APPENDIX A

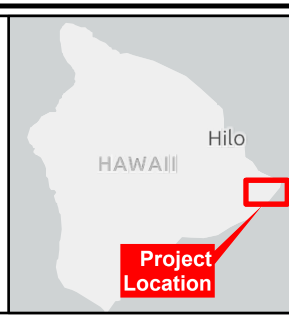
FIGURES

Legend

Parcel Number

- 140010010000
- 140010020000
- 140010190000

Note: The roads shown in the figures reflect the layout of County roads prior to the 2018 eruption.



N

Stantec

0 3,500 7,000 Feet

1 in = 7,000 feet

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

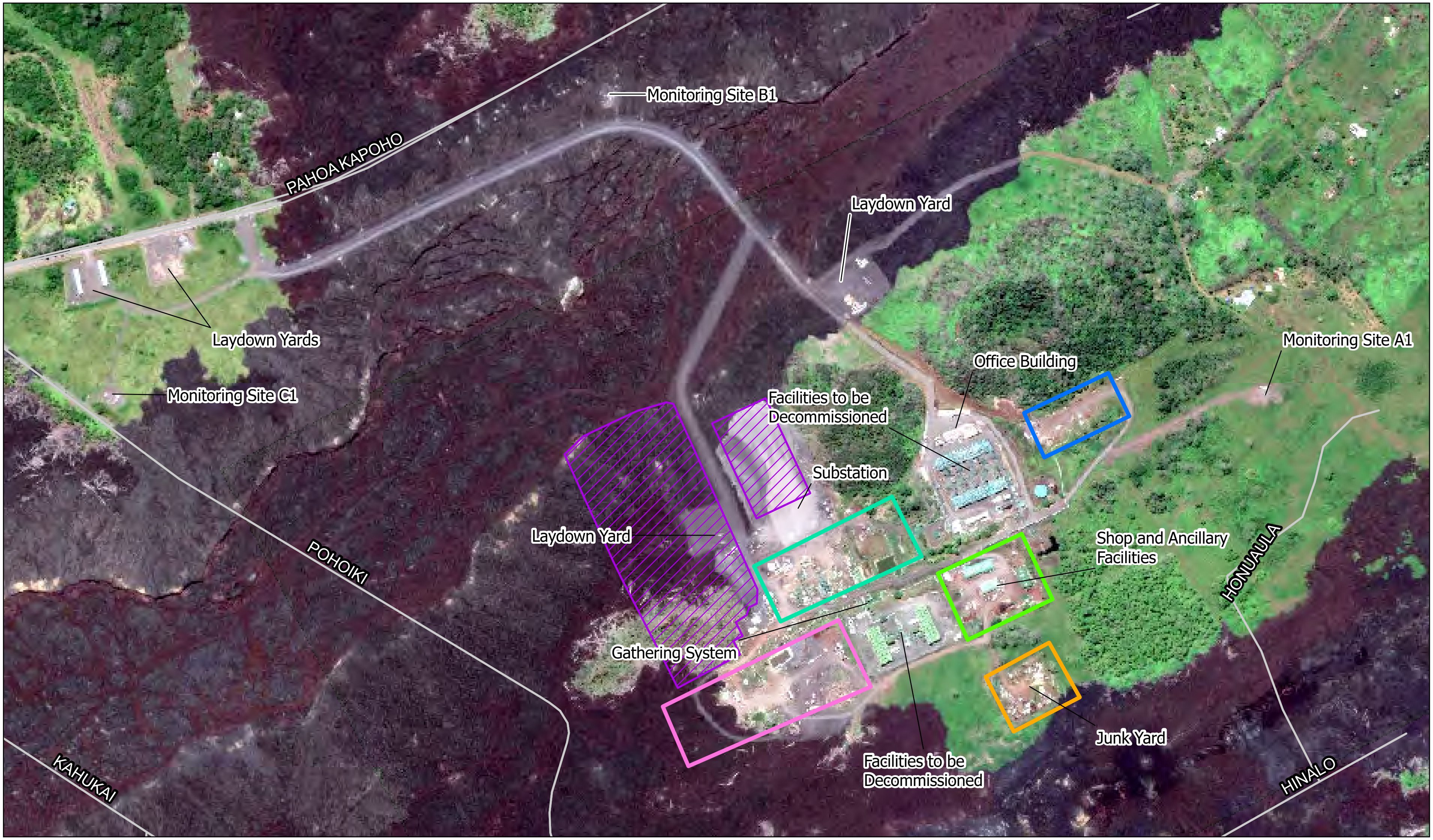
Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-03-29	PROJECT NO: 185805496	

Figure 1
Project Location

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-03-29 By: jordavis

Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Hybrid Reference Layer: Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- Proposed Disturbance Area
- PGV Property Boundary

Existing Well Pads

- Pad A
- Pad B
- Pad D (no active wells as of 2022)
- Pad E
- Pad F (no active wells as of 2022)

N

Stantec

0 350 700 Feet

1 in = 700 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML

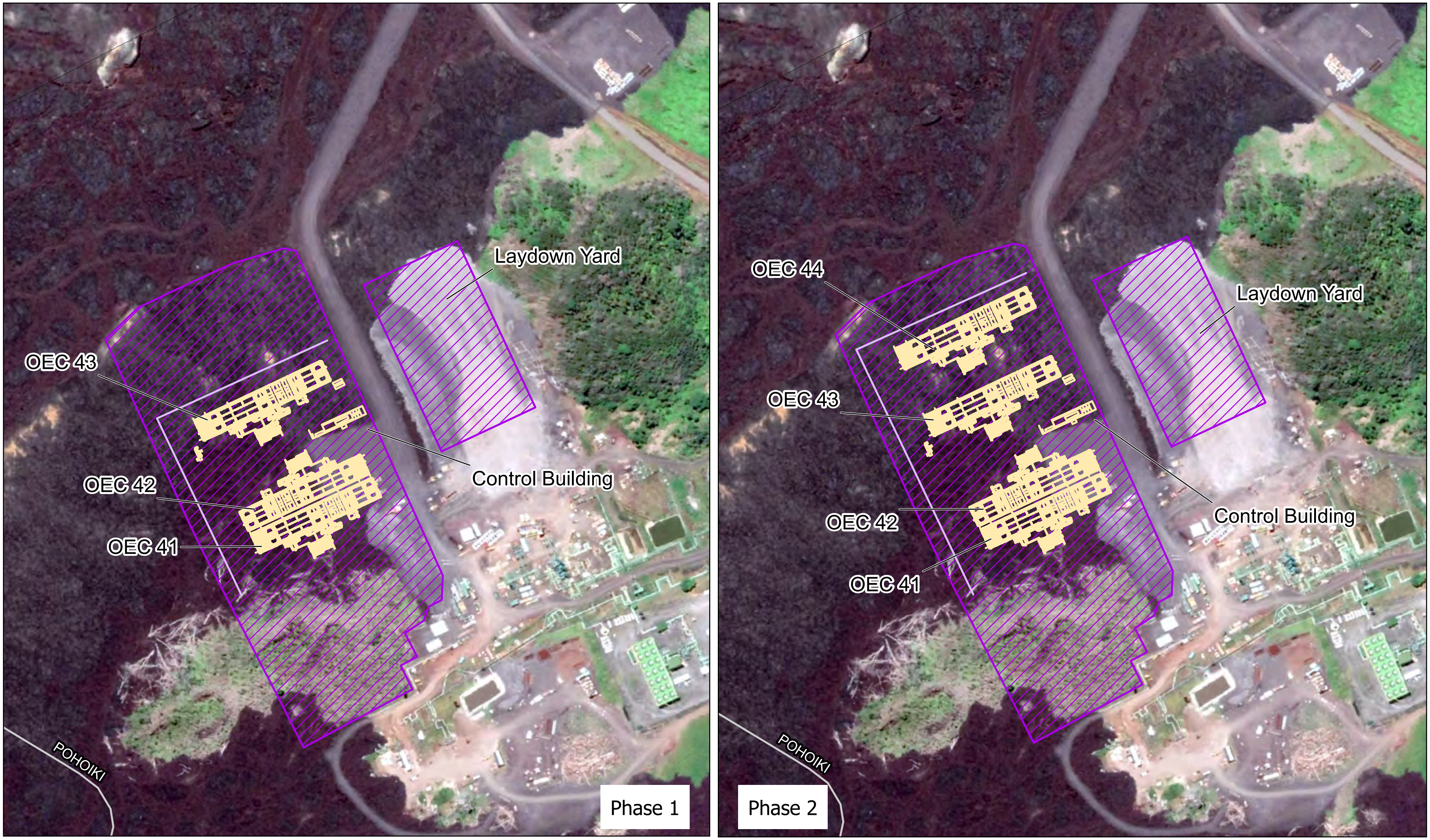
DATE: 2023-02-06 | PROJECT NO: 185805496

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 2
Existing Facilities

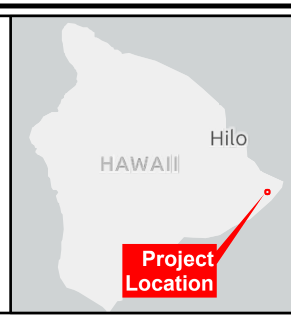
V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: btaylor

Service Layer Credits: Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- Proposed Disturbance Area
- Proposed Facilities
- Proposed Screening Wall



