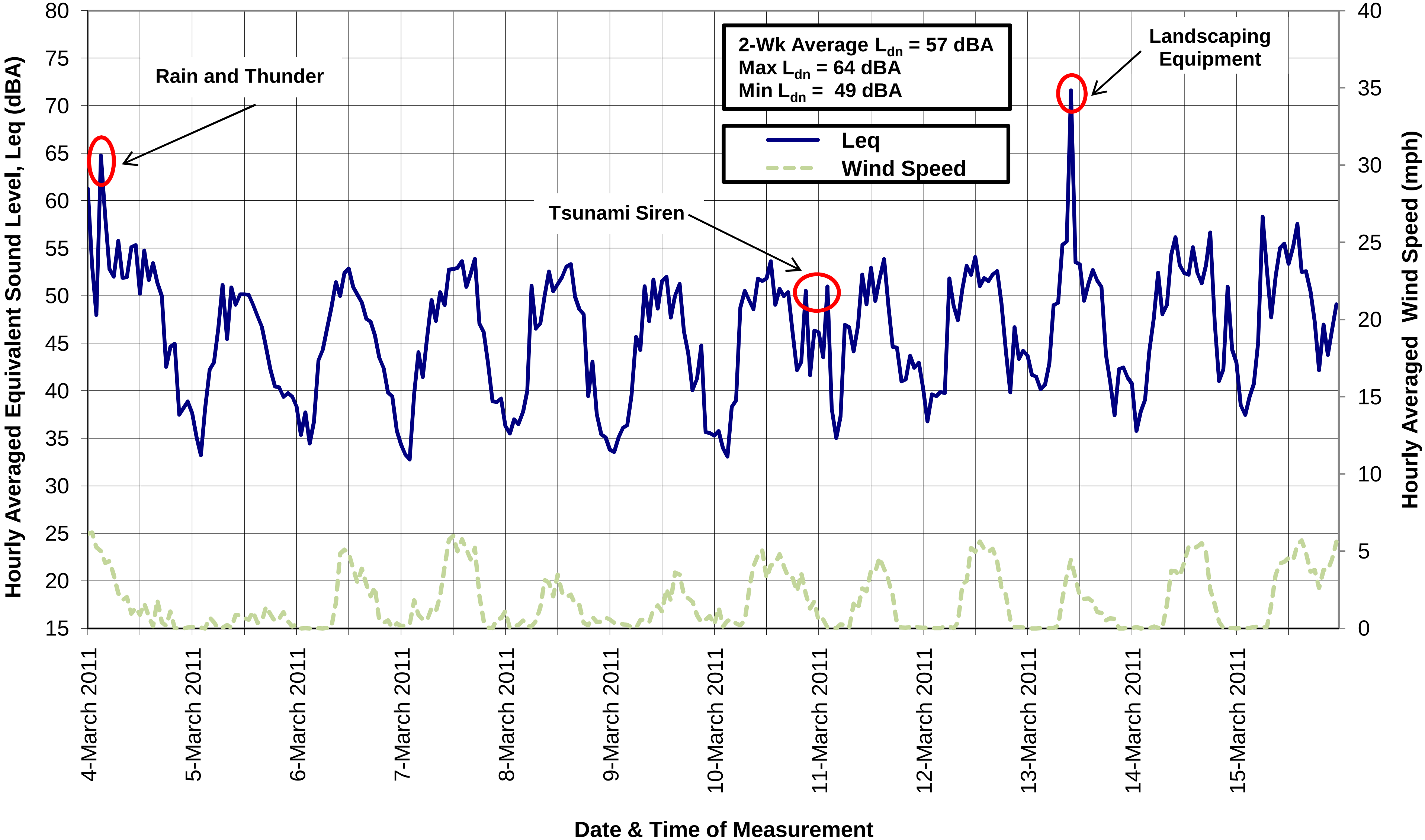
Date	Project No.	Drawn By	Figure No
March 2011	09-39A	APD	9



