Paeahu Solar Project

Initial Draft Biological Resources Survey Report

Prepared for:

Paeahu Solar, LLC

January 2020

TETRA TECH

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1.0 Introduction

Paeahu Solar, LLC (Paeahu) is proposing the Paeahu Solar Project (Project) located in Wailea on the Island of Maui. The Project will involve construction and operation of a 15 megawatt (MW) solar photovoltaic system. The major components of the Project will consist of multiple zones of ground-mounted solar photovoltaic arrays, a substation, and a battery energy storage system. A 69-kilovolt overhead generator–tie line would extend approximately 0.5 mile (0.8 kilometers [km]) from the project substation to connect into the Maui Electric Company grid at the existing Auwahi substation. The Project will be accessed via a single new access road from Piʻilani Highway to the Project. A network of existing and new on-site access roads will be utilized.

Tetra Tech, Inc. (Tetra Tech) was contracted by Paeahu to conduct biological surveys for the Project. The purpose of the surveys was to characterize the habitat and verify whether state or federally-listed threatened, endangered, or otherwise rare plants or animals have the potential to occur and could be impacted by construction or operation of the Project. This report summarizes the results of the biological surveys conducted within the Study Area by Tetra Tech, LeGrande Biological Surveys Inc., and Dr. Karl Magnacca on June 22, 2018 and over several dates in March, May, and September in 2019.

2.0 Description of Study Area

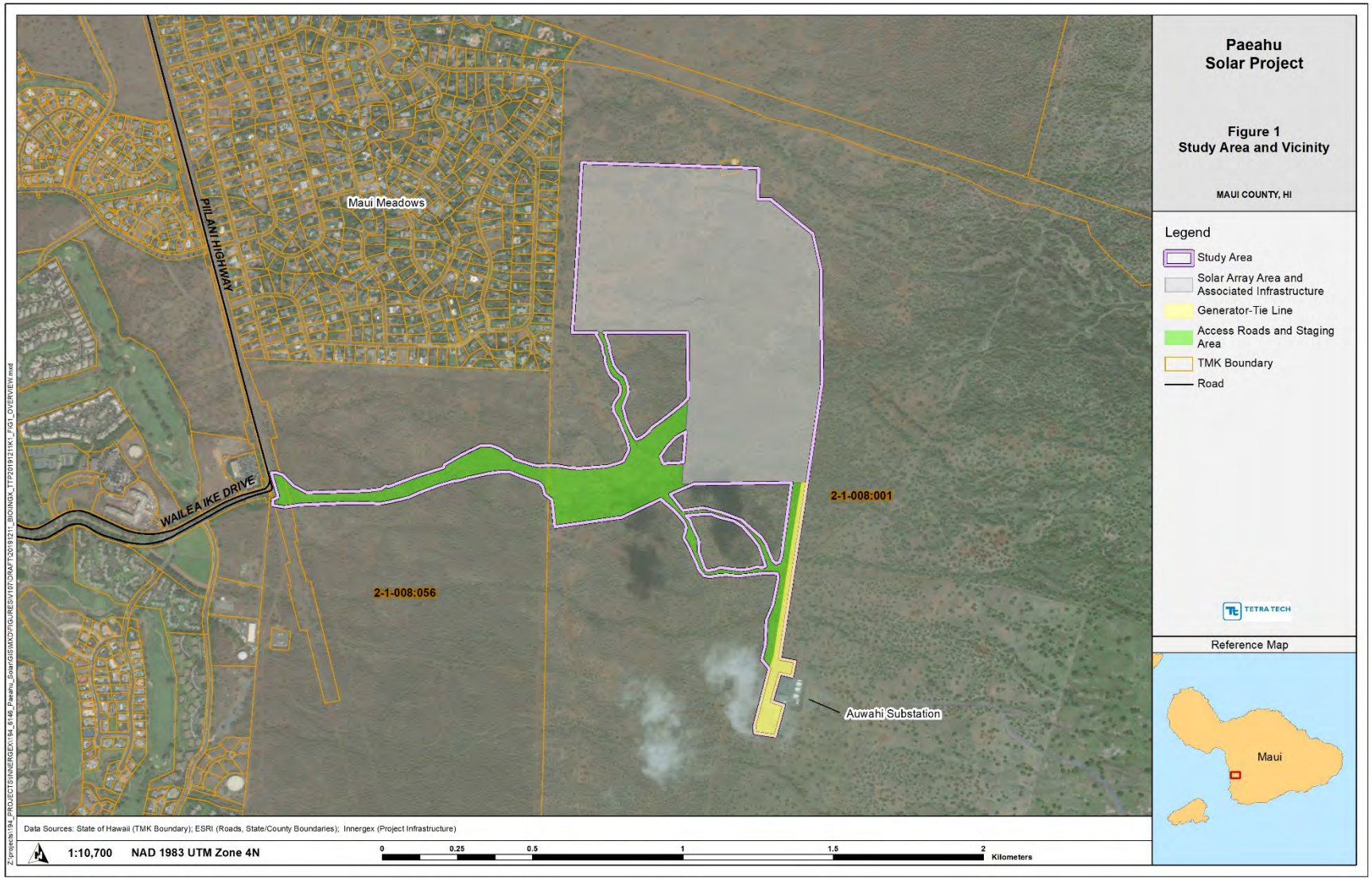
The Project is located in the Kīhei-Mākena region of south Maui on the southeastern slope of Mt. Haleakalā. It is located mauka of the Maui Meadows housing development and approximately 0.8 miles (1.3 km) from the Wailea Resort area, a planned resort-residential community. As shown in Figure 1, the Study Area encompasses approximately 212 acres (85 hectares), and includes a main solar array area, a generator–tie line area extending from the solar array area to the existing Auwahi substation, and access roads and staging/laydown areas. Most of the Study Area is within Tax Map Key (TMK) 2-1-008:001, which is owned by ʻUlupalakua Ranch and utilized as pastureland for cattle grazing. The main access road is anticipated to extend from the intersection of Piʻilani Highway and Wailea Ike Drive to the Project parcel through vacant land owned by Honuaʻula Partners, LLC (TMK 2-1-008:056). The Study Area is undeveloped, vacant land.

Details regarding past uses to be incorporated once final draft of AIS and CIA are available for review.

2.1 Climate

The climate in the Study Area is characterized as arid and sunny. The area receives a mean annual rainfall of approximately 20 inches (508 millimeters [mm]). Rainfall is typically highest in December/January and lowest in July/August (Giambelluca et al. 2013). The closest National Weather Service rainfall gage to the Study Area (ʻUlupalakua Ranch ULUH1) documented above average rainfall for February 2019 (6.6 inches or 168 mm) and below average rainfall in March 2019 (0.3 inches or 7 mm) (NWS 2019). Rainfall was also above the monthly average in September 2019 (5 inches or 126.5 mm); however, conditions were much drier in September compared to March as evident by the vegetation

color (see photos in Appendix A). Between January and September 2019, the rainfall average for this site was slightly above average (NWS 2019), which suggests conditions were normal during the surveys.


Paeahu
Solar Project
Figure 1
Study Area and Vicinity
MAUI COUNTY, HI
Legend
Study Area
Solar Array Area and Associated Infrastructure
Generator-Tie Line
Access Roads and Staging Area
TMK Boundary
Road
TETRA TECH
Reference Map
Maui
Maui Meadows
PIILANI HIGHWAY
WAILEA IKE DRIVE
2-1-008:056
2-1-008:001
Auwahi Substation
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State/County Boundaries); Innergex (Project Infrastructure)
1:10,700
NAD 1983 UTM Zone 4N
0
0.25
0.5
1
1.5
2
Kilometers

2.2 Topography, Geology, and Soils

The elevation of the Study Area ranges from approximately 330 feet (100 meters [m]) above mean sea level (amsl) in the western portion of the main access road to approximately 940 feet (287 m) amsl in the northwest portion of the Study Area (Figure 2) (Dudek 2019). In general, the terrain slopes slightly west toward the ocean; however, numerous rock outcrops and topographic features are scattered throughout the Study Area.

The northern half of the Study Area is underlain by lava flows of the Kula Volcanic Series (Qkul-Lava Flow), ranging from 140,000 to 950,000 years old (Figure 2). Younger ʻaʻā lava of the Hana Volcanic Series (Qhn2), between 13,000 and 30,000 years old, are present in the southern half of the Study Area. A very small section of the Study Area associated with the generator–tie line near the existing Auwahi substation is classified as Hana Volcanic Series (Qhn0; between 50,000 and 140,000 years old) (Sherrod et al. 2007).