N

0 200 400 Feet

1 in = 400 feet

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GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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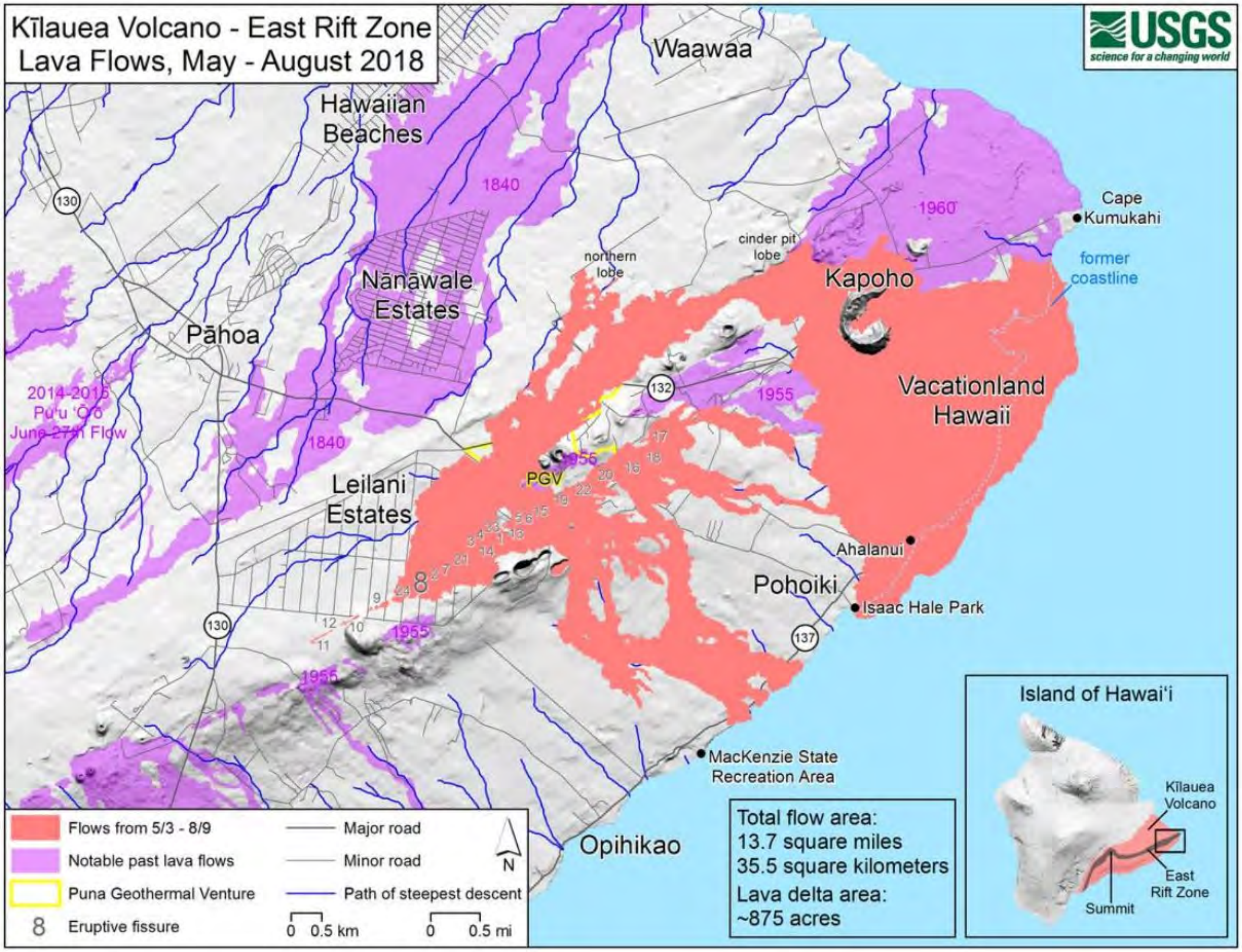
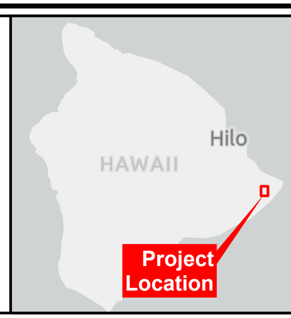
DATE: 2023-04-07	PROJECT NO: 185805496	

Figure 3
Proposed Project

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-04-07 By: jordavis

Service Layer Credits: Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
World Imagery: Resource Mapping Hawaii, Maxar





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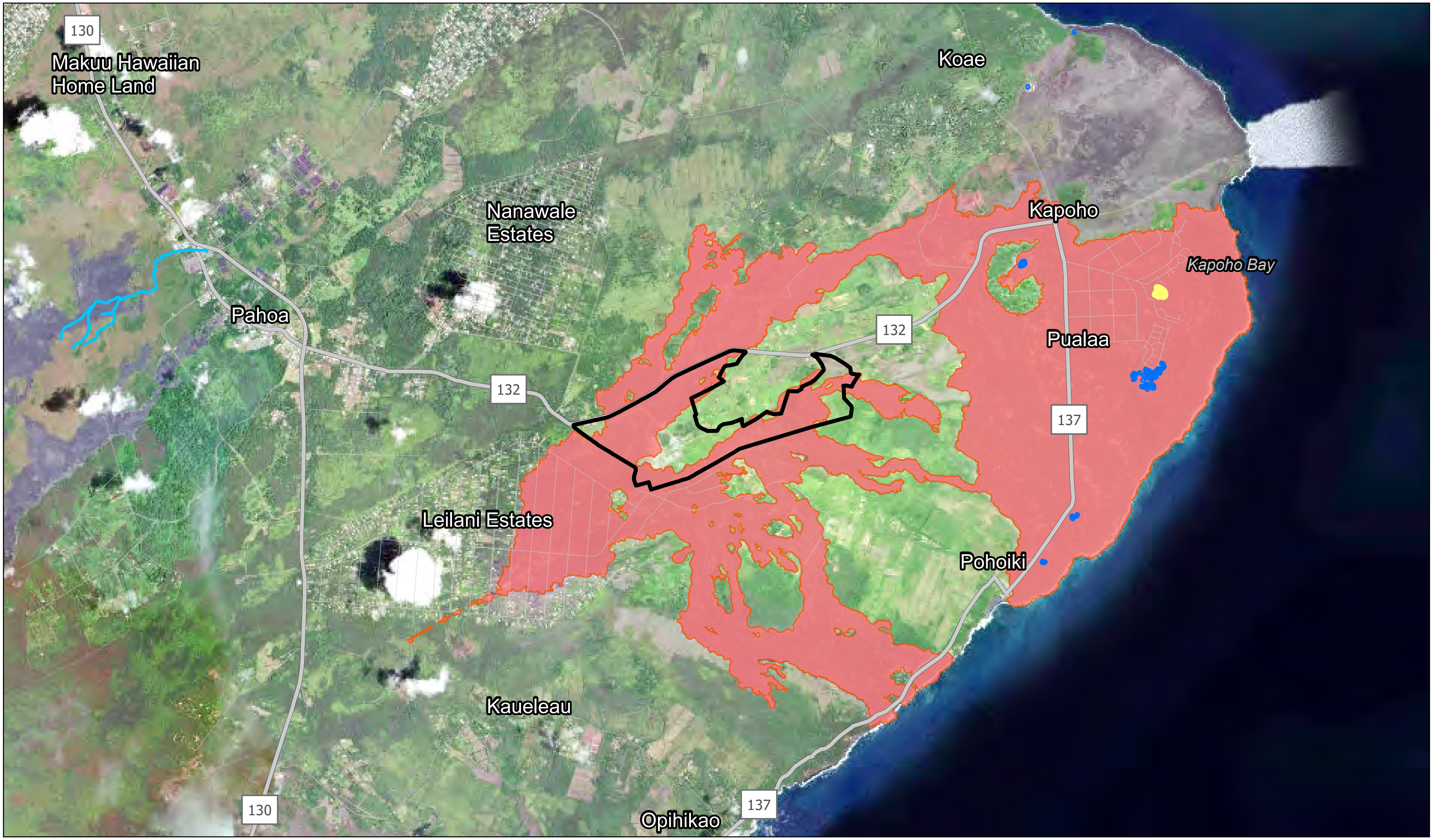
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 4
Lava Flows in the East Rift Zone

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: botaylor

Service Layer Credits: Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- PGV Property Boundary
- 2018 Lava Flow

NHD Flowlines

- Intermittent

NHD Waterbody

- LakePond
- Reservoir

N

Stantec

US Feet
0 3,500 7,000
1 in = 7,000 feet

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ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 5
National Hydrography Dataset Surface Water Features