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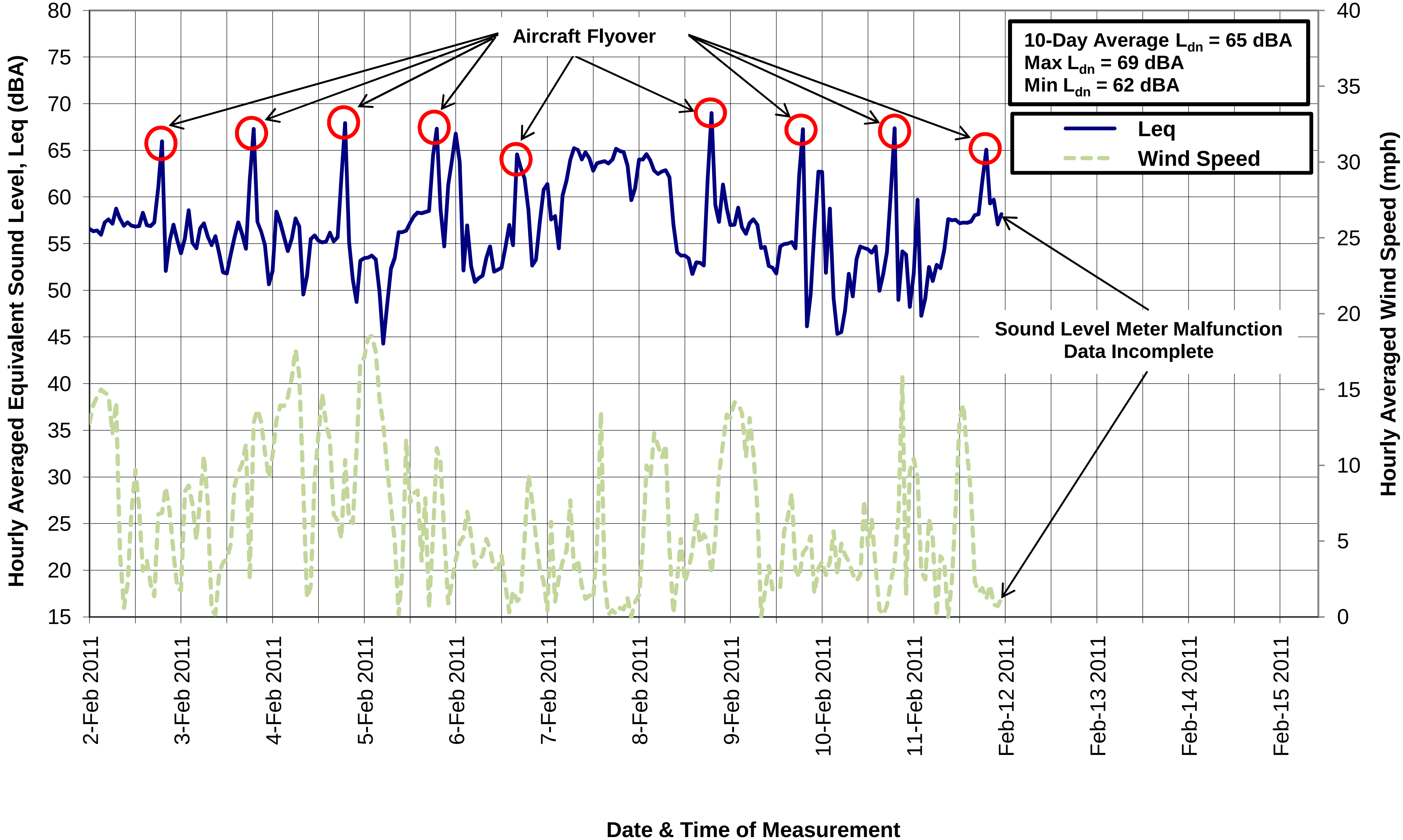
Community Noise Measurement Results - Dole Plantation (C15)

March 2011	09-39A	APD	Figure No 10
Date	Project No.	Drawn By	



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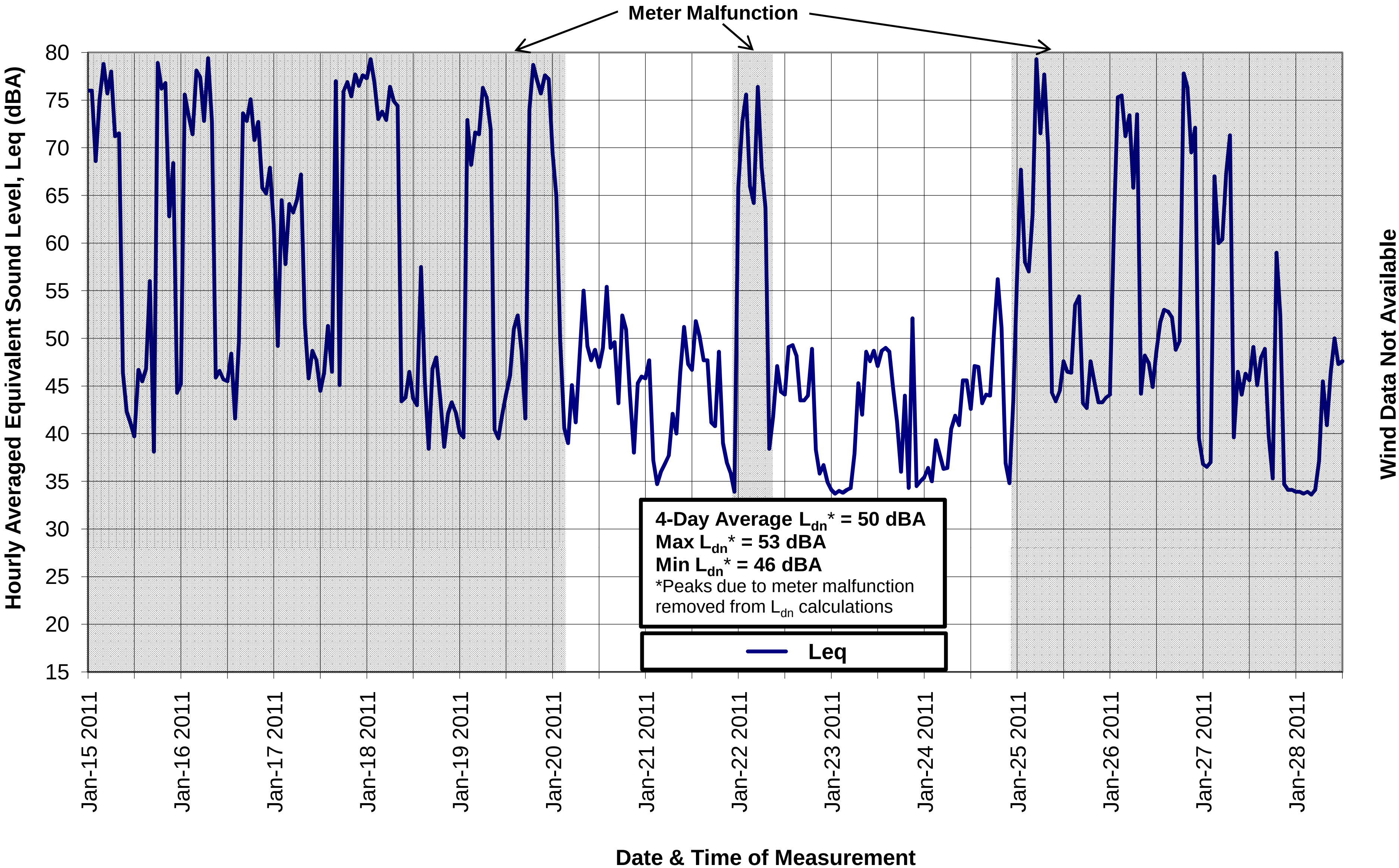
Project Site Noise Measurement Results - L1