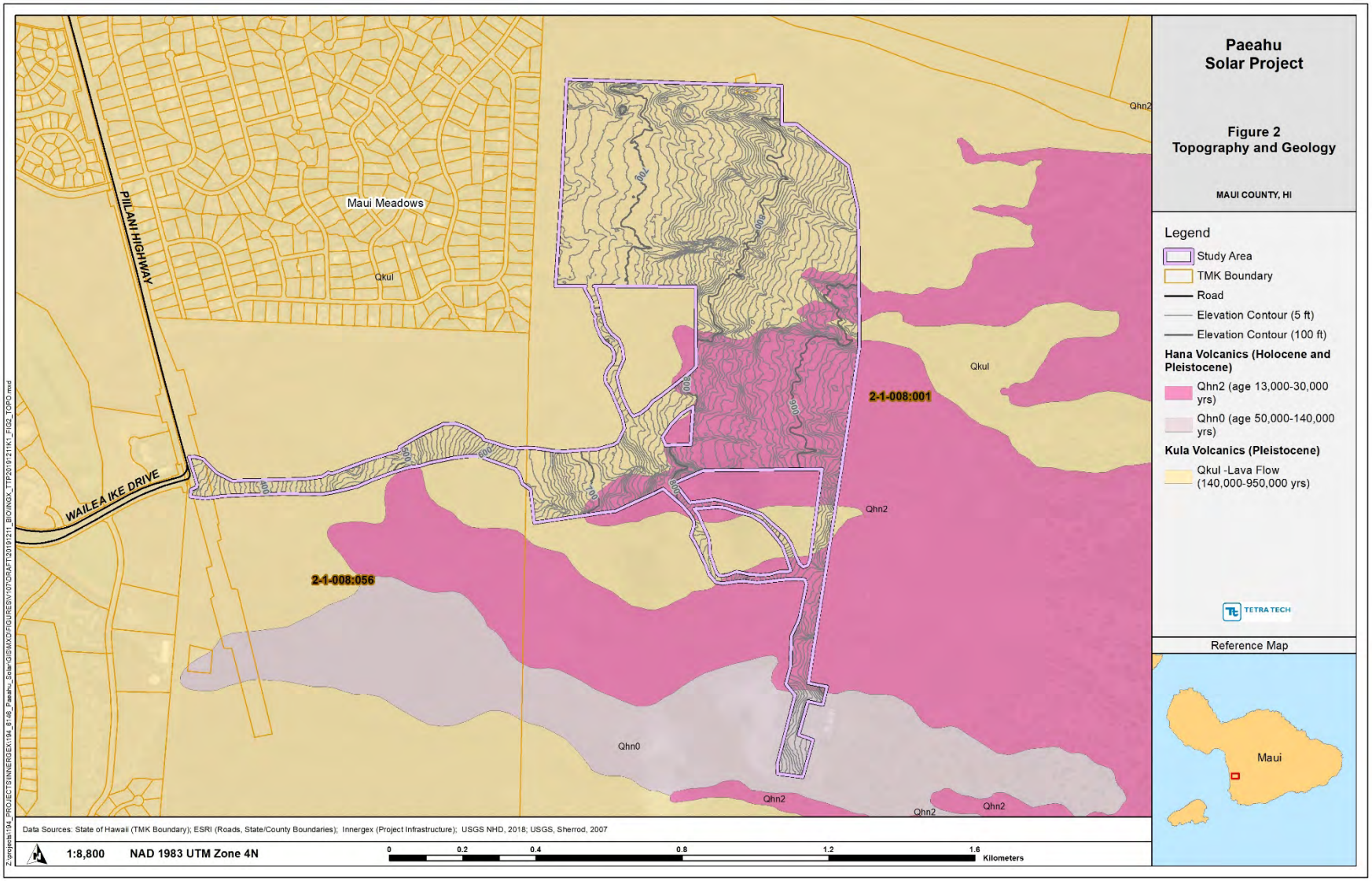
The Natural Resources Conservation Service (NRCS) identifies four soil types in the Study Area. The majority of the site is Keawakapu extremely stony silty clay loam, 3 to 25 percent slopes and Kamaole very stony silt loam, 3 to 15 percent slopes. Small areas of Makena loam, stony complex, 3 to 25 percent slopes, and very stony land are also present (NRCS 2019).

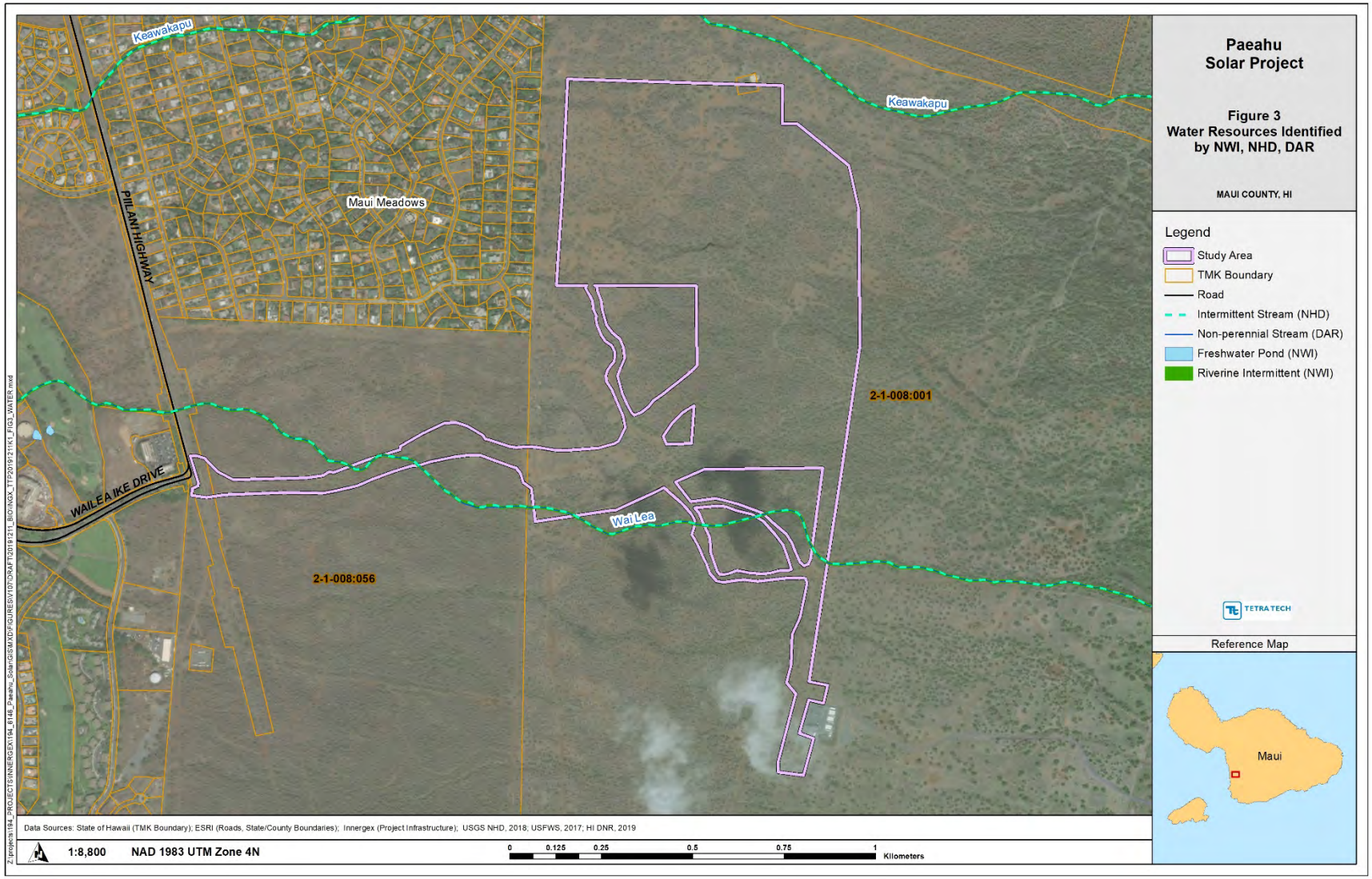
2.3 Hydrology

The Study Area is within the Wailea watershed (Water Quality Consulting, Inc. 2013). No perennial streams or wetlands are present in the Study Area. Figure 3 depicts water resources mapped within the Study Area and vicinity by the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data, the U.S. Geological Survey (USGS) topographic and National Hydrography Dataset (NHD), and the State of Hawaiʻi Division of Aquatic Resources (DAR) dataset. Only one water feature is identified within the Study Area by these datasets. Wai Lea Stream crosses through the southern portion of the Study Area, intersecting with portions of the generation-tie line and existing ranch roads and proposed access roads. Wai Lea Stream is classified as an intermittent stream by NHD (2019), non-perennial stream by DAR (2008), and Riverine, Intermittent, Streambed, Seasonally Flooded (R4SBC) by NWI (2019).

In addition to Wai Lea Stream, several erosional features and dry linear depressions are present in the Study Area that may carry water briefly in response to heavy rain events. These landforms range from narrow, shallow depressions (e.g., gullies, swales) to larger, deep depressions with steep-sides. However, because of the dry conditions in this region, these features do not have defined ordinary high water marks.

Details on the potentially jurisdictional water features within the Study Area are provided in the Project's Waters of the U.S. determination and delineation report (Tetra Tech, in prep).