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: botaylor

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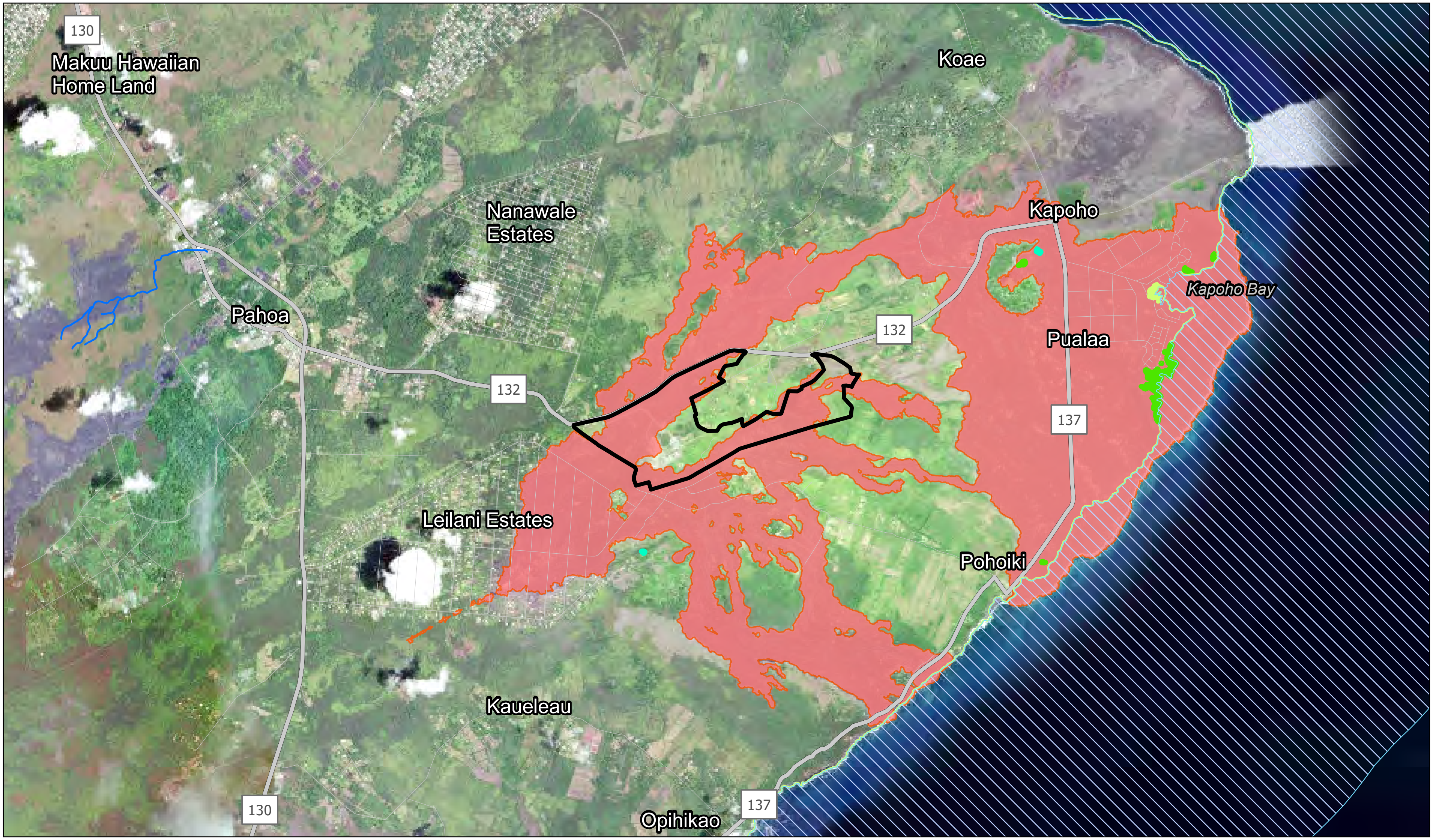
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

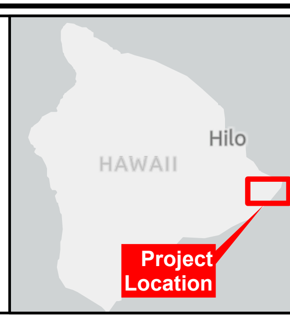


Legend

- PGV Property Boundary
- 2018 Lava Flow

USFWS Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Riverine



N

Stantec

0 3,500 7,000 US Feet

1 in = 7,000 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2023-02-06	PROJECT NO: 185805496	

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Figure 6
Wetland Features

V:\2037\Active\185805496\Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: btaylor

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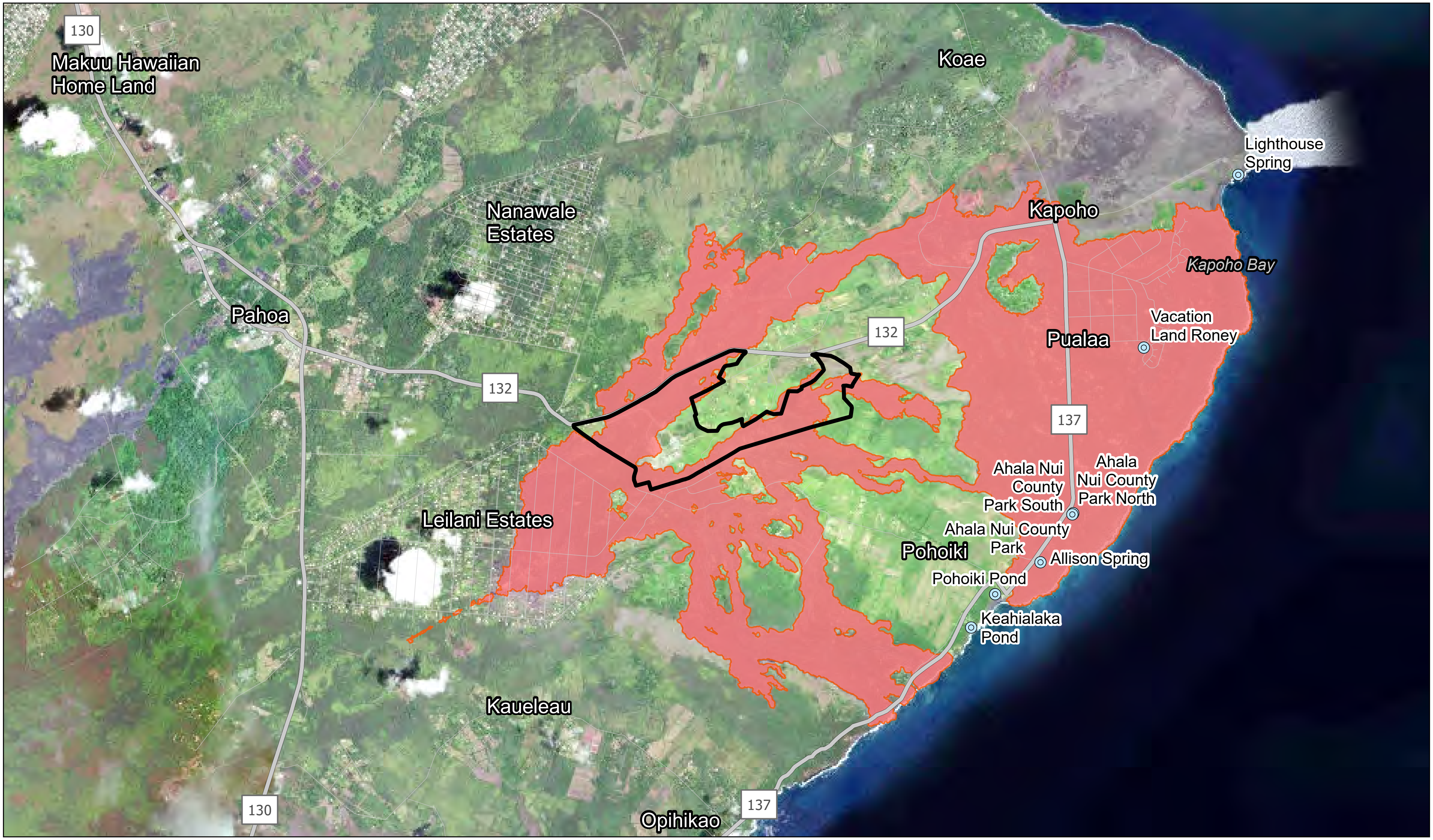
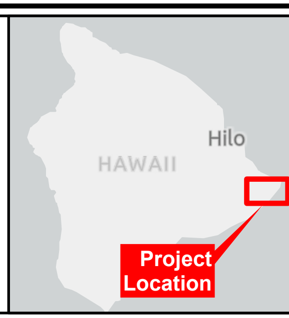
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- PGV Property Boundary
- 2018 Lava Flow
- Coastal Spring



N

Stantec

0 3,500 7,000 US Feet

1 in = 7,000 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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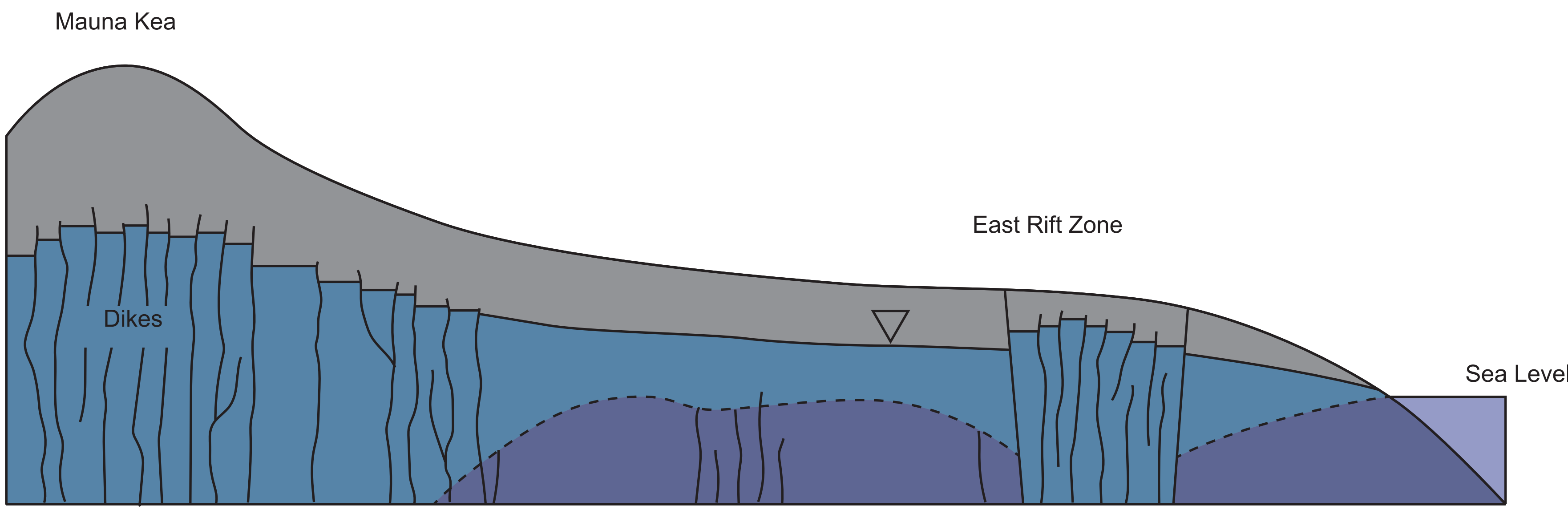
DATE: 2023-02-06	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 7
Coastal Springs

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: btaylor

Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- Water Table
- Fresh Water
- Unsaturated
- Salt Water