March 2011	09-39A	APD	Figure No 11
Date	Project No.	Drawn By	



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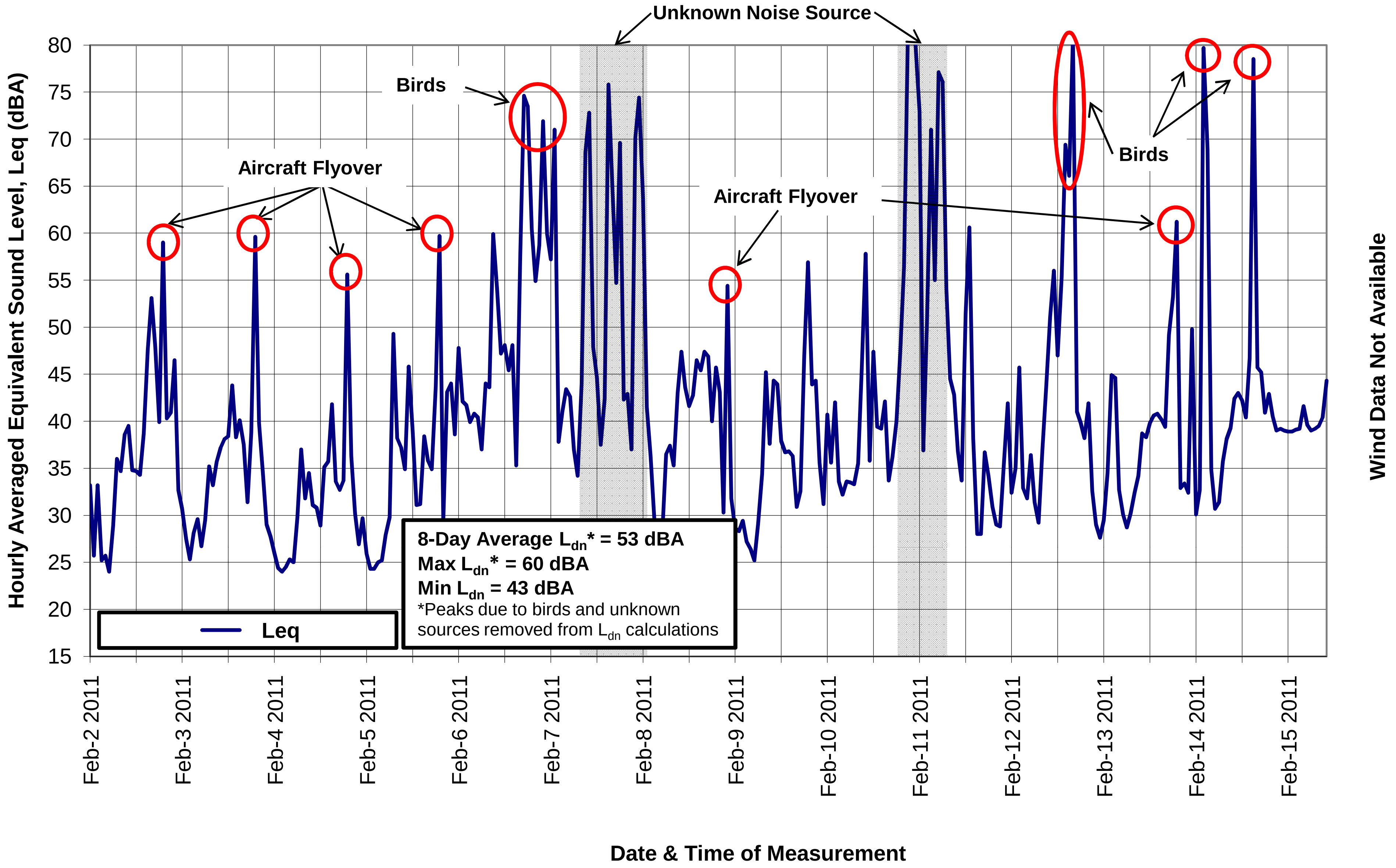
Project Site Noise Measurement Results - L2