Paeahu
Solar Project
Figure 2
Topography and Geology
MAUI COUNTY, HI
Legend
Study Area
TMK Boundary
Road
Elevation Contour (5 ft)
Elevation Contour (100 ft)
Hana Volcanics (Holocene and Pleistocene)
Qhn2 (age 13,000-30,000 yrs)
Qhn0 (age 50,000-140,000 yrs)
Kula Volcanics (Pleistocene)
Qkul -Lava Flow (140,000-950,000 yrs)
TETRA TECH
Reference Map
Maui
Maui Meadows
PIILANI HIGHWAY
WAILEA IKE DRIVE
Qkul
Qhn2
Qhn0
2-1-008:001
2-1-008:056
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State/County Boundaries); Innergex (Project Infrastructure); USGS NHD, 2018; USGS, Sherrod, 2007
1:8,800
NAD 1983 UTM Zone 4N
0 0.2 0.4 0.8 1.2 1.6 Kilometers


Paeahu
Solar Project
Figure 3
Water Resources Identified
by NWI, NHD, DAR
MAUI COUNTY, HI
Legend
Study Area
TMK Boundary
Road
Intermittent Stream (NHD)
Non-perennial Stream (DAR)
Freshwater Pond (NWI)
Riverine Intermittent (NWI)
TETRA TECH
Reference Map
Maui
Keawakapu
Keawakapu
Maui Meadows
PILANI HIGHWAY
WAILEA IKE DRIVE
Wai Lea
2-1-008:001
2-1-008:056
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State/County Boundaries); Innergex (Project Infrastructure); USGS NHD, 2018; USFWS, 2017; HI DNR, 2019
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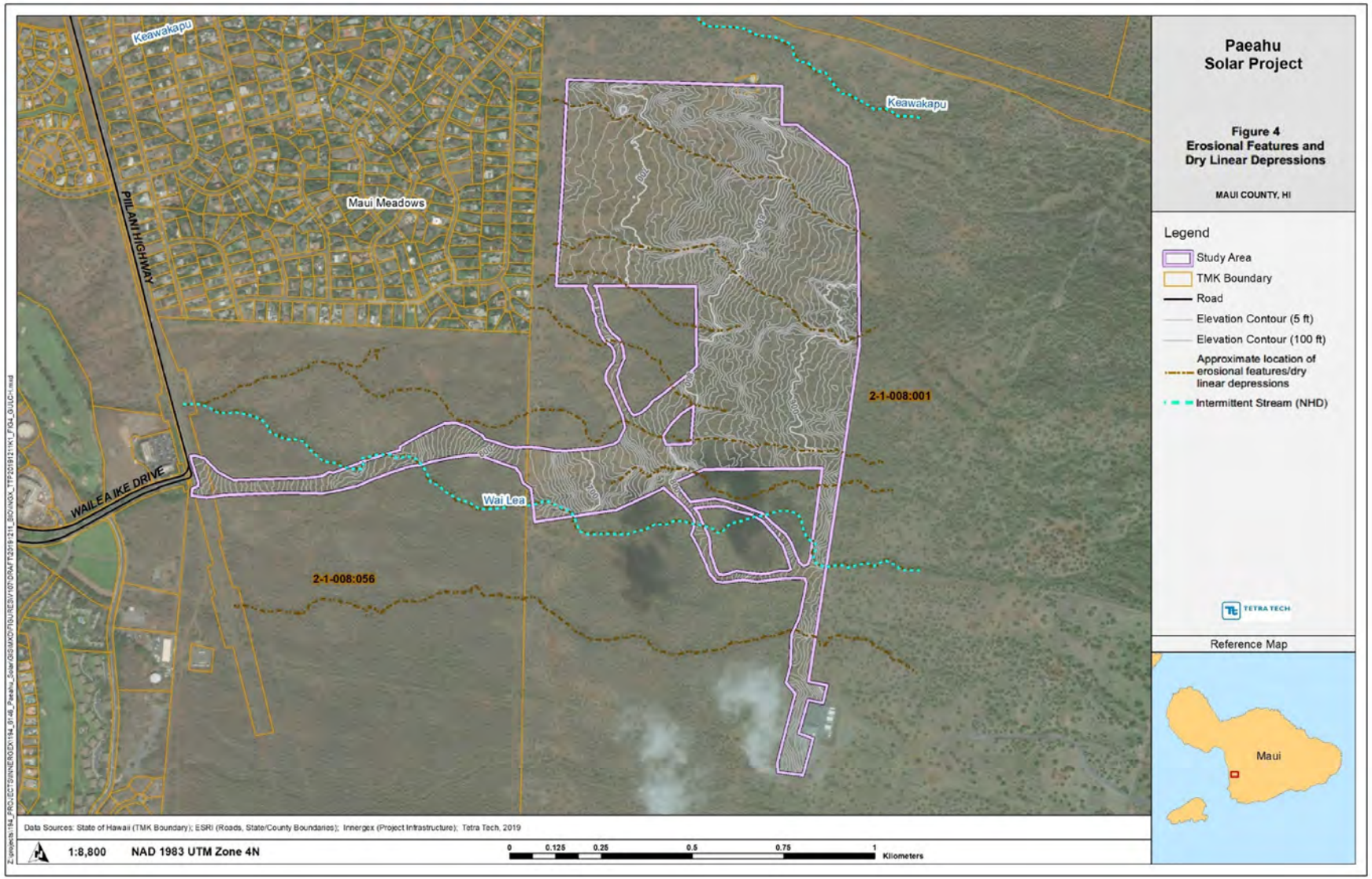
NAD 1983 UTM Zone 4N
0 0.125 0.25 0.5 0.75 1
Kilometers


Paeahu
Solar Project
Figure 4
Erosional Features and
Dry Linear Depressions
MAUI COUNTY, HI
Legend
Study Area
TMK Boundary
Road
Elevation Contour (5 ft)
Elevation Contour (100 ft)
Approximate location of erosional features/dry linear depressions
Intermittent Stream (NHD)
TETRA TECH
Reference Map
Maui
Keawakapu
Maui Meadows
PILANI HIGHWAY
WAILEA IKE DRIVE
Wai Lea
2-1-008:001
2-1-008:056
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State/County Boundaries); Innergex (Project Infrastructure); Tetra Tech, 2019
1:8,800
NAD 1983 UTM Zone 4N
0 0.125 0.25 0.5 0.75 1
Kilometers

3.0 Methods

Prior to the field survey, Tetra Tech conducted a review of relevant publicly available literature and data with respect to biological resources in and near the Study Area. This review included environmental assessments and environmental impact statements, NWI data, the U.S. Geological Survey (USGS) NHD, scientific journals and reports, and available, unpublished data that are relevant to the natural history and ecology of the area. In addition, Tetra Tech reviewed available geospatial data, aerial photographs, and topographic maps of the Study Area to identify occurrences of state or federally-listed species, or rare species, or habitats that could harbor these species.

Field surveys of the Study Area included the following:

- General plant and wildlife survey conducted March 13-14, 19-20, 27, and September 13, 2019;
- Wiliwili tree (*Erythrina sandwicensis*) survey conducted September 13, 17, 18, 2019; and
- Yellow-faced bee (*Hylaeus* spp.) survey conducted June 22, 2018 and May 11, 2019.

Details of the field survey methods are provided below.

3.1 Plants

On March 13-14, 19-20, 27 and September 13, 2019, Tetra Tech and LeGrande Biological Surveys Inc. conducted a pedestrian survey to record all plant species, dominant vegetation types, as well as any listed or rare plant species within the Study Area. During the survey, biologists examined areas more likely to support native plants (e.g., rocky outcrops, erosional features, low-topographic areas, and shady areas) intensively. Plant identifications were made in the field; plants that could not be positively identified were photo-documented for comparison with the recent taxonomic literature.

Tetra Tech mapped the location of plants listed as threatened or endangered by Hawaiʻi Revised Statutes 195D or the Endangered Species Act of 1973 (as amended) as well as plants considered potentially rare.

Plants recorded during this survey are indicative of the season and environmental conditions at the time of the survey. The presence and location of plants can be influenced by seasonal and temporal changes; therefore, it is possible additional species may occur on site, but were not present during this survey. However, the plant survey was conducted primarily during a wet period; therefore, Tetra Tech assumes that the results are representative of the site.

Following the field surveys, Tetra Tech researched historic plant observations and the potential for other rare plant species to occur in the Study Area by contacting known specialists on Maui. Tetra Tech discussed the history of known botanical resources within the Study Area with the ʻUlupalakua Ranch's botanist and the Maui Nui Plant Extinction Prevention Program.

3.1.1 Wiliwili Inventory

Innergex requested Tetra Tech record the wiliwili trees and groves within the Study area to assist with micrositing Project features and potentially avoiding or minimizing impacts to wiliwili trees. Although not state or federally-listed as threatened or endangered, wiliwili is considered a keystone species in lowland dry forests and is culturally important to Hawaiians because of its use in many Hawaiian traditions and legends (Kaufman et al. 2020). On September 13, 17, 18, 2019, biologists conducted a wiliwili trees inventory. Prior to the field survey, linear transects were created at regular intervals with Geographic Information System software. The transects were loaded on iPad Minis or Tablets with Collector for ArcGIS. Biologists walked concurrently along adjacent transects recording all wiliwili trees or groves observed within the Study Area. At each Global Positioning System (GPS) point, biologists noted number of individuals and age group (seedling, juveniles, adults).

3.2 Wildlife

3.2.1 Birds

On March 13-14, 19-20, and September 13, 2019, Tetra Tech and LeGrande Biological Surveys Inc. recorded all birds seen or heard while walking and driving within the Study Area. Habitats or plants that could support listed birds were also identified, if present (such as water features as potential habitat for listed Hawaiian waterbirds).

3.2.2 Mammals

During the general plant and wildlife survey, which was conducted on March 13-14, 19-20, and September 13, 2019 with the bird surveys, Tetra Tech and LeGrande Biological Surveys Inc. recorded all mammals observed within the Study Area. The survey was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign.

Specific surveys for the endangered Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*), through the use of acoustic bat detectors or nighttime observation, were not conducted. The USFWS and Hawaiʻi Division of Forestry and Wildlife (DOFAW) recognize all woody vegetation greater than 15 feet (4.5 m) tall as potential bat roosting habitat (DOFAW 2015, USFWS 2019a). For this reason, Tetra Tech noted the presence or absence of trees or shrubs greater than 15 feet (4.5 m) tall within the Study Area.

