
Biological surveys for a solar electrical generating facility in Waiawa, central O'ahu

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Introduction

Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC, is proposing to construct and operate a 36 MW solar electrical generating facility, including a substation and battery storage (the "Project") on approximately 200 ac (82 ha) of former agriculture land in Waiawa, central O'ahu (Figure 1). The site² is located east of the H-2 (Veterans Memorial Freeway) with proposed access from Ka Uka Boulevard, via Mililani Memorial Park Road to Waiawa Prison Road (Figure 2) or, alternatively during operation, off Waihona Street in the Pearl City Industrial Park. A gentle line will extend from the northwest side of the Project area to the west, connecting with the HECO grid near the Ka Uka Blvd H-2 freeway off-ramp.

Site Description

The Project lies within a 1,567-ac (634-ha) parcel (TMK: 9-6-004: 024) owned by Kamehameha Schools (KS) and formerly used to grow sugar cane. Ample evidence remains of this past agricultural use in the form of large irrigation pipes, ditches, and concrete field channels. The land is not presently in productive agricultural use and has not been since 1982. This parcel is part of a once proposed residential development that was proposed to be called Waiawa Ridge (see Gomes, 2009) and in 1988, a 1,395-ac (565-ha) area encompassing a

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² See glossary of terms used on page 18.

part of this parcel and other adjacent parcels was reclassified by the State Land Use Commission from the Agricultural District to the Urban District.



Figure 1. Waiawa Solar Power site (red) in central O'ahu.

Abandoned agricultural lands on O'ahu do not recover the native plant communities that characterized the location several centuries ago. Introduced naturalized plants inevitably come to dominate the landscape and it is rare for any of the native species that may have once grown here to recover even as a sparse population due to the completeness of the disturbance of the land, the long history of agrarian use, and the abilities of certain invasive species to out-compete all other species.



Figure 2. Waiawa Solar Power site (approximate, subject to refinement).

Located on the leeward slope of the Ko'olau mountain, most of the site is sloping land of the interfluvium between Waiawa Stream and an unnamed gulch tributary to Pānakauahi Gulch, the latter a tributary of Waiawa Stream. Steep lands associated with bordering gulches are not included in the Project site. The land slopes down from northeast to southwest, from approximately 540 ft (165 m) above sea level (asl) at the northeast end to 240 ft (73 m) asl at the southwest end of the site itself. A few shallow swales are present within the site. Unimproved roads, developed during the sugar cane era, access various parts of the property.

Annual rainfall over the elevation range of the site varies from approximately 40 in (103 cm) at the upper (*mauka*) end to 32 in (81 cm) at the low (*makai*) end (Giambelluca, et al., 2013). Although this difference seems insignificant, the vegetation does reflect, in a subtle way, the presence of such a gradient. Rainfall over the Project area is indicative of an island leeward environment of generally mesic conditions.

Methods

Biological surveys of the site were conducted on March 12 and 13, 2019 covering the Project "Site" of some 200 ac (82 ha) as outlined in red in Figure 2, above. The surveys entailed searches for natural resources of interest or concern in or near the Project area, with particular attention paid to native plants and animals, and especially those native species protected by statutory authority administered by the U.S. Fish and Wildlife Service and the State of Hawai'i, Department of Land and Natural Resources. Emphasis was on vascular plants and birds, with consideration given to mammals. The location of the Project on former cane lands at low elevation on O'ahu strongly suggests that non-vascular plants, invertebrates, fishes, amphibians, or reptiles of conservation interest or concern would not be present, although the biologists were tasked with making a final determination of this fact as part of the survey.

Prior to going into the field, the biology team members researched literature pertinent to the proposed Project area as detailed further in the Discussion Section of the report. Plant names used in the report follow *Manual of the Flowering Plants of Hawai'i* (Wagner, Herbst, & Sohmer, 1999) for native and naturalized flowering plants and *A Tropical Garden Flora* (Staples & Herbst, 2005) for crop and ornamental plants. More recent name changes for naturalized plants follow Imada (2012). Avian phylogenetic order and nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998) and the 42nd through the 58th supplements to the Check-List (American Ornithologists' Union, 2000; Banks et

al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser et al., 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). Mammal scientific names follow *Mammal Species of the World: a Taxonomic and Geographic Reference* (Wilson and Reeder, 2005).