March 2011	09-39A	APD	Figure No 12
Date	Project No.	Drawn By	



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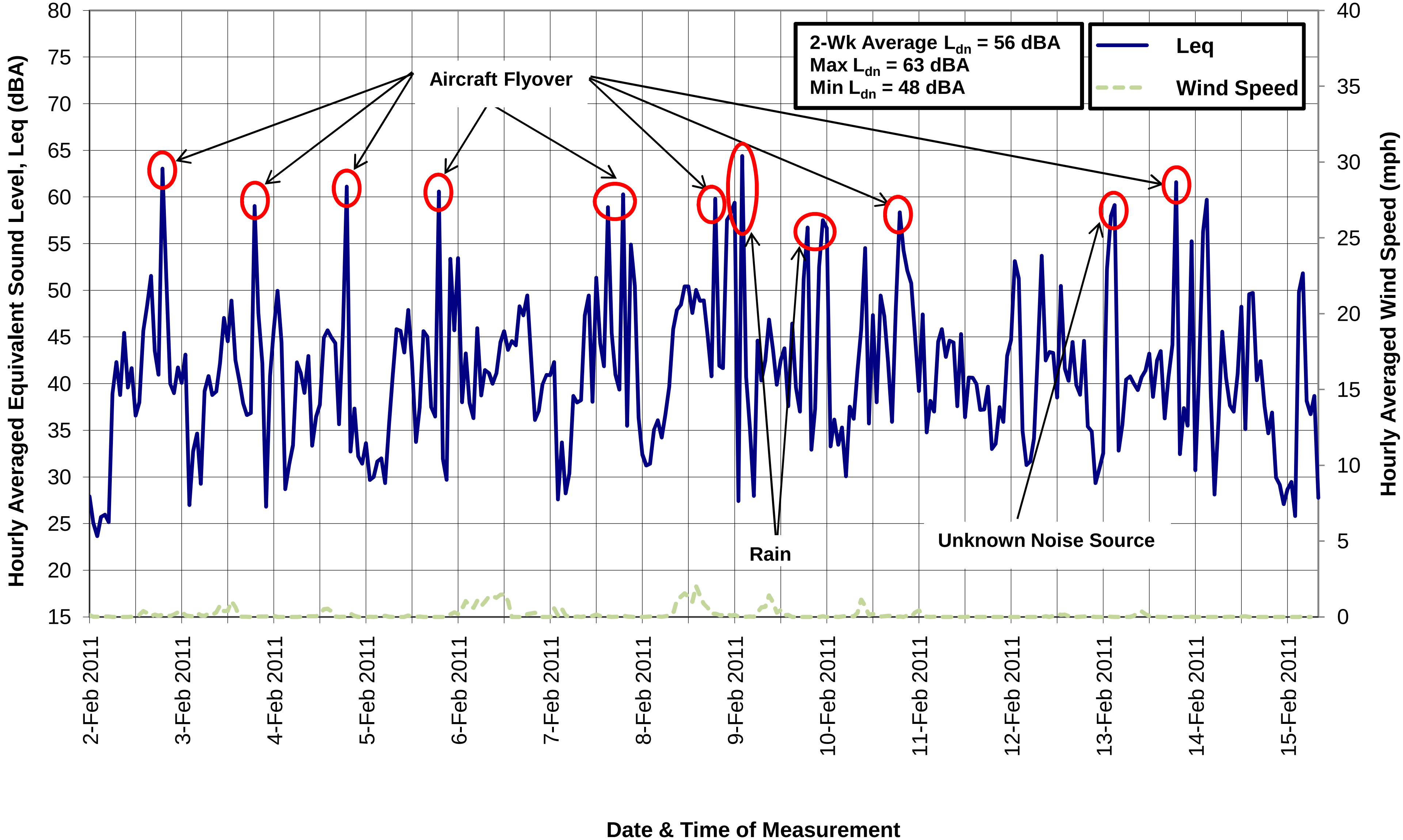
Project Site Noise Measurement Results - L3