3.2.3 Insects

The surveys focused on searching the Study Area for the presence of the state and federally-endangered Blackburn's sphinx moth (*Manduca blackburnii*)[1] and the state and federally-endangered yellow-faced bees (*Hylaeus* spp.) and their hosts plants; however, all other large insects observed while walking and driving the Study Area were also recorded.

3.2.3.1 Blackburn's Sphinx Moth

Larvae of the Blackburn's sphinx moth feed on plants in the nightshade family (Solanaceae), including the non-native, weedy tree tobacco (*Nicotiana glauca*), which is common in this region of Maui. Tree tobacco plants encountered in the Study Area during the surveys conducted on March 13-14, 19-20, 27, and September 13, 2019 were scanned for Blackburn's sphinx moth larvae, eggs, or evidence of larval feeding (such as chewed stems, frass, or leaf damage). However, each tree tobacco plant was not thoroughly examined for evidence of Blackburn's sphinx moth. General locations of tree tobacco encountered were mapped to inform Project design and future Blackburn's sphinx moth survey efforts.

3.2.3.2 Yellow-Faced Bees

Dr. Karl Magnacca surveyed the Study Area for native yellow-faced bees and their primary host plants. The solar array area was surveyed on June 22, 2018 and the generator–tie line and access roads/staging areas were surveyed on May 11, 2019. The purpose of these surveys was to identify if the Study Area may be inhabited by native yellow-faced bees, particularly the endangered assimulans yellow-faced bee (*Hylaeus assimulans*) which is known to occur at Makena, and determine if suitable habitat for native yellow-faced bees is present. Assimulans yellow-faced bee is primarily dependent on 'ilima (*Sida fallax*); therefore, 'ilima was the main host plant target of the survey. The surveys were timed to coincide with the peak 'ilima flowering period to increase the chances of observing native yellow-faced bees. Other native species were also noted as their presence would indicate a greater likelihood of being able to sustain bee populations.

Non-native ants, especially the big-headed ant (*Pheidole megacephala*) and yellow crazy ant (*Anoplolepis gracilipes*), are known to directly prey on bees and exclude yellow-faced bees (Daly and Magnacca 2003, USFWS 2016b). To determine if habitat-modifying non-native ants are present, ant baits (consisting of tuna with corn syrup) were placed at eight sites in the solar array area. Baits were checked roughly 2 hours after setting. However, no additional baits were deployed after it became clear that good yellow-faced bee habitat was not present in the area regardless of the presence of ants.

[1] The 2019 5-year review for the Blackburn's sphinx moth stated that the species "…is not likely to become extinct within the foreseeable future and more closely meets the definition of threatened rather than endangered" (USFWS 2019b)

4.0 Results and Discussion

In general, the Study Area is degraded agricultural lands that has been highly disturbed and is dominated by non-native plant and wildlife species. Of the native species observed, most were common across Maui and other Hawaiian Islands. Previous and current agricultural uses (such as cattle grazing and creation and use of dirt access roads), and the introduction of invasive species (including feral ungulates, and non-native weeds) have modified and degraded the native biological resources in the Study Area. These activities have reduced the number and abundance of native species and habitats suitable for native species.

Despite the disturbed nature of the Study Area, two state and federally-listed endangered species—the Blackburn's sphinx moth and ma'o hau hele (*Hibiscus brackenridgei* ssp. *brackenridgei*)—were observed during the survey. Several other state or federally-listed species not observed in the Study Area during the survey may occasionally occur in or traverse the Study Area. These species are discussed in further detail below. Representative photographs of the Study Area are presented in Appendix A.

4.1 Plants

Biological surveys documented 91 plant species within the Study Area (Appendix B)[2]. Thirteen of the observed plant species are native to the Hawaiian Islands (Table 1). One of the observed native species—ma'o hau hele (*Hibiscus brackenridgei* ssp. *brackenridgei*)—is listed as endangered by USFWS and DOFAW. Only a single individual ma'o hau hele individual was recorded during the survey (Figures 5 and 6; see Section 4.1.1 below). The remaining 78 plant species observed within the Study Area are non-native to the Hawaiian Islands.

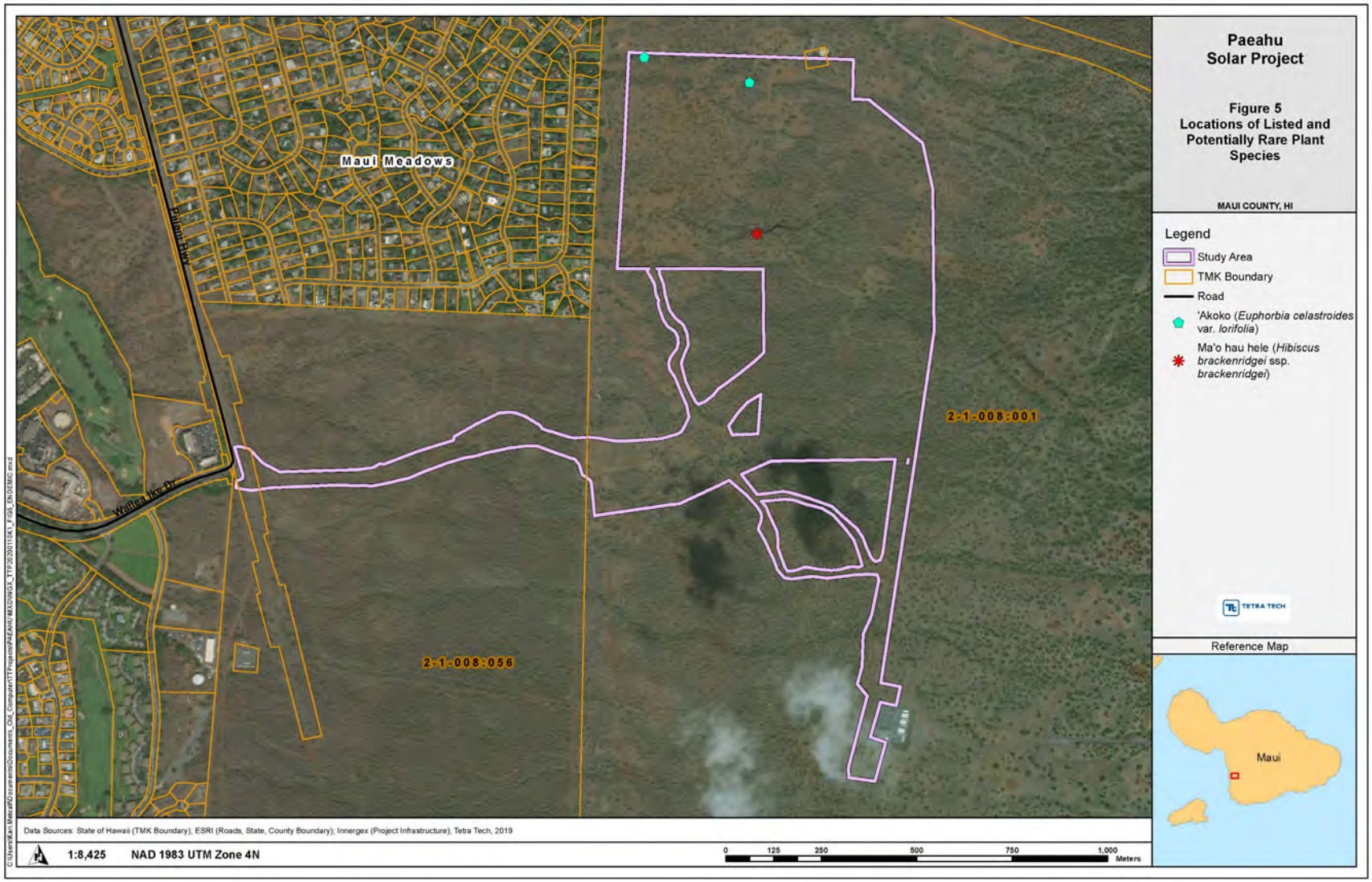
The primary vegetation type within the Study Area is Open Kiawe (*Prosopis pallida*)/Buffelgrass (*Cenchrus ciliaris*) Forest. It is characterized by large kiawe trees, roughly 15–30 feet (5–9 m) tall, which occur as small stands or scattered individuals, with dense mats of buffelgrass in the understory. The native wiliwili tree occurs commonly, particularly within the depressions and erosional features in the Study Area. Other common species widely scattered in the understory include the non-native lantana (*Lantana camara*), partridge pea (*Chamaecrista nictitans*), golden crown-beard (*Verbesina encelioides*), hairy abutilon (*Abutilon grandifolium*), wild pea (*Macroptilium lathyroides*), fireweed (*Senecio madagascariensis*), Guinea grass (*Urochloa maxima*), Natal redtop (*Melinis repens*), and sourgrass (*Digitaria insularis*). The native 'iwa'iwa fern (*Doryopteris decipiens*) and 'ilie'e (*Plumbago zeylanica*) are common on outcrops and within shady areas in depressions. Koa haole (*Leucaena leucocephala*) and klu (*Acacia farnesiana*) are scattered sparsely throughout the Study Area.

[2] The taxonomy and nomenclature of the flowering plants are in accordance with Wagner et al. (1999), Wagner et al. (2012) and Wagner and Herbst (2003) for native and naturalized flowering plants, and Staples and Herbst (2005) for ornamental plants. Common/Hawaiian names are provided first, followed by scientific names in parentheses. If no common or Hawaiian name is known, only the scientific name is provided.