Plant Survey

For the botanical survey, a boundary map was loaded into Trimble GNSS units (GeoXM and GeoXH) to serve as a guide to the survey area limits. The GNSS units recorded the progress tracks of the botanists, providing real time feedback on location and adequacy of coverage of the pedestrian survey. Plant species were identified as they were encountered and notations used to develop a qualitative sense of abundance. Any plants not immediately recognized during the survey were photographed and/or a representative feature (flower, fruit) collected for later identification at the laboratory.

Avian Survey

For the avian survey, 12 avian point-count stations were sited roughly equidistant from each other within the survey area. A single eight-minute avian point count was made at each of the 12 count stations. Field observations were made with the aid of Leica 8 X 42 binoculars and by listening for vocalizations. The avian counts were conducted in the early morning hours. Time not spent counting at point-count stations was used to search the area for species and habitats not detected during the point-counts. Weather conditions were generally good, with winds of between 2 and 15 kilometers per hour (kph) during count periods and a few intermittent light showers.

Mammalian Survey

The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial mammalian species detected during the survey. No survey was conducted for the only native Hawaiian land mammal, the 'ōpe'ape'a or Hawaiian hoary bat (*Lasiurus cinereus semotus*), detection of which would require night surveys deploying special detection equipment. The population of this bat on O'ahu is sparse. Currently, no technology exists to appropriately survey for this species. Conducting a survey over multiple nights cannot guarantee that bats would be detected or preclude the possibility that the Hawaiian hoary bat utilizes resources in the area on occasion. Consequently, habitat presence is assumed and recommendations presented on page 18 will minimize impacts to this species to the maximum extent practicable.



Figure 3. Interior of *koa haole* shrub-scrub vegetation.

Results

Vegetation

The vegetation on the Project site can be divided into two major types that blend along their common edges: 1) a *koa haole* (*Leucaena leucocephala*) shrub-scrub (Figure 3, above); and 2) a dense Guinea grass (*Megathyrsus maximus*) grassland (Figure 4). Both types extend broadly over the entire parcel. Guinea grass is a subordinate species in the *koa haole* shrubland (see Fig. 3), although the stature of the grass is low and coverage can be sparse in places. *Koa haole* and other trees and shrubs occur scattered within the otherwise open grassland where the stature of the grass can reach 2 m (6 ft) and the density nearly impenetrable. Scattered trees of several species form copses at the upper elevation parts of the site. Both vegetation types can be characterized as dominating the ground to an extent that few other plant species occur within them, except where that ground has been regularly disturbed, creating an opening in the coverage by the dominant plant species.



Figure 4. An infrequently used track through the Guinea grass grassland.

Thus, a third “vegetation” type is that of the ruderal environment on and along unimproved roads in the area. Most of the plant species recorded during the survey are actually limited in occurrence to these roadways; tracks not regularly traveled by vehicles are overgrown by Guinea grass and most ruderal species disappear (Figure 4, above). The listing of plant species observed (Table 1) has 27 species (46% of total) that are described (see note <1> in Table 1) as found only along the unimproved roads. Several others are similarly distributed, although not exclusively so, and occur within the *koa haole* vegetation type in small numbers. The rainfall gradient mentioned in the Introduction appears to be an influence only on the composition of the ruderal plant assemblage and the stature of the two dominant species of the other vegetation types.

Table 1. Plant species identified present on the Waiawa Solar Power site.