March 2011	09-39A	APD	Figure No 13
Date	Project No.	Drawn By	



Project Site Noise Measurement Results - L4

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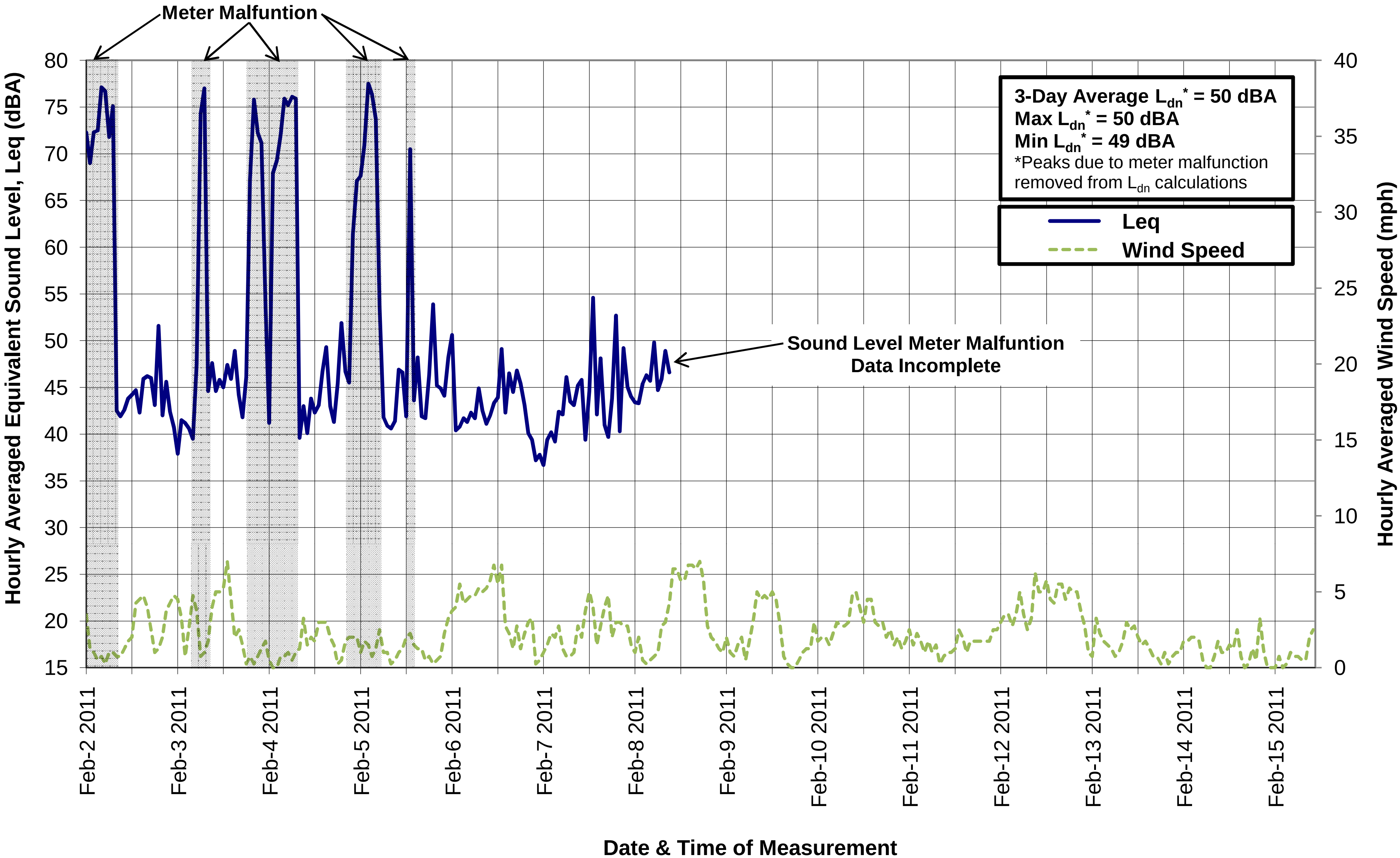
March 2011	09-39A	APD
Date	Project No.	Drawn By