Stantec

Not to Scale

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Hawaii County, HI

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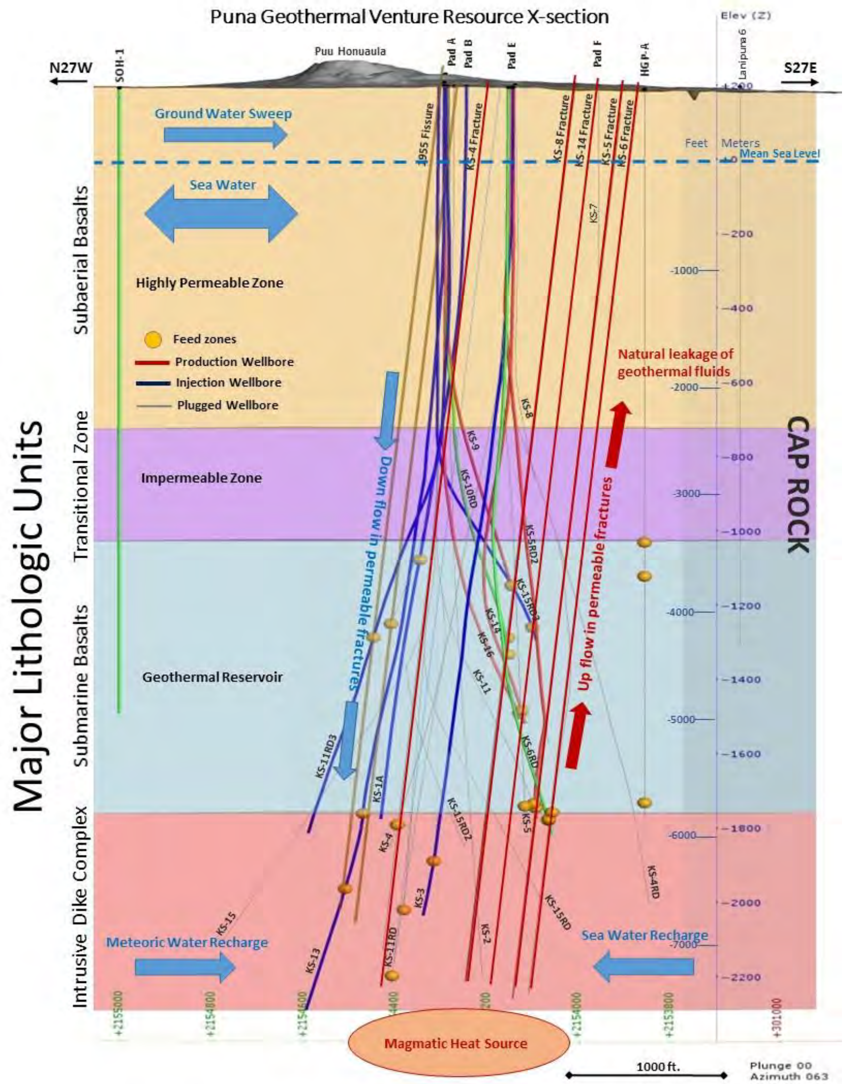
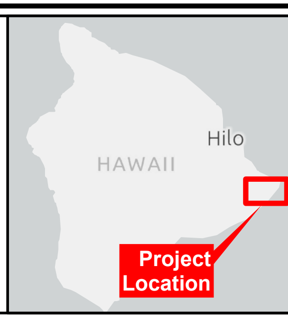
DATE: 2022-12-19 | PROJECT NO: 185805496

Figure 8
Generalized Hydrogeology Section



Legend



Stantec

Not to Scale

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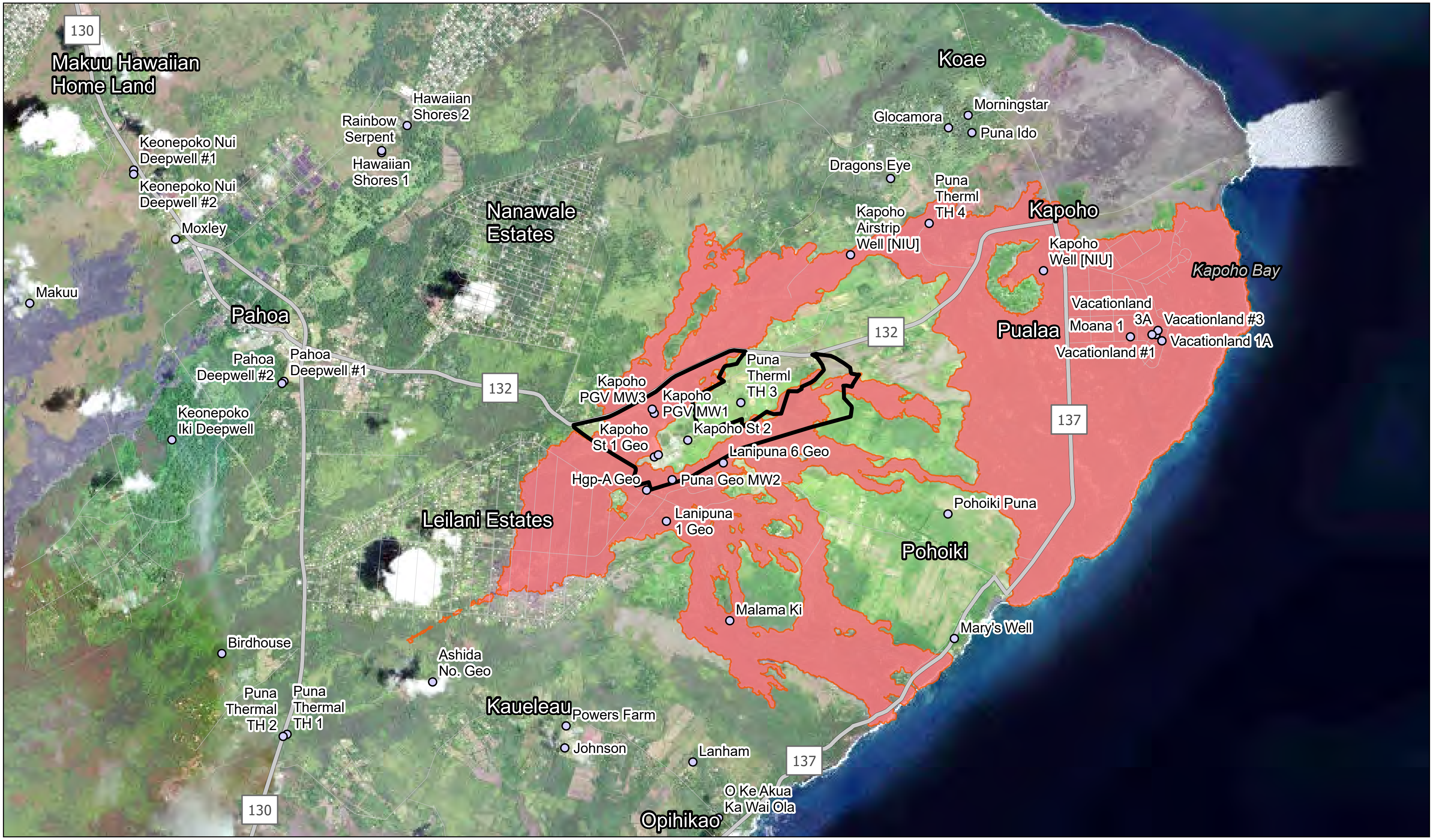
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: SS
DATE: 2022-12-19	PROJECT NO: 185805496	

Figure 9
Generalized Hydrogeology and Geothermal Model

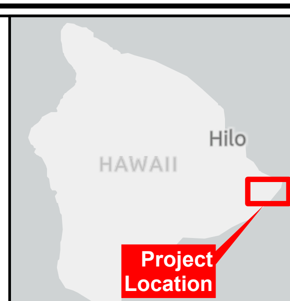


Legend

PGV Property Boundary

2018 Lava Flow

Well



N

Stantec

0 3,500 7,000 US Feet

1 in = 7,000 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2023-02-06	PROJECT NO: 185805496	

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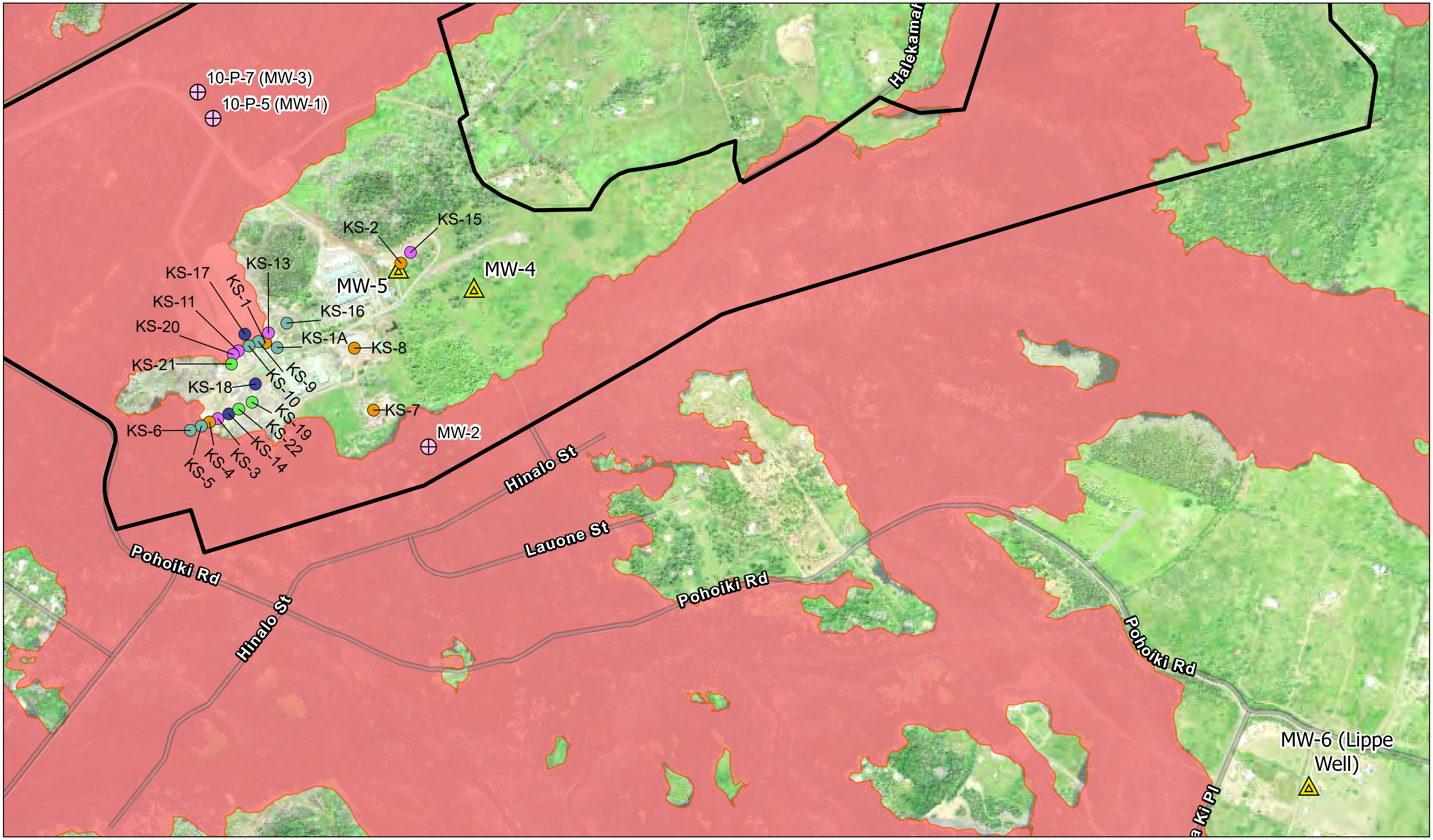
Figure 10
Area Wells