Species listed by family		Common name	Status	Abundance	Notes
<i>FLOWERING PLANTS</i>					
<i>DICOTYLEDONES</i>					
<i>ANACARDIACEAE</i>					
	<i>Schinus terebinthefolius</i> Raddi	Christmas berry	Nat	Oc	
<i>ASTERACEAE (COMPOSITAE)</i>					
	<i>Ageratum conyzoides</i> L.	<i>maile hohono</i>	Nat	R	<1>
	<i>Bidens alba</i> (L.) DC.	---	Nat	R	<1>
	<i>Conyza bonariensis</i> (L.) Cronq.	hairy horseweed	Nat	R	<1><2>
	<i>Emilia fosbergii</i> Nicolson	Flora's paintbrush, <i>pualele</i>	Nat	U	<1>
	<i>Pluchea carolinensis</i> (Jacq.) G. Don	sourbush	Nat	U	
<i>BORAGINACEAE</i>					
	<i>Carmona retusa</i> (Vahl) Masamune	Fukien-tea	Nat	R	
<i>BIGNONIACEAE</i>					
	<i>Spathodea campanulata</i> P. Beauv.	African tulip tree	Nat	U	
<i>CARICACEAE</i>					
	<i>Carica papaya</i> L.	papaya	Nat	R	
<i>EUPHORBIACEAE</i>					
	<i>Macaranga tanarius</i> (L.) Müll. Arg.	---	Nat	R	
<i>FABACEAE</i>					
	<i>Acacia confusa</i> Merr.	Formosan koa	Nat	Ou	
	<i>Chamaecrista nictitans</i> (L.) Moench	partridge pea	Nat	Oc	<1>
	<i>Crotalaria incana</i> L.	fuzzy rattlepod	Nat	R	
	<i>Desmanthus pernambucanus</i> (L.) Thellung	virgate mimosa	Nat	U	
	<i>Desmodium incanum</i> DC.	Spanish clover	Nat	Uc	<1>
	<i>Enterolobium cyclocarpum</i> (N. Jacq.) Grisb.	earpod tree	Nat	R	
	<i>Falcataria moluccana</i> (Miq.) Barneby & Grimes	albizia	Nat	R	<2>
	<i>Neonotonia wightii</i> (Wight & Arnott) Lackey	glycine vine	Nat	O	
	<i>Indigofera suffruticosa</i> Mill.	indigo	Nat	R	<1>
	<i>Leucaena leucocephala</i> (Lam.) deWit	<i>koa haole</i>	Nat	AA	
	<i>Pithecelobium dulce</i> (Roxb.) Benth.	<i>'opiuma</i>	Nat	O	

Table 1 (continued).

Species listed by family

	Common name	Status	Abundance	Notes
<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth	<i>kiawe</i>	Nat	R	
MALVACEAE				
<i>Sida ciliaris</i> L.	---	Nat	C	<1>
<i>Sida spinosa</i> L.	prickly sida	Nat	C	<1>
<i>Waltheria indica</i> L.	' <i>uhaloa</i>	Ind	C	
MYRTACEAE				
<i>Psidium guajava</i> L.	common guava	Nat	U	
<i>Syzigium cumini</i> L.	Java plum	Nat	Oc	
PASSIFLORACEAE				
<i>Passiflora foetida</i> L.	running pop	Nat	R	<2>
PHYTOLACCACEAE				
<i>Rivina humilis</i> L.	coral berry	Nat	U	
PITTOSPORACEAE				
<i>Pittosporum pentandrum</i> (Blanco) Merr.	---	Nat	O	
PROTEACEAE				
<i>Grevillea robusta</i> A. Cunn. ex R. Br.	silk oak	Nat	U	
RUTACEAE				
<i>Murraya paniculata</i> (L.) W. Jack	mock orange	Nat	O	
SAPINDACEAE				
<i>Dodonaea viscosa</i> Jacq.	' <i>a'ali'i</i>	Ind	U	
SAPOTACEAE				
<i>Chrysophyllum oliviforme</i> L.	satin leaf	Nat	R	
SOLANACEAE				
<i>Solanum seaforthianum</i> Andr.	---	Nat	U	
VERBENACEAE				
<i>Lantana camara</i> L.	lantana	Nat	R	
<i>Stachytarpheta australis</i> Moldenke	---	Nat	U	<1>
<i>Stachytarpheta jamaicensis</i> (L.) Vahl	Jamaica vervain	Nat	O	<1>
FLOWERING PLANTS				
MONOCOTYLEDONES				
POACEAE				
<i>Megathyrsus maximus</i> (Jacq.) B.K. Simon & W.L. Jacobs	Guinea grass	Nat	AA	

Table 1 (continued).