Figure No

14



Project Site Noise Measurement Results - L5

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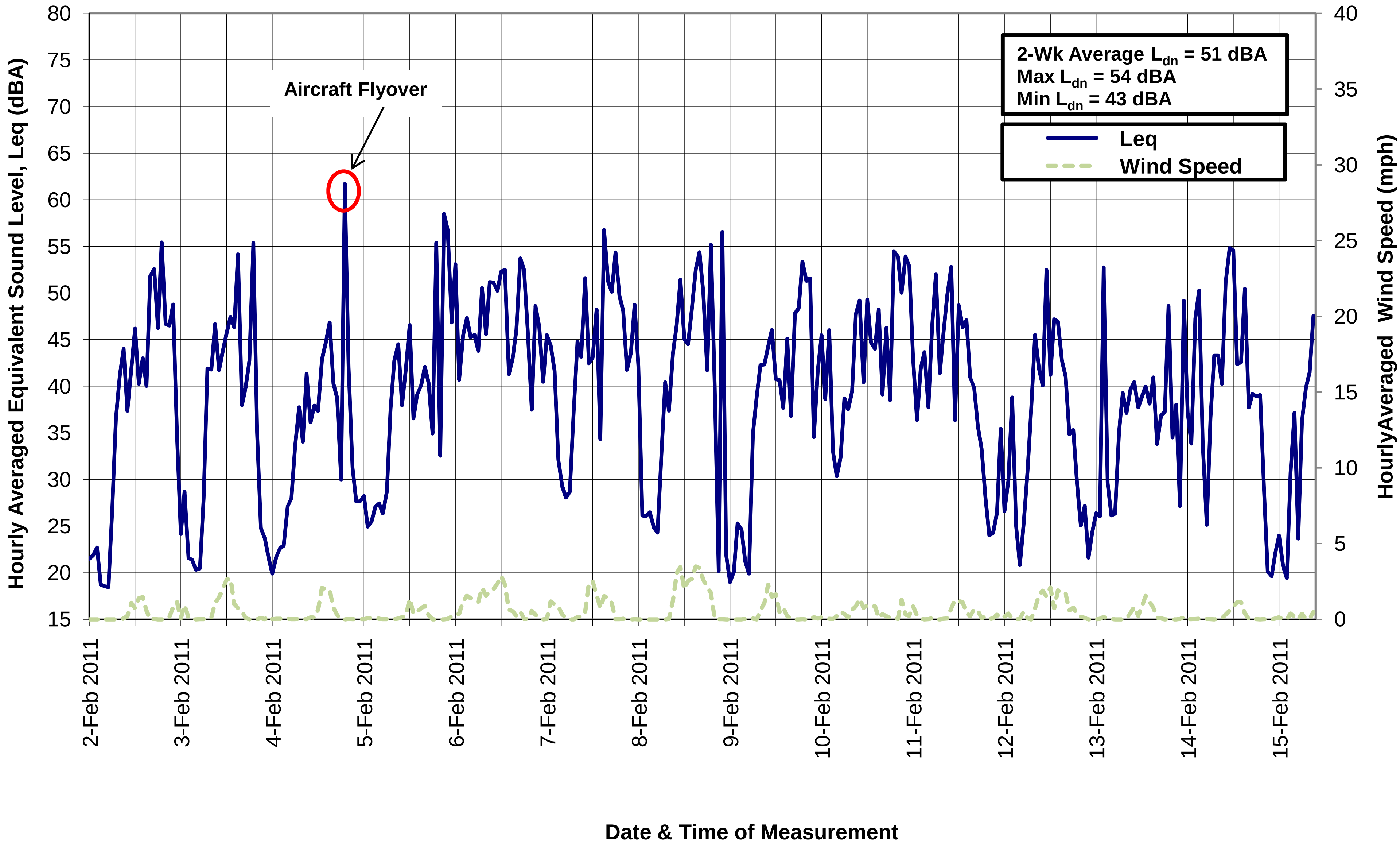
Date	Project No.	Drawn By	Figure No
March 2011	09-39A	APD	15



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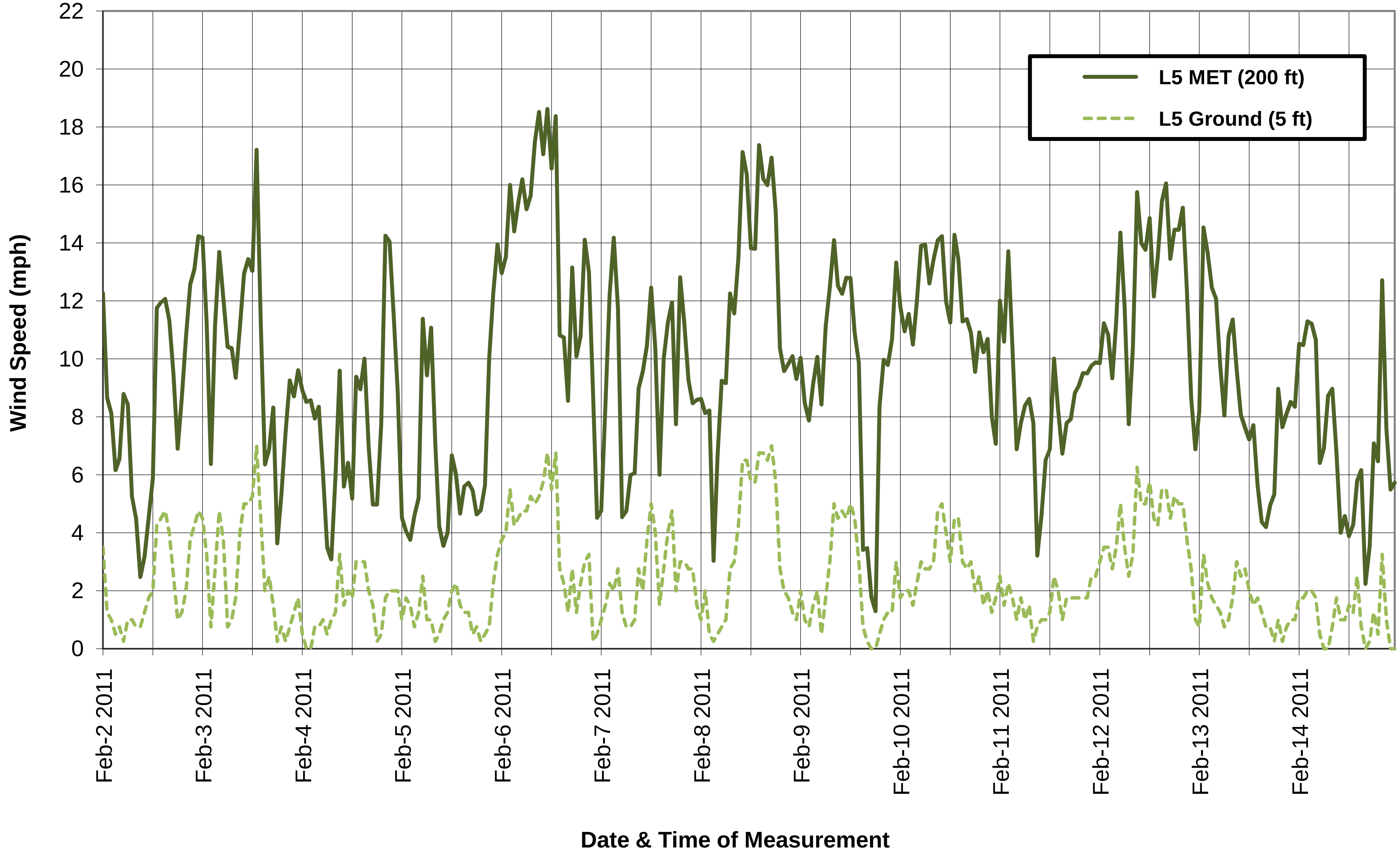
Project Site Noise Measurement Results - L6