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: botaylor

Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

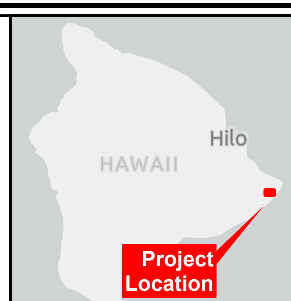


Legend

- PGV Property Boundary
- 2018 Lava Flow
- Current Monitoring Wells
- Historical Monitoring Wells

PGV Wellheads

- Idle
- Injection
- Plugged and Abandoned
- Planned
- Production



N

Stantec

0 600 1,200 US Feet

1 in = 1,200 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2023-02-06	PROJECT NO: 185805496	

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ENVIRONMENTAL IMPACT STATEMENT

Figure 11
Production, Injection and Monitoring Wells

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Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Hybrid Reference Layer: Esri Community Maps Contributors, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, US Census Bureau, USDA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

Legend

Proposed Disturbance Area

Biological and Archaeological Survey Area

N

Stantec

Feet

0 150 300

1 in = 300 feet

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GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 12
Biological and Archaeological Survey Area

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna_EIS_20230203\Puna_EIS_20230203.aprx Revised: 2023-02-06 By: botaylor

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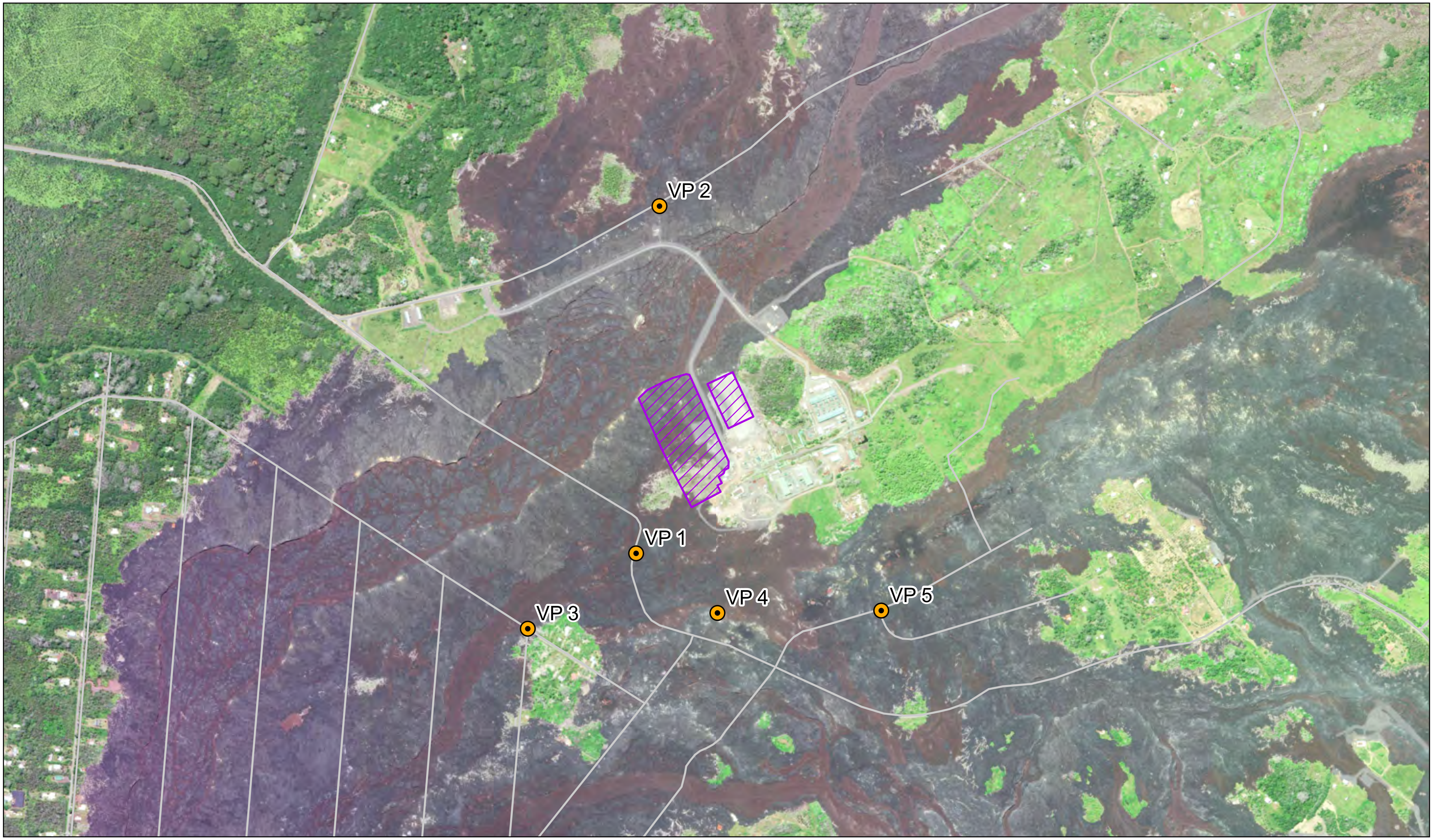
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

Proposed Disturbance Area

Viewpoints

Feet

0 750 1,500

1 in = 1,500 feet

Stantec

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2023-02-07 | PROJECT NO: 185805496

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 13
Viewpoints for Visual Analysis

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Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

a) View to the north-northeast from a point above the path of Pāhoa-Pohoiki Road, which was destroyed during the 2018 Lower Puna eruption. Existing OECs are visible in the right portion of the view, as close as a third of a mile away.

b) View from VP 1 with Phase 1 of the Proposed Action simulated and existing OECs removed.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 14a
Viewpoint 1

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\AestheticsTitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

c) View from VP 1 with Phases 1 and 2 of the Proposed Action simulated.

Printed at 100% (11″ x 17″), this image should be held approximately 17 inches from the viewer to best approximate the focal length of an actual view of the proposed Project.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

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DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 14b
Viewpoint 1

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\Aesthetics\TitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

Service Layer Credits:

a) View to the north-northeast from a point above the path of Pāhoa-Pohoiki Road, which was destroyed during the 2018 Lower Puna eruption. Existing OECs are visible in the right portion of the view, as close as a third of a mile away.

b) View from VP 1 with Phase 1 of the Proposed Action simulated and existing OECs removed.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 15a
Viewpoint 2

c) View from VP 2 with Phases 1 and 2 of the Proposed Action simulated.

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ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 15b
Viewpoint 2

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\Aesthetics\AestheticsTitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

Service Layer Credits:

a) View to the northeast from within a portion of Leilani Estates that was destroyed by the 2018 Lower Puna eruption, above the former path of Pohoiki Road. Existing OECs are detectable in the center of the view, as near as 0.6 mile away

b) View from VP 3 with Phase 1 of the Proposed Action simulated and existing OECs removed.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 16a
Viewpoint 3

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\AestheticsTitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

c) View from VP 3 with Phases 1 and 2 of the Proposed Action simulated.

Printed at 100% (11” x 17”), this image should be held approximately 17 inches from the viewer to best approximate the focal length of an actual view of the proposed Project.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

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DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 16b
Viewpoint 3

a) View to the north from a point above and near the intersection of Leilani Avenue and Pāhoa-Pohoiki Road, in a part Leilani Estates destroyed by lava flow. Existing OECs are visible in the right portion of the view, as close as 0.3 mile away.

b) View from VP 4 with Phase 1 of the Proposed Action simulated and existing OECs removed.

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GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

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DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 17a
Viewpoint 4

c) View from VP 4 with Phases 1 and 2 of the Proposed Action simulated.

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PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 17b
Viewpoint 4

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\Aesthetics\AestheticsTitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

Service Layer Credits:

a) View to the north-northwest from a point above and near the intersection of Hinalo Street and Lauone Street within Lanipuna Gardens, where a portion of the existing PGV project is visible in the center of the view.

b) View from VP 5 with Phase 1 of the Proposed Action simulated.

Stantec

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 18a
Viewpoint 5

c) View from VP 5 with Phases 1 and 2 of the Proposed Action simulated.