Table 1. Native Plant Species Recorded in the Study Area During the Survey

Common/Hawaiian Name	Scientific Name	Status
ʻakoko	*Euphorbia celastroides* var. *lorifolia*	E
hoary abutilon	*Abutilon incanum*	I
ʻilieʻe	*Plumbago zeylanica*	I
ʻilima	*Sida fallax*	I
ʻiwaʻiwa	*Doryopteris decipiens*	E
koali awahia	*Ipomoea indica*	I
kūpala	*Sicyos pachycarpus*	E
maiapilo	*Capparis sandwichiana*	E
maʻo hau hele*	*Hibiscus brackenridgei* ssp. *brackenridgei*	E, End
pili	*Heteropogon contortus*	I
pōpolo	*Solanum americanum*	I
wiliwili	*Erythrina sandwicensis*	E
ʻuhaloa	*Waltheria indica*	I

Status: E = Endemic (native only to the Hawaiian Islands); I = Indigenous (native to the Hawaiian Islands and elsewhere); End = Federally and State endangered.


Paeahu
Solar Project
Figure 5
Locations of Listed and Potentially Rare Plant Species
MAUI COUNTY, HI
Legend
Study Area
TMK Boundary
Road
'Akoko (Euphorbia celastroides var. lorifolia)
Ma'o hau hele (Hibiscus brackenridgei ssp. brackenridgei)
TETRA TECH
Reference Map
Maui
Maui Meadows
Piilani Hwy
Waiola Ike Dr
2-1-008:001
2-1-008:056
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State, County Boundary); Innergex (Project Infrastructure); Tetra Tech, 2019
1:8,425
NAD 1983 UTM Zone 4N
0 125 250 500 750 1,000 Meters

4.1.1 Listed Species and Critical Habitat

As stated above, ma‘o hau hele is listed as endangered by USFWS and DOFAW. This subspecies occurs on the islands of Maui, Lana‘i, and Hawai‘i, with an estimated 376 individuals (24 mature, 52 immature, and 300 reintroductions) across the three islands (USFWS 2013). In 2006, there were at least 11 ma‘o hau hele individuals within the central portion of the Study Area (Figure 6); however, after severe drought conditions between 2006 and 2012, all but one individual died. The one remaining ma‘o hau hele individual is located within a small exclosure at the top of a steep slope (see photo 9 in Appendix A). This exclosure was built by the Maui Nui Plant Extinction Prevention Program in May 2011 to prevent damage by ungulates (Diana Crow/‘Ulupalakua Ranch, pers. comm., September 2019). According to the landowner’s botanist, this ma‘o hau hele individual occasionally produces seeds (Diana Crow/‘Ulupalakua Ranch, pers. comm., June 2019). Notable leaf insect damage was observed on the individual during the survey, which is consistent with damage from the Chinese rose beetle (*Adoretus sinicus*).

No federally designated critical habitat occurs in the Study Area. The closest plant critical habitat to the Study Area is Lowland Dry Unit 03, which is 0.73 mile (1.17 km) to the southwest of the Project boundary (Figure 7). Lowland Dry Unit 03 is currently occupied by one listed plant species—‘āwikiwiki (*Canavalia pubescens*)—and is considered by USFWS to be unoccupied critical habitat for 16 additional listed plant species (USFWS 2016a). ‘Āwikiwiki was not observed in the Study Area and has not been seen during previous surveys in the Study Area (Diana Crow/‘Ulupalakua Ranch, pers. comm., September 2019). Lowland Dry Unit 03 is underlain by a younger lava flow than the Study Area; therefore, that area is more likely to support rare native plants than the Study Area (Figure 7).

Lowland Dry Unit 02 is 1.7 miles (2.7 km) to the northeast of the Project boundary (Figure 7). The plants *Bonamia menziesii*, ‘āwikiwiki, and ma‘o hau hele are present in this critical habitat unit. The unit is also considered by USFWS to be unoccupied critical habitat for 15 additional listed plant species (USFWS 2016a). Besides ma‘o hau hele, none of the other listed plants with designated critical habitat in Lowland Dry Unit 02 were observed in the Study Area. Lowland Dry Unit 02 is primarily underlain by a younger lava flow than the Study Area; therefore, that area is more likely to support rare native plants than the Study Area.

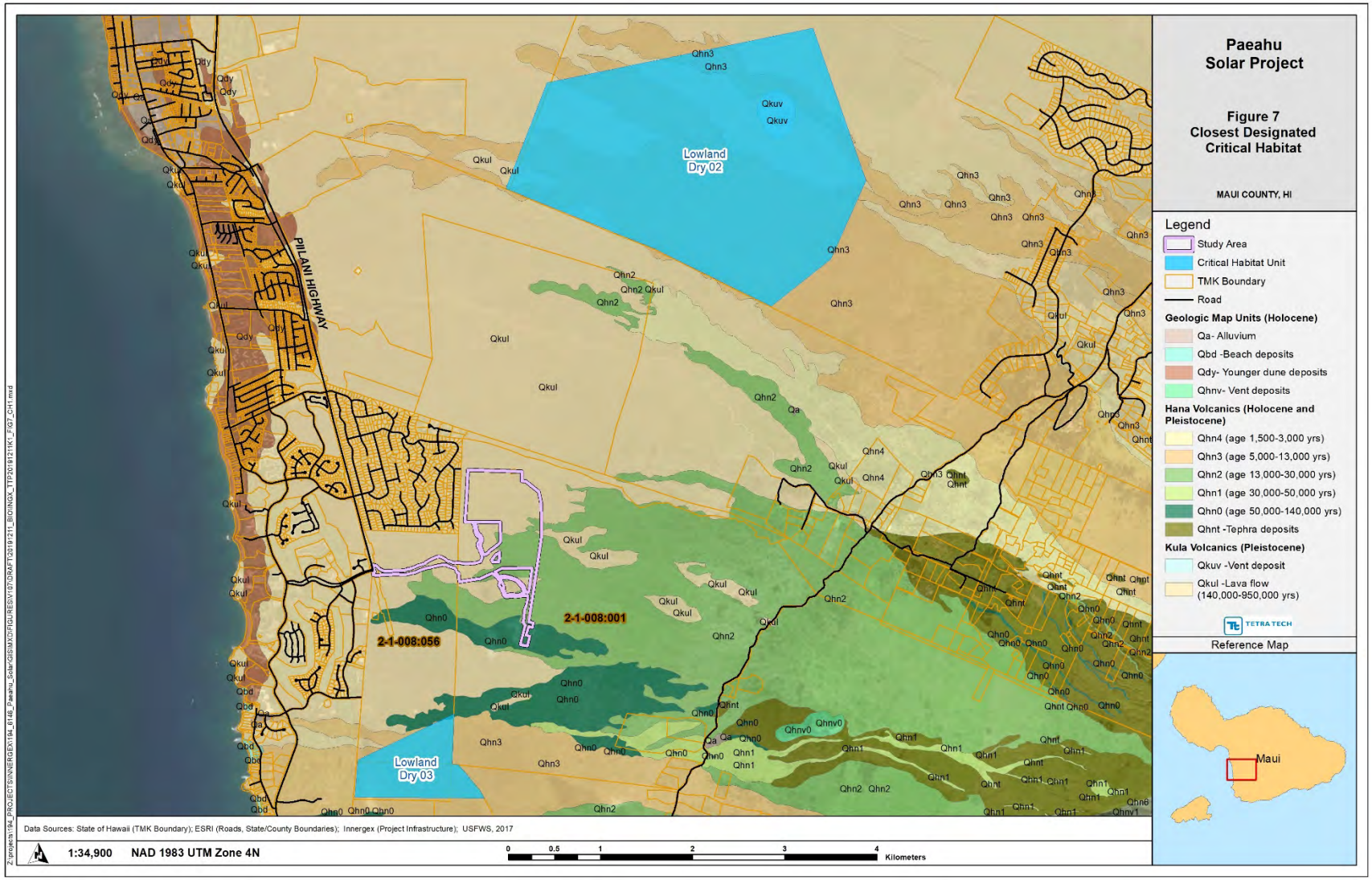
4.1.2 Other Plant Species of Interest

‘Akoko (*Euphorbia celastroides* var. *lorifolia*) was observed on two rock outcrops near the northern boundary of the Study Area (Figure 5). This variety of ‘akoko is potentially considered rare in Hawai‘i by some botanists (Hank Oppenheimer /Maui Nui Plant Extinction Prevention Program, pers. comm., October 2019); however, quantitative distribution information is not currently available.

Tetra Tech is continuing to coordinate with appropriate botanists to obtain more quantitative and distribution data on this variety of ‘akoko. Current coordination with various experts has resulted in conflicting information on the relative abundance of this species.

Survey recordings documented 461 wiliwili trees in the Study Area. Most of the trees occur in low topographic areas (e.g., swales, dry depressions). Several large wiliwili groves are present; the largest grove recorded consisted of 22 adults, and is located along the eastern Project boundary. No saplings were seen and only one juvenile wiliwili tree was observed.