Date	Project No.	Drawn By	Figure No
March 2011	09-39A	APD	16



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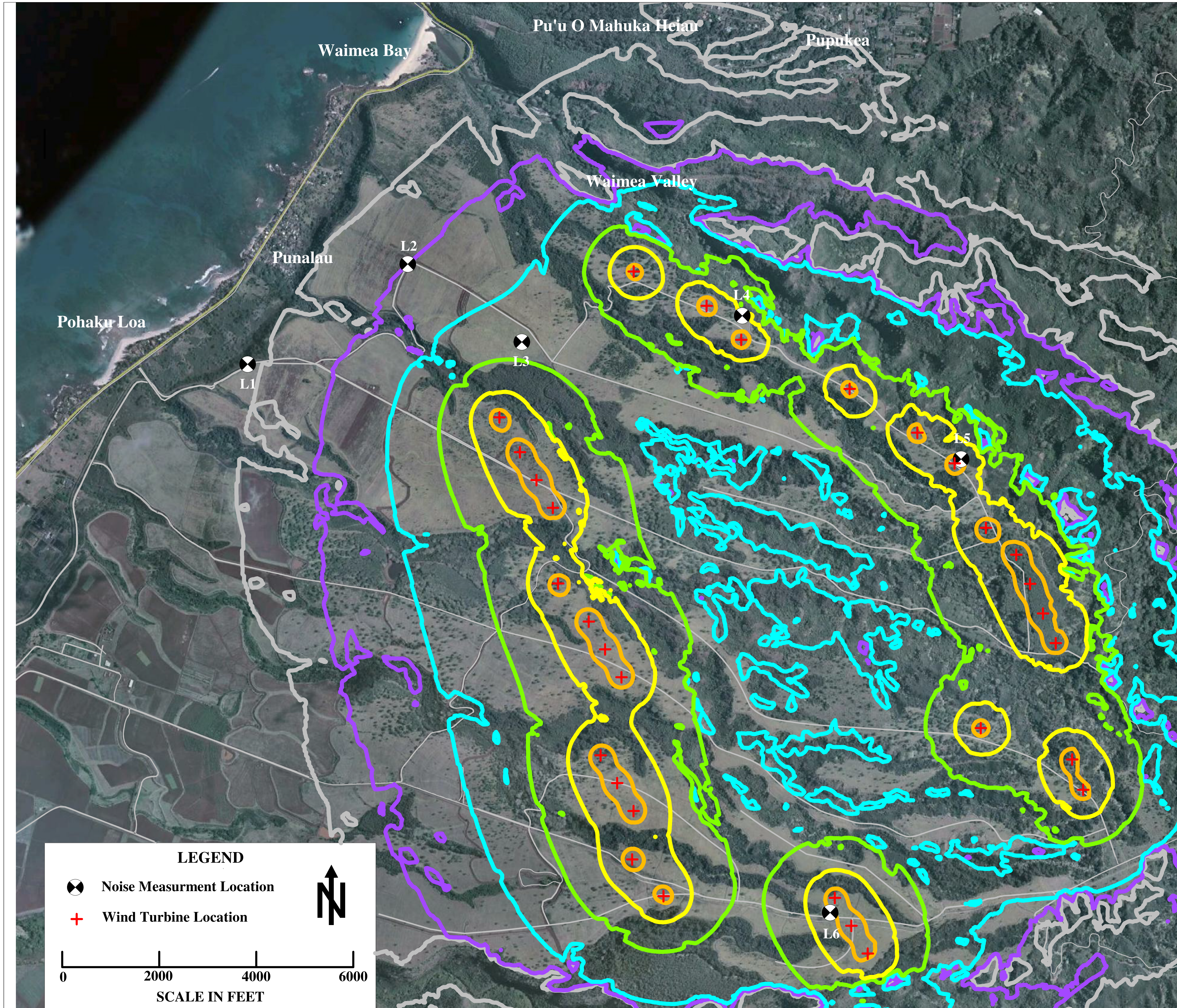
Project Site Wind Speed Results - L5