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Stantec

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GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2023-02-06	PROJECT NO: 185805496	

Figure 18b
Viewpoint 5

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna Aesthetics\Aesthetics\AestheticsTitleBlockSimulations\AestheticsTitleBlockSimulations.aprx Revised: 2023-02-06 By: jordavis

Service Layer Credits:

APPENDIX B

SCOPING DOCUMENTS

EIS PREPARATION NOTICE

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Mayor

Lee E. Lord
Managing Director

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74-5044 Ane Keohokālole Hwy
Kailua-Kona, Hawaiʻi 96740
Phone (808) 323-4770
Fax (808) 327-3563

County of Hawaiʻi
PLANNING DEPARTMENT

Zendo Kern
Director

East Hawaiʻi Office
101 Pauahi Street, Suite 3
Hilo, Hawaiʻi 96720
Phone (808) 961-8288
Fax (808) 961-8742

July 18, 2022

Mary Alice Evans, Director
Office of Planning and Sustainable Development
Environmental Review Program
235 S. Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Ms. Evans,

SUBJECT:	**Publication of the Environmental Impact Statement Prep Notice (EISPN) for the Proposed Puna Geothermal Venture Repower Project**
Applicant:	**Puna Geothermal Venture**
Location:	**Pāhoa, Puna District, Island of Hawaiʻi, State of Hawaiʻi**
TMK(s):	**(3) 1-4-001:001; (3) 1-4-001:002; (3) 1-4-001:019**

With this letter, the County of Hawaiʻi Planning Department determines that an Environmental Impact Statement is required, in accordance with Hawaiʻi Administrative Rules Section 11-200.1-23(a). We hereby transmit this EISPN determination for the Puna Geothermal Venture Repower Project, located in the Puna District, on Hawaiʻi Island, for publication in the next edition of "The Environmental Notice" on July 23, 2022.

If there are any questions regarding this letter, please contact April Surprenant at (808) 961-8288 or via email at planning@hawaiicounty.gov.

Sincerely,

ZENDO KERN
Planning Director

Puna Geothermal Venture Repower Project
Environmental Impact Statement Preparation Notice

Prepared for: County of Hawai‘i Planning Department

July 2022

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Project Information Summary

Project Name:	Geothermal Repower Project
Applicant:	Puna Geothermal Venture P.O. Box 30 Pāhoa, HI 96778 Contact: Mike Kaleikini Phone: 808-369-9094 Email: mkaleikini@ormat.com
Accepting Authority:	County of Hawaii Planning Department Aupuni Center 101 Pauahi Street, Suite 3 Hilo, HI 96720 Phone: 808-961-8288
Planning Consultant:	Stantec Consulting Services Inc. P.O. Box 191 Hilo, HI 96721 Contact: Michele Lefebvre Phone: 808-494-2039 Email: michele.lefebvre@stantec.com
Location:	14-3860 Kapoho-Pāhoa Road Pāhoa, HI 96778
District:	Puna
Tax Map Keys:	(3) 1-4-001: 001, 002, and 019
Land Area:	815 acres
Recorded Fee Owner	Kapoho Land & Development Co. Ltd
Existing Use:	Portions include Puna Geothermal Venture facility, and portions undeveloped
State Land Use District:	State Land Use Agricultural District
Lava Flow Hazard Zone	LF1
Special Management Area:	Not within the Special Management Area
Zoning:	A-10a (Agricultural District, minimum building site of 10 acres)
Flood Zone Designation:	Zone X
Proposed Action:	See Section 2.0
Chapter 343, HRS Trigger(s):	Under a recent new interpretation of statutory definitions of “land” by the PUC, the heat extracted from the geothermal fluid beneath the site, a resource to which the State of Hawai`i claims title, is state “land,” so the Project’s continued use of the geothermal resource triggers environmental review. (1) Propose the use of state or county lands or the use of state or county funds
Agencies to be Consulted:	See Section 5.0

List of Acronyms and Abbreviations

AAQS	Ambient Air Quality Standards
ARPPA	Amended and Restated Power Purchase Agreement
BLNR	Board of Land and Natural Resources
BOP	Balance of Plant
CDA	Hawai‘i Civil Defense Agency
CDP	Census Designated Place
CFR	Code of Federal Regulations
CIA	Cultural Impact Assessment
CO	Carbon monoxide
CO_2	Carbon dioxide
DBEDT	Department of Business, Economic Development & Tourism
DOH	Hawai‘i Department of Health
EA	Environmental Assessment
EIS	Environmental Impact Statement
EISPN	Environmental Impact Statement Preparation Notice
EPA	Environmental Protection Agency
ERC	Hawai‘i Emergency Response Commission
ERP	Emergency Response Plan
ERSF	Emergency Steam Release Facility
GHG	Greenhouse gas
GRP	Geothermal Resource Permit
H_2	Hydrogen gas
H_2S	Hydrogen sulfide
HAPs	Hazardous air pollutants
HAR	Hawaii Administrative Rules
Hawaiian Electric	Hawaiian Electric Company
HCEI	Hawaii Clean Energy Initiative
HELCO	Hawaiian Electric Light Company, Inc.
Hg	Mercury
HRS	Hawaii Revised Statute
ITLU	Integrated two level unit
kph	kilo-pounds per hour
kV	Kilovolt
LERZ	Lower East Rift Zone
MW	Megawatts
N_2	Nitrogen gas
NAAQS	National Ambient Air Quality Standards
NCG	Non-Condensable Gas
NOx	Nitrogen oxides
OEC	Ormat energy converter
OPSD	Office of Planning and Sustainable Development
Ormat	Ormat Technologies, Inc.
PGV	Puna Geothermal Venture
PPA	Power Purchase Agreement
PUC	Public Utilities Commission
Rn	Radon
RPS	Renewable Portfolio Standard
SO_2	Sulfur dioxide
TSP	Total suspended particulates
U.S.	United States
UIC	Underground Injection Control

USGS	U.S. Geological Survey
VRMU	Vapor Recovery Maintenance Unit
VRU	Vapor Recovery Unit

1.0 Introduction

1.1 Project Introduction and Overview

Puna Geothermal Venture (PGV), a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant in the Puna District on Hawaiʻi Island and proposes to replace the current 12 operating power-generating units with up to four upgraded power-generating units (Project). The proposed Project would be constructed within the current PGV facility site fence line, would have a smaller footprint of disturbance than the current units, and would increase power production from 38 to 46 megawatts (MW) in Phase 1 and further increase production to 60 MW in Phase 2. The location of the facility as well as existing and proposed Project features are shown on Figures 1 through 3. The site is located on private property and is leased by PGV.

Why this Environmental Impact Statement is Being Prepared: History of PGV's Power Purchase Agreements

To generate the proposed increase in power, PGV needs approval from the Public Utilities Commission (PUC) of the Amended and Restated Power Purchase Agreement (ARPPA) consistent with the State of Hawaiʻi Public Utilities Law (Chapter 269, Hawaiʻi Revised Statutes [HRS]). This section provides the context of the approved Power Purchase Agreements (PPAs) for the Project.

According to the original PPA (signed on March 24, 1986), PGV agreed to provide a capacity of 25 MW of energy on-peak, and 22 MW off-peak, to Hawaiian Electric Light Company, Inc. (HELCO)[1], the utility company which serves Hawaiʻi Island. In August 1987, although there was no statutory trigger, an Environmental Impact Statement (EIS) for the now operating power plant was voluntarily prepared by PGV in accordance with Chapter 343, HRS (commonly referred to as HEPA) and the Hawaiʻi Administrative Rules (HAR) in effect at the time and submitted to the County of Hawaiʻi Planning Department. In November 1987, the EIS was published and the Hawaiʻi County Planning Commission approved the original Geothermal Resource Permit (GRP) for the geothermal power plant in 1987.

PGV came online in 1993 with a generating capacity of 25 MW and expanded to 30 MW in 1995, without adding any new equipment or drilling additional geothermal wells. The additional 5 MW was produced only by the increased use of steam. An additional 8 MW were added in an Expansion PPA in 2012, which allowed PGV to provide a total of 38 MW to HELCO. New generating equipment was added at that time, but no additional geothermal wells were required because the equipment used to generate the additional 8 MW was designed to utilize the hot fluid (or brine) from the existing geothermal resource.

PGV continued providing renewable geothermal energy to HELCO which distributed the energy around Hawaiʻi Island until 2018. In May 2018, approaching lava from the 2018 eruption of Kīlauea on the Lower East Rift Zone (LERZ) inundated the main access road to the power plant, the wellheads of two geothermal wells, the substation of the complex, and an adjacent warehouse that stored a drilling rig. PGV restored the damaged access and facilities and on November 5, 2020, electricity production partially resumed. PGV continued the geothermal field recovery work to increase the production of energy since then and as of early 2022, PGV currently produces approximately 25.7 MW.

Since the previous PPA's term was set to expire on December 31, 2027, PGV proposed to upgrade to more efficient equipment and make associated improvements to the original facility. PGV and HELCO reached an agreement on the ARPPA which would combine the two existing PPAs into one PPA, repower the existing plant using the same amount of geothermal resource, extend the term until 2052, increase capacity of the geothermal plant to 46 MW, and delink pricing for energy from oil costs with no escalation. The ARPPA was filed within the PUC on December 31, 2019, for its review and approval (Docket No. 2019-0333).

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[1] Hawaiian Electric Company is the parent company of HELCO.

The PUC suspended the docket reviewing the ARPPA on March 31, 2021, pending Ormat's submittal of a Supplemental EIS pursuant to Chapter 343, HRS and Chapter 11-200.1, HAR, however, the PUC declined to be the accepting authority for any environmental review and deferred such authority to another undetermined agency that would serve as the accepting authority for the environmental review.