Paeahu
Solar Project
Figure 6
Observed and Historical Locations of Endangered Ma'o Hau Hele (*Hibiscus brackenridgei* ssp. *brackenridgei*)
MAUI COUNTY, HI
Study Area
TMK Boundary
Hibiscus brackenridgei ssp. *brackenridgei*) Location
Historical Occurence
Observed March 2019
TETRA TECH
Reference Map
2-1-008:001
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State, County Boundary); Innergex (Project Infrastructure); Diane Crowe March 2019
1:908
NAD 1983 UTM Zone 4N
0 12.5 25 50 75 100
Meters


Paeahu
Solar Project
Figure 7
Closest Designated
Critical Habitat
MAUI COUNTY, HI
Legend
Study Area
Critical Habitat Unit
TMK Boundary
Road
Geologic Map Units (Holocene)
Qa- Alluvium
Qbd -Beach deposits
Qdy- Younger dune deposits
Qhnv- Vent deposits
Hana Volcanics (Holocene and Pleistocene)
Qhn4 (age 1,500-3,000 yrs)
Qhn3 (age 5,000-13,000 yrs)
Qhn2 (age 13,000-30,000 yrs)
Qhn1 (age 30,000-50,000 yrs)
Qhn0 (age 50,000-140,000 yrs)
Qhnt -Tephra deposits
Kula Volcanics (Pleistocene)
Qkuv -Vent deposit
Qkul -Lava flow
(140,000-950,000 yrs)
TETRA TECH
Reference Map
Maui
Lowland Dry 02
Lowland Dry 03
PIILANI HIGHWAY
2-1-008:001
2-1-008:056
Data Sources: State of Hawaii (TMK Boundary); ESRI (Roads, State/County Boundaries); Innergex (Project Infrastructure); USFWS, 2017
1:34,900
NAD 1983 UTM Zone 4N
0 0.5 1 2 3 4
Kilometers

4.2 Wildlife

4.2.1 Birds

Twenty bird species were recorded within the Study Area (Table 2)[3]. Most of these bird species are non-native to the Hawaiian Islands, and are species commonly found in rural or agricultural areas. One native/endemic bird species—the pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*)—was seen in the Study Area and immediate vicinity. Japanese white-eye (*Zosterops japonicus*), common myna (*Acridotheres tristis*), and zebra dove (*Geopelia striata*) were the most common bird species recorded during the survey. Several of the bird species seen or heard during the survey are protected by the Migratory Bird Treaty Act (Table 2).

Table 2. Birds Recorded in the Study Area During the Survey

Common Name	Scientific Name	Status	MBTA
African silverbill	*Euodice cantans*	NN	
Barn owl	*Tyto alba*	NN	X
Black francolin	*Francolinus francolinus*	NN	
Cattle egret	*Bubulcus ibis*	NN	X
Common myna	*Acridotheres tristis*	NN	
Erckel's francolin	*Pternistis erckelii*	NN	
Grey francolin	*Francolinus pondicerianus*	NN	
Pueo, Hawaiian short-eared owl	*Asio flammeus sandwichensis*	E	
House finch	*Haemorhous mexicanus*	NN	X
Japanese white-eye	*Zosterops japonicus*	NN	
Java sparrow	*Padda oryzivora*	NN	
Mourning dove	*Zenaida macroura*	NN	X
Northern cardinal	*Cardinalis cardinalis*	NN	X
Northern mockingbird	*Mimus polyglottos*	M	X
Nutmeg mannikin	*Lonchura punctulata*	NN	
Rock pigeon	*Columba livia*	NN	
Rosy-faced lovebird	*Agapornis roseicollis*	NN	
Spotted dove	*Streptopelia chinensis*	NN	
Wild turkey	*Meleagris gallopavo*	NN	
Zebra dove	*Geopelia striata*	NN	

Status: E = Endemic, M = Migrant, NN = non-native established species, MBTA = Migratory Bird Treaty Act.

[3] Scientific nomenclature for birds follows Chesser et al. (2019).

No state or federally-listed bird species were recorded during the survey; however, several such species have the potential to be present in or transverse the Study Area, as discussed below.

- Seabirds: The endangered Hawaiian petrel (*Pterodroma sandwichensis*), threatened Newell's shearwater (*Puffinus newelli*), and endangered band-rumped storm-petrel (*Oceanodroma castro*) (collectively referred to as seabirds) have not been documented in the Study Area, and suitable nesting habitat does not occur in the Study Area. However, suitable nesting habitat exists at upper elevations of East Maui, suggesting it is possible for these birds to fly over the Study Area at night from May through October while transiting between nest sites and the ocean. These listed seabirds may be attracted to construction lights at night. Disorientation and fallout as a result of light attraction could occur for individuals attracted to nighttime construction lighting and unshielded nighttime facility lighting. Juvenile birds are particularly vulnerable to light attraction, and grounded birds are vulnerable to mammalian predators or vehicle strikes.
- Waterbirds: The endangered Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian duck (*Anas wyvilliana*), and Hawaiian coot (*Fulica alai*) (collectively referred to as waterbirds) have not been documented in the Study Area, and suitable habitat for these species does not occur in the Study Area. At solar facilities in the continental U.S., water-dependent birds (such as grebes, loons, rails, coots, shorebirds, and waterfowl) have been documented to collide with photovoltaic arrays (Kagan et al. 2014, WEST 2014, Walston et al. 2016). However, there has been no evidence from operating solar facilities in Hawaiʻi to suggest this risk to waterbirds occurs in Hawaiʻi.
- Hawaiian goose: The endangered nēnē or Hawaiian goose (*Branta sandwichensis*) uses various habitat types, including beach strand, shrubland, grasslands to lava rock (Banko 1988; Banko et al. 1999). Hawaiian geese are also known to use landscaped/maintained areas, such as golf courses, grazed agricultural areas, playing fields, and housing developments. No Hawaiian goose were observed in the Study Area during the biological survey, and have not been reported in the vicinity (SWCA 2016); however, it is possible that Hawaiian geese fly through the Study Area when in transit to and from areas with known populations. Hawaiian geese also have the potential to be attracted to the Study Area during or after construction if their preferred habitat is created (i.e., mowed lawns).

4.2.2 Mammals

Several non-native terrestrial mammalian species were detected during the survey. Several herds of axis deer (*Axis axis*) were seen throughout the Study Area[4]. A single domestic cow (*Bos taurus*) was observed grazing, and one small Indian mongoose (*Herpestes javanicus*) was seen along the main access road. Evidence of feral goats (*Capra hircus*) were seen. Although not observed, other introduced mammals,

[4] Scientific nomenclature for mammals follows Tomich (1986).

such as dogs (*Canis familiaris*), cats (*Felis catus*), pigs (*Sus scrofa*), house mice (*Mus musculus*), and rats (*Rattus* spp.) are likely to occur within the Study Area.

The state- and federally-endangered Hawaiian hoary bat is likely to transit, forage, or roost in the Study Area. This species will forage in open and semi-cluttered landscapes in a wide range of habitats and vegetation types (Bonaccorso et al. 2015). Most of the trees within the Study Area (kiawe, wiliwili, koa haole) are over 15 feet tall and have the potential to function as bat roost trees, per USFWS and DOFAW. A single Hawaiian hoary bat was sighted roughly half mile (0.8 km) southwest of the Study Area during a nighttime survey in 2008 (SWCA 2016).

4.2.3 Insects

Insects observed during the surveys are listed in Table 3[5]. Of these, only the Blackburn's sphinx moth and two dragonflies—globe skimmer (*Pantala flavescens*) and green darner (*Anax junis*)—are native to the Hawaiian Islands. These two dragonflies are common in Hawai'i. The Blackburn's sphinx moth is discussed below.

Table 3. Insects Recorded in the Study Area During the Survey

Common Name	Scientific Name	Status
Black house ant	*Ochetellus glaber*	NN
Blackburn's sphinx moth	*Manduca blackburnii*	E, End
Cabbage white butterfly	*Pieris rapae*	NN
Globe skimmer	*Pantala flavescens*	I
Green darner	*Anax junis*	I
Ladybird beetle	*Coccinellidae* sp.	NN
Leafcutter bee	*Megachile chlorura*	NN
Longhorn crazy ant	*Paratrechina longicornis*	NN
Long-tailed blue	*Lampides boeticus*	NN
Pharaoh ant	*Monomorium pharaonis*	NN
Monarch butterfly	*Danaus plexippus*	NN
Sonoran carpenter bee	*Xylocopa sonorina*	NN
Western honey bee	*Apis mellifera*	NN
Yellow garden spider	*Argiope aurantia*	NN

Status: E = Endemic, End = State and federally-endangered, I = Indigenous, NN = non-native species.

4.2.3.1 Blackburn's Sphinx Moth

Three state- and federally-endangered Blackburn's sphinx moth caterpillars were observed on two tree tobacco plants during the survey (Figure 8, also see photos in Appendix A). Two of the caterpillars were

[5] Scientific nomenclature follows Nishida (2002) for insects.