Legend to Table 1

STATUS = distributional status for the Hawaiian Islands:

- Ind** = indigenous; native to Hawaii, but not unique to the Hawaiian Islands.
Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
Orn = A cultivated plant; a species not thought to be naturalized (spreading on its own) in Hawai'i.

ABUNDANCE = occurrence ratings for plant species:

- = Species not present in specified area.
R - Rare seen in only one or perhaps two locations.
U - Uncommon seen at most in several locations
O - Occasional seen with some regularity
C - Common observed numerous times during the survey
A - Abundant found in large numbers; may be locally dominant.
AA - Very abundant abundant and dominant; defining vegetation type.
 Letters (u, c, or a) following qualitative rating of abundance indicate a localized abundance that is greater than the occurrence rating. For example, Ra would be a plant encountered perhaps only once or twice, but very numerous where encountered.

- NOTES: <1> - Distribution generally limited to roadway margins (ruderal).
 <2> - Plant lacking key diagnostic characteristics (flower, fruit); identification, therefore, not confirmed.

Flora

A list of all the flowering plant species observed on the Project site is given above as Table 1. No ferns or conifers were found. A total of 39 species were recorded during our survey. The observations included two (2) indigenous native species: 'uhaloa (*Waltheria indica*) and 'a'ali'i (*Dodonaea viscosa*). No early Polynesian introduced or Hawaiian Islands endemics are present. With the exception of 'uhaloa, these indigenous species are rare or uncommon in the survey area. 'Uhaloa is a common and typically ruderal plant that here is moderately common along roads in the area. The remaining 37 species (95%) are non-native species.

Avian Count Survey

A total of 408 individual birds (23 species, representing 16 separate families) were recorded during station counts (Table 2). One species detected within the site, albeit while moving between point-count locations, the Pacific Golden-Plover (*Pluvialis fulva*), is an indigenous, migratory shorebird species. The remaining 22 species recorded during the course of this survey are alien to the Hawaiian Islands. Two species—Japanese White-eye (*Zosterops japonicus*) and Red-vented Bulbul (*Pycnonotus cafer*)—accounted for 48% of all birds recorded

during station counts. The most frequently recorded species was Japanese white-eye, which accounted for 25% of the total number of birds recorded during station point-counts.

Table 2. Avian species detected at the Waiawa Solar Power site in March 2019.

Common Name	Scientific Name	ST	RA
GALLIFORMES			
Phasianinae - Pheasants & Allies			
Gray Francolin	<i>Francolinus pondicerianus</i>	A	0.92
Chicken	<i>Gallus gallus</i>	D	0.67
COLUMBIFORMES			
COLUMBIDAE - Pigeons & Doves			
Spotted Dove	<i>Streptopelia chinensis</i>	A	0.42
Zebra Dove	<i>Geopelia striata</i>	A	0.50
CHARADRIIFORMES			
CHARADRIIDAE - Lapwings & Plovers			
Charadriinae - Plovers			
Pacific Golden-Plover	<i>Pluvialis fulva</i>	IM	1-20
PELECANIFORMES			
ARDEIDAE - Herons, Bitterns & Allies			
Cattle Egret	<i>Bubulcus ibis</i>	A	0.08
PSITTACIFORMES			
PSITTACIDAE - Lories Parakeets, Macaws & Parrots			
Psittacinae - Typical Parrots			
Rose-ringed Parakeet	<i>Psittacula krameri</i>	A	2.08
Arinae - New World Parakeets, Macaws & Parrots			
Red-crowned Parrot	<i>Amazona viridigenalis</i>	A	1.67
PASSERIFORMES			
PYCNONOTIDAE - Bulbuls			
Red-vented Bulbul	<i>Pycnonotus cafer</i>	A	7.67
Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	A	2.00
CETTIIDAE - Cettia Warblers & Allies			
Japanese Bush-Warbler	<i>Cettia diphone</i>	A	2.17
ZOSTEROPIDAE - White-eyes			
Japanese White-eye	<i>Zosterops japonicus</i>	A	8.50
TIMALIIDAE - Babblers			
Chinese Hwamei	<i>Garrulax canorus</i>	A	0.08
Red-billed Leiothrix	<i>Leiothrix lutea</i>	A	0.83
MIMIDAE - Mockingbirds & Thrashers			
Northern Mockingbird	<i>Mimus polyglottos</i>	A	0.08

Table 2 (continued).