March 2011	09-39A	DFD	Figure No 17
Date	Project No.	Drawn By	



Kawailoa Wind Farm Project

Haleiwa, Oahu, Hawaii

April 2011

Figure 18

Projected Sound Level Contours due to Wind Turbine Noise in Project Vicinity

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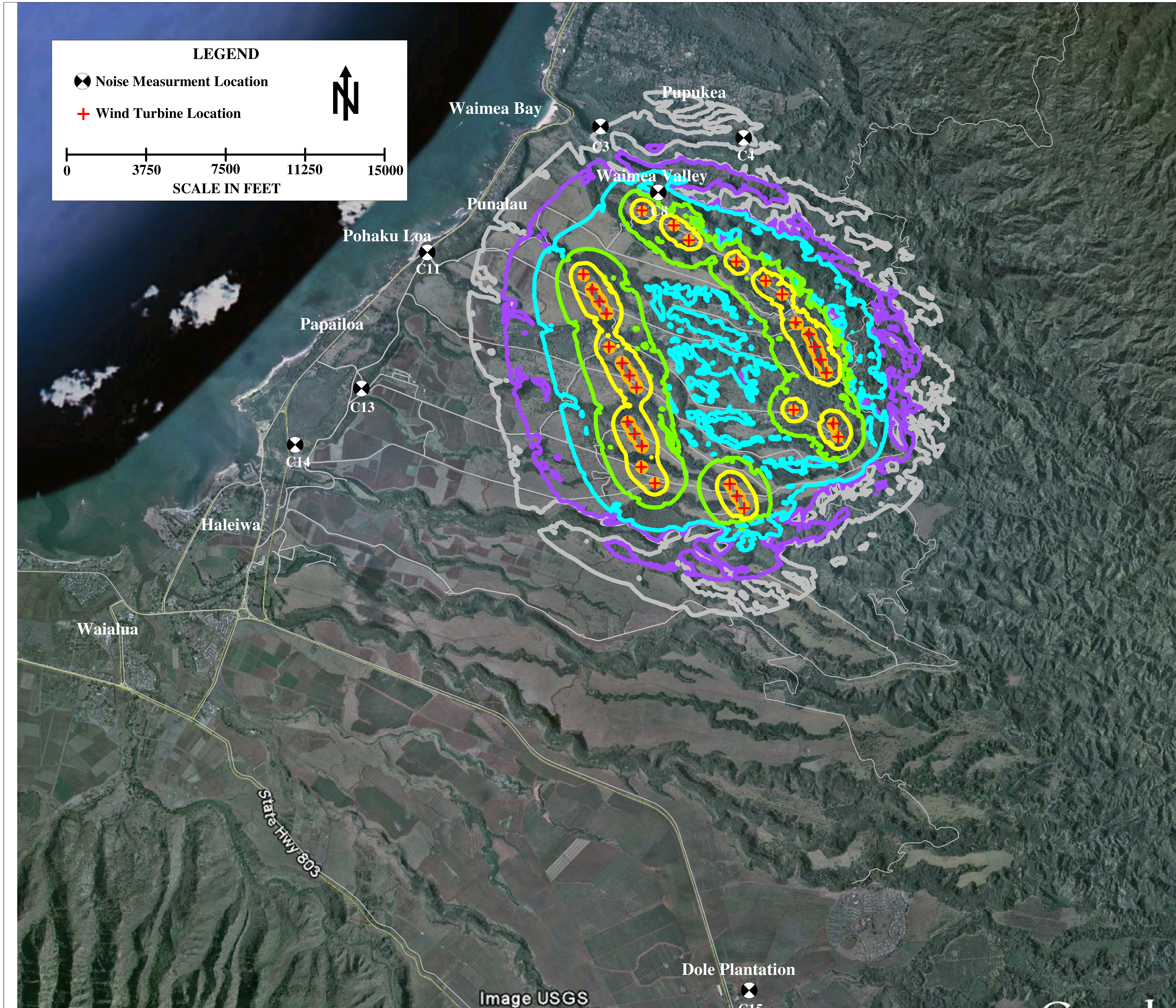

Kawailoa Wind Farm Project

Haleiwa, Oahu, Hawaii

April 2011

Figure 19

Projected Sound Level Contours due to Wind Turbine Noise in North Shore Region

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