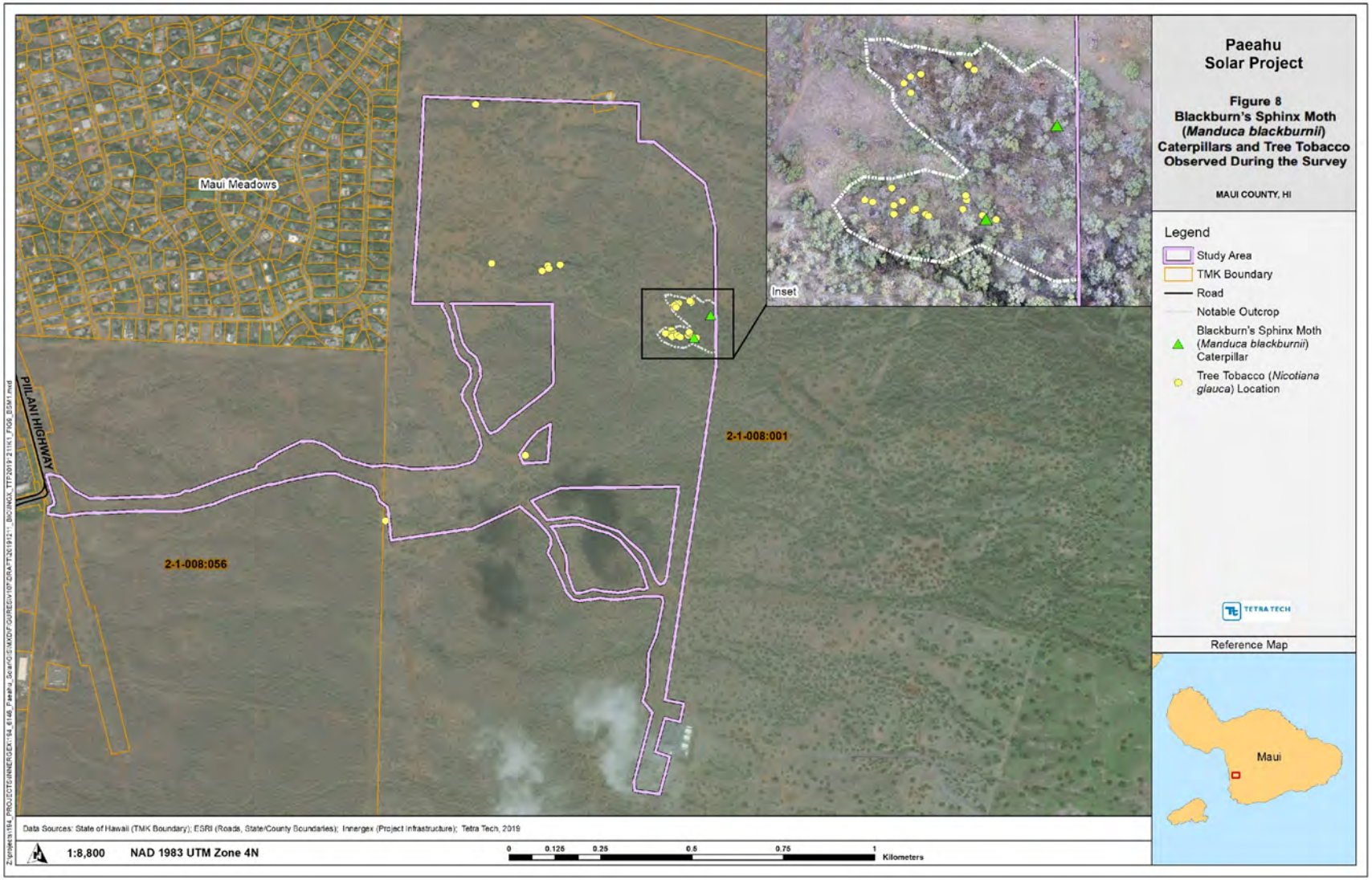
1st instars, and one was in 5th instar stage. A host plant for the caterpillar, tree tobacco, is scattered within the Study Area. Figure 8 shows the general locations of tree tobacco encountered, but does not represent a comprehensive inventory of all tree tobacco in the Study Area (see Section 5.2.4 regarding recommended pre-construction surveys). The largest concentration of tree tobacco occurs on the large rock outcrop along the eastern boundary of the Study Area (Figure 8). Due to the extent of tree tobacco within the Study Area, not all plants were thoroughly searched for Blackburn's sphinx moth caterpillars or eggs, and additional caterpillars may occur in the Study Area. Potential evidence of feeding (cut stems and leaves) was observed on at least three tree tobacco plants during the survey; however, because various lepidopterans and other species can cause leaf and stem damage on tree tobacco, feeding signs in the Study Area cannot be attributed only to Blackburn's sphinx moth. Blackburn's sphinx moth caterpillars have also been observed in the vicinity of the Study Area (SWCA 2016).

The two native, larval host plants for Blackburn's sphinx moth (*Nothocestrum latifolium* and *N. breviflorum*) were not found and are not likely to occur in the Study Area. These two *Nothocestrum* species are primary constituent elements required by Blackburn's sphinx moth larvae for foraging, sheltering, maturation, and dispersal (USFWS 2003). The invasive, non-native tree tobacco is widespread across the Hawaiian Islands and not considered a primary constituent element for Blackburn's sphinx moth critical habitat; tree tobacco is short-lived, vulnerable to prolonged drought, and the plant's water content may not be suitable for optimal larvae growth (USFWS 2003). Three likely native adult stage host plants for the Blackburn's sphinx moth—maiapilo, 'ilie'e, koali awahia (*Ipomoea indica*)—were observed in the Study Area.

The closest Blackburn's sphinx moth critical habitat unit (Unit 1 Pu'u O Kali) is located roughly 1.7 miles (2.7 km) to the northeast of the Study Area boundary. This moth critical habitat unit overlaps with the plant Lowland Dry Unit 02 unit.

4.2.3.2 Yellow-Faced Bees

No native yellow-faced bees were observed during the surveys. 'Ilima, the primary host plant for the endangered assimulans yellow-faced bee, mostly occurs as widely scattered individuals throughout the Study Area, and therefore, does not provide enough food resources to sustain a population of native yellow-faced bees. Uhaloa (*Waltheria indica*) is the only one other native plant present in the Study Area that is known to be visited by native yellow-faced bees. Similar to 'ilima, uhaloa also occurs as scattered individuals or small patches. Thus, Dr. Karl Magnacca concluded the Study Area is poor quality habitat for native yellow-faced bees. Although several non-native ant species were observed (see Table 3), the big-headed ant and yellow crazy ant were not observed during the surveys.



Note: Tree tobacco points represent single plants or plant patches; however, this is not a complete inventory of all tree tobacco plants in the Study Area.

5.0 Conclusions and Recommendations

As described in Section 4, the majority of the plants and animals observed in the Study Area are introduced, non-native species. Although the native biological resources in the area are degraded by agricultural activities and invasive species, two state and federally-listed endangered species—the Blackburn's sphinx moth and maʻo hau hele—occur in the Study Area. Several other listed wildlife species have the potential to occur in or transit through the Study Area. Recommended measures to avoid and minimize impacts to state and federally-listed species that could occur in the Study Area are outlined below.

Recommended measures to avoid and minimize impacts to state and federally-listed species that could occur in the Study Area are being drafted and are subject to further consultation with wildlife agencies.

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APPENDIX A

REPRESENTATIVE PHOTOGRAPHS OF THE PAEAHU SOLAR STUDY AREA

Photo 1. Overview of Study Area (solar array area) looking southwest, showing dominant kiawe trees (*Prosopis pallida*) and buffelgrass (*Cenchrus ciliaris*) (Date: March 13, 2019).

Photo 2. Open Kiawe (*Prosopis pallida*)/Buffelgrass (*Cenchrus ciliaris*) Forest, the primary vegetation type within the Study Area (Date: March 13, 2019).

Photo 3. Typical conditions within the access road and staging area from Pi‘ilani Highway to the Project (Date: September 13, 2019).

Photo 4. Native wiliwili trees (*Erythrina sandwicensis*) are a common component of the vegetation, especially in low topographic areas (Date: March 13, 2019).

Photo 5. Low topographic area (dry depression) within the Study Area, showing native wiliwili trees (*Erythrina sandwicensis*) (Date: March 13, 2019).

Photo 6. Topography is varied in the Study Area, as shown by this steep cliff within the solar array portion of the Study Area (Date: March 14, 2019).

Photo 7. Wai Lea Stream, looking downstream from the western edge of the Study Area, showing wetter conditions in March 2019 vs. September 2019 (see Photo 8 below) (Date: March 27, 2019).

Photo 8. Wai Lea Stream, looking downstream from the western edge of the Study Area, showing drier conditions in September 2019 vs. March 2019 (see Photo 7 above) based on vegetation color (Date: September 18, 2019).

Photo 9. One remaining endangered ma‘o hau hele (*Hibiscus brackenridgei* ssp. *brackenridgei*) individual located within a small exclosure at the top of a steep slope (Date: March 27, 2019).

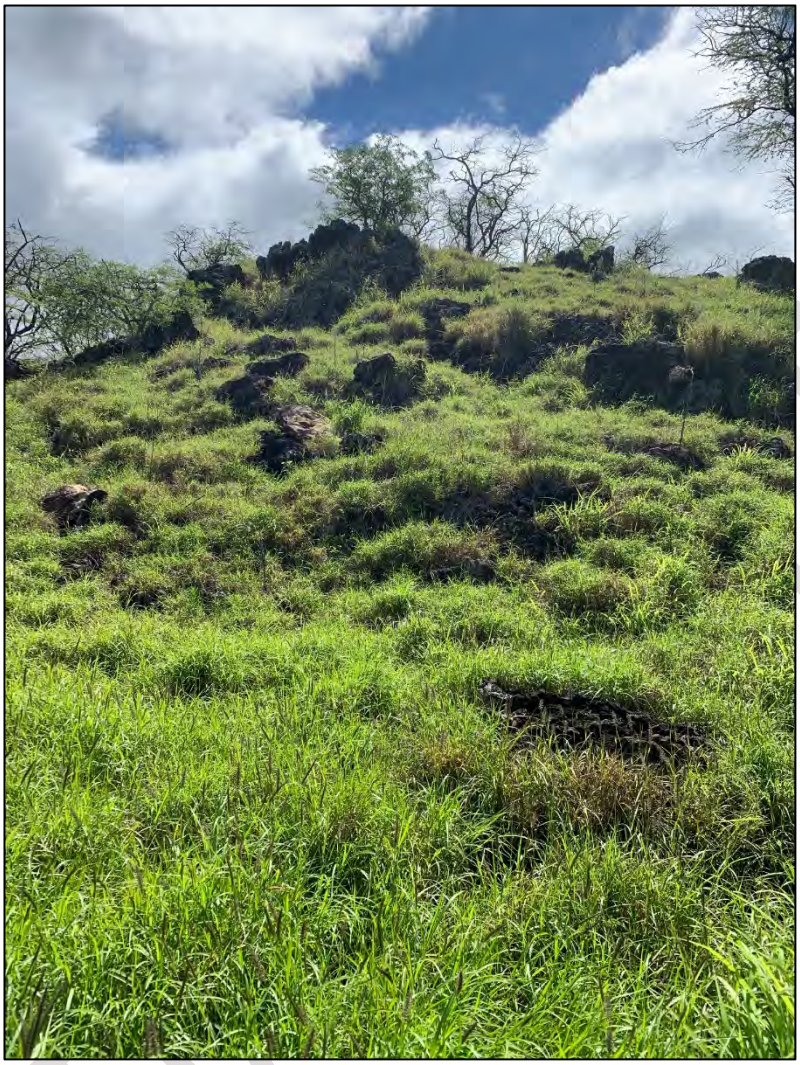

Photo 10. Outcrop with ʻakoko (*Euphorbia celastroides* var. *lorifolia*) near the northern boundary of the Study Area (Date: March 13, 2019).