Common Name	Scientific Name	ST	RA
STURNIDAE - Starlings			
Common Myna	<i>Acridotheres tristis</i>	A	0.33
FRINGILLIDAE - Fringilline and Carduline Finches & Allies			
Carduelinae - Carduline Finches & Hawaiian Honeycreepers			
House Finch	<i>Haemorhous mexicanus</i>	A	1.25
TURDIDAE - Thrushes			
White-rumped Shama	<i>Copsychus malabaricus</i>	A	0.83
CARDINALIDAE - Cardinals Saltators & Allies			
Northern Cardinal	<i>Cardinalis cardinalis</i>	A	1.67
THRAUPIDAE - Tanagers			
Red-crested Cardinal	<i>Paroaria coronata</i>	A	0.92
ESTRILDIDAE - Estrildid Finches			
Common Waxbill	<i>Estrilda astrild</i>	A	0.75
Java Sparrow	<i>Lonchura oryzivora</i>		
Scaly-breasted Munia	<i>Lonchura punctulata</i>	A	0.25
Chestnut Munia	<i>Lonchura atricapilla</i>	A	0.33

Key to Table 2

ST Status

A Alien - Introduced to the Hawaiian Islands by humans

D Domesticated - Species which has become partially feral, but is not considered to be established in the wild on O'ahu

IM Indigenous Migrant - Native but not unique to the Hawaiian Islands, does not nest in the Islands

RA Relative Abundance - Number of birds detected divided by the number of count stations (12)

Mammalian Survey

Four terrestrial mammalian species were detected in the vicinity of the Project during the course of this survey. We saw a number of small Indian mongoose (*Herpestes auropunctatus*) within the site. We also saw three individuals of the house mouse (*Mus musculus*) and individuals, scat, tracks, trails, and other sign of pig (*Sus scrofa*) in numerous locations within the survey area. Domestic dog (*Canis familiaris*) was heard barking from locations outside of the survey area on both days that we were on the site. All four of these mammalian species are alien to the Hawaiian Islands and deleterious to native wildlife.

Discussion

Flora

The authors previously surveyed a proposed solar facility on 387 ac (157 ha) in the same general area (located approximately 0.8 mi [1500 m] to the northwest of the current Project site; AECOS, 2014). That earlier survey produced a plant species list of 62 species, a higher count than that of the present survey in an area of more or less identical vegetation, but where disturbed ground was a greater proportion of the survey area. Comparison of the two floras, however, shows nearly half of the species in each list did not appear on the other listing: that is, 36 species listed in 2014 are unique (not seen in the present survey) and 13 species are unique to our 2019 (this report) survey. While perhaps unexpected, the differences can be attributed in part to the fact that 66% of the species observed in 2014 were rare or uncommon and 62% were rare or uncommon in the 2019 list. As is the case with regard to the present survey, no plants of any particular interest or concern were report for the 2014 survey.

Unrelated to the current survey, the lead author surveyed the flora of a parcel adjacent on the east owned by the U.S. Navy (TMK: 9-6-004:001). The Navy property includes the rocky side wall of Waiawa Valley rising steeply some 200 ft (60 m) on the Navy side of the common property line. The following is excerpted from the AECOS report (2016, p. 132):

Parallel to the west of the forested valley bottom occurs a scrub forest of *koa haole* and Guinea grass... [and partially mapped along the solar farm Project site boundary]. The scrub growth, and the similar but more open growth on the steep valley margin... dominates much of the [Navy] property. This latter vegetation type—designated “low-statured koa haole scrub” by Char... —is well described in her report, and includes five of the natives reported by Char from the [Navy] property.