In letters dated November 2, 2021, and March 22, 2022, the State of Hawaiʻi Office of Planning and Sustainable Development (OPSD) responded to PGV's request to designate an approving agency for the environmental review. The OPSD designated the County of Hawaiʻi Planning Department as the approving agency for the Project for any environmental review that is required. The County of Hawaiʻi Planning Department was selected as a permissible approving agency under HRS Section 343-5 because the Proposed Action will occur on Hawaiʻi island, the Planning Department is capable of overseeing the Chapter 343 process, has the greatest expertise or access to information, and has the greatest participation because it would be issuing ministerial permits, such as a Grading and Grubbing Permit, for the Project.

On November 5, 2021, in Order No. 38063 following OPSD's designation, the PUC lifted the suspension of the docket and stated it would proceed with its review of the ARPPA concurrently with Hawaiʻi County's environmental review. In response to these events, the County of Hawaiʻi Planning Department determined that an EIS was the appropriate level of environmental review for the Project to satisfy the PUC's request for environmental review and to assure a comprehensive understanding of the environmental aspects of the proposed Project. On March 16, 2022, the PUC approved the ARPPA (Decision and Order No. 38276) with conditions that the "HEPA review" be complete prior to the commencement of Project construction.

The EIS will be prepared in accordance with Chapter 343, HRS and Chapter 11-200.1 HAR. The Project covered by the EIS proposes to upgrade equipment and associated infrastructure. Under a recent new interpretation of statutory definitions of "land" by the PUC, the heat extracted from the geothermal fluid beneath the site, a resource to which the State of Hawai`i claims title, is state "land," so the Project's use of the geothermal resource triggers environmental review. The property is held in private title and no state or county funds are proposed to be used for the Project.

1.2 Proposed Action

The Project is an upgrade to an existing facility. PGV operates the first commercial geothermal power plant and associated geothermal wellfield in the State of Hawaiʻi. Current production of electric power at PGV includes production wells, injection wells, a steam plant, a brine plant, and associated infrastructure. The Project would replace existing geothermal energy converters with more efficient energy converters using the same geothermal energy source. The increase in power production during Phase 1 would be 8 MW (from 38 MW to 46 MW), or an approximately 21 percent increase. The overall property size would remain 815 acres. Most of the existing infrastructure and buildings would remain for the Project including administration buildings, the control room, maintenance areas, well pads, and the gathering system. As part of the Project, the existing 12 steam and brine energy converters would be replaced with three new energy converters in Phase 1 (and one (1) additional converter in Phase 2) at a new location on the site (**Figure 3**). The amount of power generated in Phase 1 matches the amount approved in the ARPPA. PGV would need to further amend the agreement prior to implementing Phase 2 which would increase power generation to 60 MW (30 percent increase from 46 MW).

The Project would also install new piping and reduce existing steel structures, piping, mechanical components, and associated flange connections (associated with the replacement of the currently operating equipment).

1.3 Project Background and Purpose

The Project would increase the production of renewable energy at the existing facility (within the current site fence line) using new geothermal power-generating units on a smaller land footprint compared to the existing units.

Hawaiʻi's Current Energy Mix

The current energy mix for Hawaiʻi consists of both fossil fuels and various sources of renewable energy. Hawaiian Electric Company (which provides electricity for 95 percent of residents of the state on Oahu, Maui, Molokai, Lanai, and Hawaiʻi Island) tracks its sales of renewable energy (Hawaiian Electric 2022a). The exact mix of renewables produced in Hawaiʻi is a product of complex and in-flux considerations of fossil fuel prices, renewable energy technologies, renewable energy regulations and policies, consumption patterns, a grid adapting to distributed generation, environmental impacts, perceptions of different energy production by residents, and investor interest. In this context, it is useful to briefly consider a comparison of energy production in the State, the position of geothermal energy relative to the current renewable energy policies and goals, and the role of geothermal energy in the local production and consumption of electricity.

Hawaiʻi's geographic isolation has historically required Hawai'i to import fuel resources to meet its energy needs for electricity as well as land, sea, and air transportation. In 2021, approximately 80 percent of Hawaiʻi's energy was met by imported petroleum (which is consistent with figures from previous years), making Hawaiʻi the most petroleum-dependent state in the nation. Since there are no local sources of fossil fuel, the state is dependent on imported petroleum for both transportation and electricity generation. This dependence on imported petroleum for generating electricity and the isolated island grids contribute to Hawaiʻi having the highest average electricity retail price of any state, and nearly triple the United States (U.S.) average rate (U.S. Energy Information Administration 2022). With the current dramatic rises in fossil fuel prices, electricity costs for island residents is predicted to increase an additional 20 percent (Hawaii Tribune-Herald 2022).

In 2017, greenhouse gas (GHG) emissions from the energy sector accounted for 86 percent of Hawaiʻi's total GHG emissions. Of the 86 percent generated by the energy sector, stationary combustion facilities (e.g., electric power plants, petroleum refineries and fugitive emissions from petroleum refineries, and industrial facilities) generated the second most GHG emissions after transportation at 46 percent (HSEO 2022a).

In addition to petroleum and imported resources, Hawaiʻi utilizes renewable resources to produce electricity throughout the state, including solar power, onshore wind resources, biomass, hydropower, geothermal, and other developing hydro-related technologies.

Hawaiʻi Renewable Energy Goals and Policies

The Hawaiʻi Clean Energy Initiative (HCEI) was established to reduce the state's dependence on imported petroleum for energy production and locally produce more clean energy. The HCEI was launched in 2008 when a Memorandum of Understanding was signed between the state and the U.S. Department of Energy and developed a framework of statutes and regulations to establish renewable energy goals and policy. The original goal was for Hawaiʻi to meet 70 percent of its total energy needs through clean sources by 2030.

HCEI's renewable energy and energy efficiency targets, which have been codified into law, drive Hawaiʻi's clean energy policy agenda. Other policy actions include regulatory reform to tax policy and clean energy financing. The state exceeded the HCEI original target to achieve a 2015 renewable portfolio standard (RPS) of 15 percent, and in 2018 the state was generating 27 percent of its electricity sales from clean energy sources (HCEI 2018). In May 2015, the state set its goals higher and the adopted an RPS of 100 percent by 2045 with interim targets of 30 percent by 2020 (which was met, reaching 35 percent), 40 percent by 2030, and 70 percent by 2040. HCEI identified the following objectives to help meet that goal:

- Define the new infrastructure needed for a clean energy economy;
- Foster and demonstrate innovation in the use of clean energy technologies, creative financing, and public policy to accelerate the transition to clean energy;
- Create economic opportunity by developing and diversifying Hawaiʻi's economy;

- Establish an open-source learning model that supports other island communities with similar goals; and
- Build a workforce with new skills that form the foundation of an energy-independent Hawai‘i (HCEI 2022).

Additionally, Hawaiian Electric has committed to helping to achieve the state's goals of increasing Hawai‘i’s use of clean energy and reducing dependency on imported oil, with a goal to cut carbon emissions from power generation by 70 percent by 2030 (from 2005 levels) and to achieve net zero or net negative carbon emissions (i.e., if there are any emissions, they will be captured or offset) by 2045. The key elements to meet this goal include the shutting down of the state’s last coal plant on Oahu in 2022, adding rooftop solar systems, retiring at least six fossil-fueled generating units and reducing the use of other fossil fuel units as new renewable resources come online, adding community-based renewable energy, using more grid-scale and customer-owned energy storage, expanding geothermal resources, and creating customer incentives to change patterns of energy use (Hawaiian Electric 2021a).

State Renewable Energy Production

In 2021, Hawaiian Electric Company (Hawaiian Electric) reported the percentage of renewable energy generated in the state was 38 percent (for a total of 468,039 customers) (Hawaiian Electric 2021b). The island of Kaua‘i is powered by a utility cooperative owned by Kaua‘i energy users (the Kaua‘i Island Utility Cooperative), which achieved 67 percent renewable energy generation in 2020 (HSEO 2022b).

In 2021, Hawaiian Electric reported the following breakdown of renewable power generation facts:

- For its 307,378 customers, Oahu generated **32.8 percent** of its energy through renewable resources (with a peak of 69.8 percent on March 17, 2021);

- For its 87,357 customers, Hawaii Island generated **60 percent** of its energy through renewable resources (with a peak of 87 percent on July 1, 2021);

- For its 73,304 customers on Maui, Molokai, and Lanai, Maui County generated **50.2 percent** of its energy through renewable resources (with a peak of 76.3 percent on September 26, 2021) (Hawaiian Electric 2021b).

The 2021 percentage of 38 percent of electricity sales from renewable resources in the state was an increase from 34.8 percent in 2020, and 28.4 percent in 2019 (Hawaiian Electric 2022b).

Hawai‘i Island Renewable Energy Production

Hawai‘i Island currently has the highest percent of energy among Hawaiian Electric powered islands generated by renewable resources in the state[2]. The mix of firms and resources that generated power in 2021 are included in **Table 1-1** below, and include oil (40 percent) and renewables (60 percent) including sources from geothermal, hydroelectricity, wind, and solar.

Table 1-1 Power Generation on Hawaii Island in 2021

Type of Source	Source Name	Amount Generated (Megawatts)
Firm Generation[1]		
Hawaiian Electric Plants (Oil)	Keahole	77.6
	Puna	36.7
	Kanoelehua	21.0

[2] Hawaiian Electric does not provide power on Kauai, so this comparison includes Oahu, Maui County, and Hawai‘i Island.