Photo 11. Notable outcrop along the eastern boundary of the Study Area where Blackburn's sphinx moth (*Manduca blackburnii*) and concentration of tree tobacco were observed (Date: March 13, 2019).

Photo 12. Young (1st instar) Blackburn's sphinx moth (*Manduca blackburnii*) caterpillar on non-native tree tobacco with signs of leaf feeding (Date: March 14, 2019).

Photo 13. Older Blackburn's sphinx moth (*Manduca blackburnii*) caterpillar on non-native tree tobacco (Date: March 27, 2019).

APPENDIX B

LIST OF PLANT SPECIES OBSERVED DURING SURVEYS OF THE PAEAHU SOLAR STUDY AREA

Table B-1 provides a list of plant species observed in the Project Area by Tetra Tech on March 13-14, 19, 27 and September 13, 2019. The plant names are arranged alphabetically by family and then by species into three groups: Ferns/Lycophytes, Monocots, and Dicots. The taxonomy and nomenclature of the ferns and lycophytes follow Palmer (2002), with recent name changes in accordance with Smith et al. (2011). Flowering plants are in accordance with Wagner et al. (1999), Wagner and Herbst (2003), and Staples and Herbst (2005); recent name changes are those recorded in Wagner et al. (2012). If no common or Hawaiian name is known, only the scientific name is provided.

Status:

- E = endemic = native only to the Hawaiian Islands
- I = indigenous = native to the Hawaiian Islands and elsewhere
- P = Polynesian = introduced by Polynesians
- X = introduced/ non-native = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (Cook's arrival in the islands in 1778)

Table B-1. List of Plant Species Observed During Surveys for the Paeahu Solar Project

Scientific Name and Authorship	Hawaiian/Common Name	Status
FERNS & LYCOPHYTES		
Adiantaceae		
Doryopteris decipiens (Hook.) J.Sm.	ʻiwaʻiwa	E
Lomariopsidaceae		
Nephrolepis brownii (Desv.) Hovenkamp & Miyam.	sword fern	X
Pteridaceae		
Adiantum hispidulum Sw.	rough maidenhair fern	X
MONOCOTS		
Arecaceae		
Cocos nucifera L.	niu, coconut	P
Livistona chinensis (Jacq.) R.Br. ex Mart.	Chinese fan palm	X
Poaceae		
Bothriochloa pertusa (L.) A.Camus	pitted beardgrass	X
Cenchrus ciliaris L.	buffelgrass	X
Cenchrus echinatus L.	common sandbur	X
Chloris barbata Sw.	swollen finger	X
Cynodon dactylon (L.) Pers	Bermuda grass, mānienie	X
Digitaria insularis (L.) Mez ex Ekman	sour grass	X
Eragrostis amabilis (L.) Wight & Arn.	lovegrass	X
Heteropogon contortus (L.) P.Beauv. ex Roem. & Schult.	pili grass	I
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X
Urochloa maxima (Jacq.) R.D.Webster	Guinea grass	X

Scientific Name and Authorship	Hawaiian/Common Name	Status
DICOTS		
Acanthaceae		
Asystasia gangetica (L.) T.Anderson	Chinese violet	X
Amaranthaceae		
Amaranthus spinosus L.	spiny amaranth	X
Anacardiaceae		
Schinus terebinthifolius Raddi	Christmas berry	X
Araliaceae		
Schefflera arboricola (Hayata) Merr.	dwarf umbrella plant	X
Schefflera actinophylla (Endl.) Harms	octopus tree, umbrella tree	X
Asclepiadaceae		
Asclepias physocarpa (E.Mey.) Schltr.	balloon plant	X
Calotropis procera (Aiton) W.T.Aiton	small crown flower	X
Stapelia gigantea (N.E. Brown)	zulu giant	X
Asteraceae		
Bidens pilosa L.	Spanish needle	X
Conyza bonariensis (L.) Cronq.	hairy horseweed	X
Conyza canadensis (L.) Cronquist var. canadensis	horseweed	X
Emilia sonchifolia (L.) DC.	Flora's paintbrush	X
Montanoa hibiscifolia Benth.	tree daisy	X
Parthenium hysterophorus L.	false ragweed	X
Senecio madagascariensis Poir.	fireweed	X
Sonchus oleraceus L.	sow thistle, pualele	X
Tridax procumbens L.	coat buttons	X
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	X
Zinnia peruviana (L.) L.	pua pihi	X
Bignoniaceae		
Spathodea campanulata P.Beauv.	African tulip tree	X
Cactaceae		
Pilocereus royenii (L.) Byles & Rowley	Royen's tree cactus	X
Capparaceae		
Capparis sandwichiana DC.	maiapilo	E
Chenopodiaceae		
Chenopodium murale L.	goosefoot, pigweed	X
Convolvulaceae		
Ipomoea indica (J. Burm.) Merr.	koali awahia	I
Merremia aegyptia (L.) Urb.	hairy merremia	X

Scientific Name and Authorship	Hawaiian/Common Name	Status
Cucurbitaceae		
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber, hedgehog gourd	X
Momordica charantia L.	bitter melon	X
Sicyos pachycarpus Hook. & Arn.	kūpala	E
Euphorbiaceae		
Euphorbia celastroides Boiss. var. *lorifolia* (A.Gray) Sherff	ʻakoko	E
Euphorbia hirta L.	hairy spurge	X
Ricinus communis L.	castor bean	X
Fabaceae		
Acacia farnesiana (L.) Wild.	klu	X
Chamaecrista nictitans (L.) Moench	partridge pea	X
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X
Desmanthus pernambucanus (L.) Thell.	slender mimosa	X
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X
Erythrina sandwicensis O.Deg.	wiliwili	E
Indigofera suffruticosa Mill.	indigo	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium lathyroides (L.) Urb.	wild bean	X
Neonotonia wightii (Wight & Arn.) Lackey	–	X
Prosopis pallida Kunth	kiawe	X
Samanea saman (Jacq.) Merr.	monkeypod	X
Lamiaceae		
Hyptis pectinata (L.) Poit.	comb hyptis	X
Leonotis nepetifolia (L.) R.Br.	lion's ear	X
Ocimum basilicum L.	sweet basil	X
Ocimum gratissimum L.	basil	X
Malvaceae		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X
Abutilon incanum (Link.) Sweet	hoary abutilon	I
Hibiscus brackenridgei A.Gray ssp. brackenridgei	maʻo hau hele	E
Malva parviflora L.	cheese weed	X
Malvastrum coromandelianum (L.) Garcke ssp. coromandelianum	false mallow	X
Sida acuta Burm.f. ssp. carpinifolia (L.f.) Borss.Waalk.	–	X
Sida ciliaris L.	–	X
Sida fallax L.	ʻilima	I
Sida rhombifolia L.	–	

Scientific Name and Authorship	Hawaiian/Common Name	Status
Oxalidaceae		
Oxalis corniculata L.	wood sorrel	X
Meliaceae		
Melia azedarach L.	Chinaberry	X
Moraceae		
Ficus microcarpa L.f.	Chinese banyan	X
Nyctaginaceae		
Boerhavia coccinea Mill.	–	X
Papavaraceae		
Argemone mexicana L.	Mexican poppy	X
Bocconia frutescens L.	–	X
Plumbaginaceae		
Plumbago zeylanica L.	ʻilieʻe	I
Portulacaceae		
Portulaca oleracea L.	pigweed	X
Portulaca pilosa L.	ʻākulikuli	X
Primulaceae		
Anagallis arvensis L.	scarlet pimpernel	X
Solanaceae		
Capsicum annum L.	chili pepper	X
Datura stramonium L.	jimson weed	X
Nicandra physalodes (L.) Gaertn.	apple of Peru	X
Nicotiana glauca Graham	tree tobacco	X
Solanum americanum Mill.	pōpolo	I?
Solanum seaforthianum Andrews	–	X
Sterculiaceae		
Waltheria indica L.	ʻuhaloa	I
Tiliaceae		
Triumfetta semitriloba Jacq.	Sacramento bur	X
Verbenaceae		
Lantana camara L.	lantana	X
Stachytarpheta cayennensis (Rich.) Vahl	oī	X