These five species are: *pili* grass (*Heteropogon contortus*), ‘a‘ali‘i, *pōpolo*, ‘ala ‘ala wai nui (*Peperomia leptostachya*), and ‘uhaloa (Char, 2000). Two were recorded for the present survey on the Project site. The other three—*pili*, *pōpolo*, and ‘ala‘ala wai nui—could potentially occur as rare or uncommon on the Project property. However, *P. leptostachya* is typically found on rock outcrops, a habitat not observed on the site. An unusual aspect of our present survey results is that only one grass species was recorded. A survey of the proposed solar farm site to the northwest (AECOS, 2014) listed a somewhat more typical 6 grass species, all common grasses, *pili* not included.

In conclusion, the Navy report stated (AECOS, 2016, p. 133):

No plant species listed as threatened, endangered, or proposed for listing under federal (USFWS, 2015) or state statutes (DLNR, 1997) were found or have been reported in recent decades at the Waiawa Watershed property. Native species are sparsely distributed on the valley floor; most occur on the steep western margin of the valley [adjacent to the present Project eastern property line].

None of the plant species observed at the Project site are considered important from a natural resources perspective. No plant species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs (HDLNR, 1998; USFWS, nd a) were detected during the course of our survey.

Fauna

Avian diversity and densities are in keeping with the highly disturbed habitats present on the study site and similar to those reported from a previous survey conducted on land to the northwest of the current survey site (AECOS, 2014). No vertebrate species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs (HDLNR, 2015; USFWS, nd a) were detected during the course of this survey.

Shorebirds - As noted above, the Pacific Golden-Plover is an indigenous migratory shorebird species that nests in the high Arctic during the late spring and summer months, returning to Hawai'i and the tropical Pacific to spend the fall and winter months each year. Plover usually leave Hawai'i and return to the Arctic in late April or the very early part of May and are commonly encountered in open areas throughout the Hawaiian Islands from late summer through mid-spring.

Seabirds - Although no seabirds were detected during this survey, it is possible that the endangered Hawaiian Petrel (*Puffinus sandwichis*) and the threatened Newell's Shearwater (*Puffinus newelli*) over-fly the project area between April and the middle of December each year in very small numbers. Newell's Shearwaters are not known to breed on the Island of O'ahu, though recent acoustical surveys conducted on the Island have recorded low numbers of this species calling over the higher reaches of the Island (Young, et al., 2019). These authors also recorded one Hawaiian Petrel over the Island.

The primary cause of mortality in Hawaiian Petrels and Newell's Shearwaters is thought to be predation by alien mammalian species at the nesting colonies

(USFWS, 1983; Simons and Hodges, 1998; Ainley et al., 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with man-made structures and, if not killed outright, become easy targets of opportunity for feral mammals (Hadley, 1961; Telfer, 1979; Sincock, 1981; Reed et al., 1985; Telfer et al., 1987; Cooper and Day, 1998; Podolsky et al., 1998; Ainley et al., 2001; Hue et al., 2001; Day et al., 2003).

Mammals - The findings of the mammalian survey are consistent with the location of the property and environments present on the site. It is likely that cat (*Felis catus*) and some of the other established alien Muridae found on O'ahu—roof rat (*Rattus rattus*), brown rat (*Rattus norvegicus*), and Polynesian rat (*Rattus exulans hawaiiensis*)—use various resources within the general project area on a seasonal basis. All of these introduced rodents are deleterious to native ecosystems and native faunal species within them.

Potential Impacts to Protected Species

Hawaiian hoary bat - It is possible that the Hawaiian hoary bat overflies the Project area on a seasonal basis. A potential impact that the installation and operation of a PV generating farm poses to bats is during the clearing and grubbing phase of construction when taller vegetation is being removed. The removal of vegetation may temporarily displace individual bats, which use trees for roosting. Because this bat uses multiple roosts within a home territory, the disturbance resulting from removal of trees is likely to be minimal. However, during the pupping season, a female carrying a pup may be less able to rapidly vacate a roost site when an inhabited tree is being felled. Further, an adult female may leave a pup in the roost tree while foraging. Very small pups will be unable to flee a tree that is being felled. Potential adverse effects from such disturbance can be avoided or minimized by not clearing woody vegetation taller than 15 ft (4.6 m) between June 1 and September 15, the bat pupping season. Stringing barbed wire along the top of security fences is a potential threat to flying bats.

Seabirds - A potential impact that the installation and operation of a PV generating facility poses to seabirds is the increased threat that birds will be downed after becoming disoriented by lights associated with a project during the fledging season. The two main areas that outdoor lighting could pose a threat to these nocturnally flying seabirds are: 1) during construction if it is deemed expedient or necessary to conduct night-time construction activities; and 2) following build-out, the operation of security lighting.

Other Species - The USFWS iPaC website (USFWS, nd a) was visited for a list of protected species included in a USFWS database. The website generated no ESA-listed species for the Project area, but listed two "migratory birds": Brown Booby (*Sula leucogaster*) and O'ahu 'Amakihi (*Hemignathus flavus*³).

O'ahu 'Amakihi is an endemic, year-round resident on the Island of O'ahu. This species is not migratory and does not occur at the Project elevation in the Waiawa area. The Brown Booby is a pelagic seabird species that nests on offshore islands in the Hawaiian chain. The species is not found in the interior of any of the high islands. Additionally, no place exists within the Project site where a Brown Booby could land if an individual chose to explore the area.

Jurisdictional Waters

The Project site does not contain waters that would be considered jurisdictional under the Clean Water Act (CWA). All of the Project site is located on an interfluvium with no perennial or intermittent streams present. Some topographic maps and the HDLNR stream shapefile (HDLNR-DAR, 2008) show partial representations of water conveyance pipes ("aqueduct") and channels (as blue line features on USGS map, 7.5-Minute Series (Topographic), Waipahu Quadrangle (USGS, 1998). All of these features are long abandoned and no longer functional; they do not hold or convey water.

The National Wetlands Inventory (NWI) Wetlands Mapper (USFW, nd b) shows no wetlands or streams in the survey area, and no hydrology or vegetation indicative of wetlands were observed during our survey of the Project area. The nearest jurisdictional water, Waiawa Stream, is found to the east of the Project on U.S. Navy property and within the Pearl City Industrial Park along the valley bottom, separated from the site by a high valley wall.

³ This species was elevated to a full species in 1995. The current accepted name is *Chlorodrepanis flava*.

Critical Habitat and State Conservation Districts

Federally delineated Critical Habitat is not present in the Project area (USFWS, nd a). No equivalent designation exists under state law. Conservation zoning in Hawai'i is promulgated at the state level by state Conservation Districts. No Conservation Districts occur near the Project.

Recommendations

- If night-time construction activity or equipment maintenance is conducted during construction of the Project, all associated lighting should be shielded and, if large work lights are used, these must be placed on poles that are high enough to allow the lights to be pointed directly towards the ground.
- If exterior facility lighting is installed, it is recommended that the lights be manual, timed, or motion sensor configured and downward shielded to reduce the potential for causing interactions between nocturnally flying seabirds and man-made structures (Reed et al., 1985; Telfer et al., 1987).
- To avoid deleterious impacts to roosting bats, it is recommended that no woody vegetation taller than 4.6 m (15 ft) be removed between June 1 and September 15. Any fencing erected should not utilize strands of barbed wire.

Implementing the recommendations listed above, as appropriate for construction and/or operation phases of the proposed Project, will avoid or minimize adverse impacts to any and all flora and fauna of concern associated with the Project area.

Glossary

AECOS Inc. traditionally uses the following definitions for selected terms appearing in this report:

Area – General term for a usually imprecisely bounded place including the subject Project, the bounds typically more narrowly specified as, for examples, in “survey area” or “project area”, the latter meaning more generally the location of the project.

Parcel – a specific tract of land defined by meets and bounds and assigned a Tax Map Key (TMK) number by the county.

Project – A defined development, typically called the “Project” after describing and thereafter used as a proper noun.

Site - The area of disturbance to be occupied by a project and may encompass a portion, one, or several parcels and shown outlined on a figure (Figure 2 in this report).

Vicinity – Area(s) outside the project site, usually in some sense adjacent to it or the project area.

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