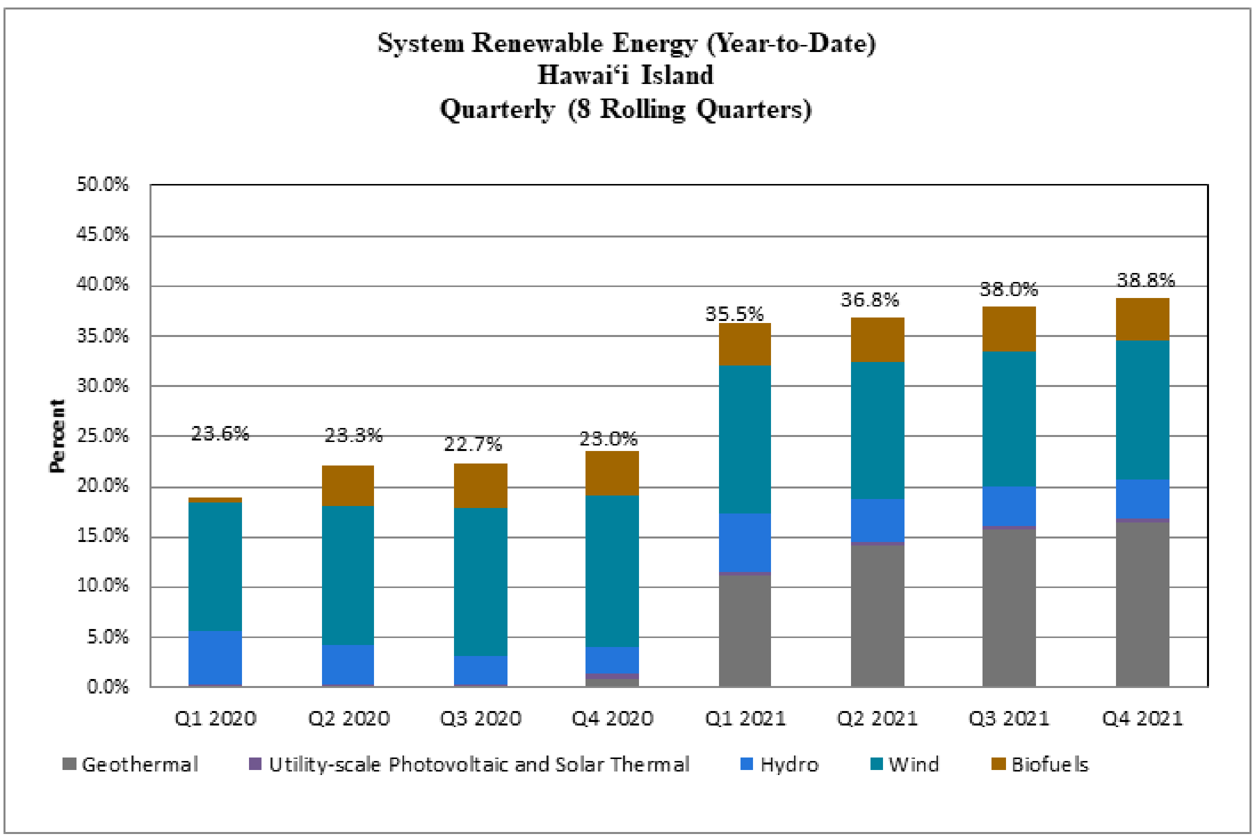
Type of Source	Source Name	Amount Generated (Megawatts)
	Waimea	7.5
	Hill	5.5
	Dispersed generation	5.0
Independent Power Producers	Hamakua Energy (Oil)	60.0
	Puna Geothermal Venture (Geothermal)	38.0
	Total firm capacity	**251.3**
Variable (As-Available) Generation		
Hawaiian Electric Plants	Puueo Hydro	3.4
	Waiau Hydro	1.1
Independent Power Producers	Pakini Nui Wind, Wailuku River Hydro, Hawi Renewable Development, Customer-site renewable, Shared Solar	150.9
	Approximate non-firm capacity	**155.4**

Source: Hawaiian Electric 2022a

[1] Retired Units: Shipman (oil) (capacity: 15.2 MW): 0 MW generated in 2021

The amount of power generated on Hawaiʻi Island from renewable energy in 2020, before PGV came back online, was between 22.7 percent and 23.6 percent (Graph 1). With the production of energy from geothermal resources at PGV, Hawaiʻi Island was able to increase this amount to approximately 38 percent in 2021 (Hawaiian Electric 2022a).

Graph 1 Hawaii Island Percent System Renewable Energy



Source: Hawaiian Electric 2022a

Hawaiian Electric also identifies additional solar, biomass, and energy projects in development on Hawai‘i Island, which would add approximately 184.5 MW if they come online (Hawaiian Electric 2021b).

Project Purpose

The purpose of the Project is to continue supplying electrical power produced using renewable geothermal resources in response to Hawaiian Electric’s forecasted need for energy on Hawai‘i Island. According to the PUC, “in addition to providing new energy and firm dispatchable capacity, the 8 MW upgrade increases PGV’s ability to provide inertia and useful grid services such as primary frequency response, and reactive power to Hawaiian Electric’s system.” The upgrades would be useful and complementary to other generators and to those expected to be added in the coming years.

The proposed upgrades, described in further detail below in Section 2.2, would occur in two phases to adapt to HELCO's projected increase in energy demand. The Project is consistent with both state and county goals to increase efficiency at an operating power facility to generate more energy for the residents of Hawai‘i Island in an area already set aside for this purpose, reducing energy costs for residents, and decreasing Hawai‘i’s reliance on imported fossil fuels.

1.4 Alternatives

The Project (the Proposed Action) consists of upgrading certain generating equipment and increasing geothermal energy production at an existing operating facility. The applicant, PGV, is a geothermal power producer with no plans to investigate different alternative energy sources in Hawai‘i County such as solar, wind, tidal power, or biomass. Neither PGV nor Ormat have additional land positions for geothermal energy that would give them the ability to utilize other locations on Hawai‘i Island or elsewhere in the state to commercially produce energy using geothermal resources. Further, PGV is not proposing to work with HELCO or Hawaii Electric to export the energy generated at the PGV facility from Hawai‘i Island.

Therefore, the only practical alternative to the Proposed Action is the No Action Alternative. Under this alternative, Ormat would not upgrade equipment at the PGV facility. Since the proposed location of the upgraded energy generating units is within the current PGV site and within the Kapoho Section of the Kīlauea Lower East Rift Geothermal Resource Subzone, future actions at the site would likely be associated directly or indirectly with energy production although other land uses including farming, tourism, or housing would not be precluded. These future actions would depend on many factors including the market and government permitting and are not proposed at this time. For the purposes of analysis in the anticipated EIS for the Project, however, the No Action Alternative considers mainly the consequences of the present situation, which is the current operation of the geothermal energy production facility through 2027 or an extended term of the PPA under the status quo conditions. This provides a useful baseline for comparison of impacts with the Proposed Action, and it will be actively considered throughout the EIS, as required by HEPA rules.

1.5 Geothermal Land Use Background and Project Location

Geothermal Resource Subzones: A Brief History

The development of geothermal energy began in Hawai‘i in 1961 with the drilling of the first exploratory wells. Under direction of the University of Hawai‘i, the Hawaii Geothermal Project (HGP) began in 1972, which led to the drilling of the first successful well in 1976 and to the construction of the 3 MW HGP-A operating plant in 1981, which was funded by the National Science Foundation and the U.S. Department of Energy with contributions by the state. The HGP-A plant operated for approximately eight years and demonstrated the technical and economic feasibility of geothermal energy in Hawai‘i. In an effort to promote use of indigenous resources for energy production, Hawai‘i’s State Legislature enacted the Geothermal Resource Subzone Assessment and Designation Law (296-83) determining that the development and exploration of Hawai‘i’s geothermal resources is of statewide concern, and that this interest must be balanced with preserving Hawai‘i’s unique social and natural environment (Yoshihara 1985).

Act 296-83 mandated the creation of “geothermal resource subzones” where geothermal development could take place, regardless of the existing land use classification (urban, rural, agricultural, and conservation). The intent was not to overhaul or displace the existing land use system but to add the requirement of a subzone procedure application to geothermal activities. The counties would continue to maintain jurisdiction and authority to approve site-specific activities on agricultural, rural, and urban lands, while the Board of Land Natural Resources (BLNR) would continue to maintain jurisdiction on conservation lands (Yoshihara 1985).

The subzones were defined in HRS Section 205-5.1 and designated subzones included: Lihue (Kaua‘i); Koolau and Waianae (Oahu); West Molokai (Molokai); Palawai (Lanai); Honolua, Lahaina, Olowalu, Haleakala Northwest Rift Zone, Haleakala Southwest Rift Zone, Haleakala East Rift Zone (Maui), and Kohala, Kawaihae, Hualalai, Mauna Kea Northwest Rift Zone, Mauna Kea East Rift Zone, Mauna Loa Northeast Rift Zone, Mauna Loa Southwest Rift Zone, Kīlauea Southwest Rift Zone, and Kīlauea East Rift Zone (Hawai‘i) (https://files.hawaii.gov/dbedt/op/gis/maps/geothermal_maps.pdf). However, HRS Section 205-5.1 was repealed by Act 97 (2012). Geothermal resource development is a permitted use in all State Land Use districts in accordance with HRS 205.2.

Project Location

The Project is located on an approximately 815-acre site in the Kapoho Section of the Kīlauea Lower East Rift Geothermal Resource Subzone, an area that has produced geothermal heat for hundreds of years and is expected to continue producing geothermal heat for hundreds of years to come.

It should be noted that the State of Hawai‘i owns all mineral rights (including geothermal resources) in the state, including those for the Project, and has issued a Geothermal Resources Mining Lease for the existing PGV facility under which the Project would continue to operate.

2.0 Project Description

2.1 Existing Operations

Construction and operation of the facility has been previously authorized under a variety of permits issued by the County of Hawaiʻi. The 1987 Puna Geothermal Venture Project EIS, as noted earlier, was submitted to the County of Hawaiʻi (PGV 1987). Ormat is the parent company of PGV and has over 56 years of experience in developing and operating geothermal power facilities and producing geothermal energy, and currently owns and operates over 1,000 MW of geothermal energy production, storage, photovoltaic solar, and recovered energy generation around the globe. The description provided below is a summary of the authorized and existing facilities and operations as of May 2022. Where applicable, the 1987 EIS is referenced in the description of authorized operations below.

2.1.1 Existing Operations: Geothermal Wells and Wellfield Facilities

The existing facility currently consists of five well pads (A, B, D, E, and F), of which three have operational wells (pads A, B, and E). Wells are spaced approximately 50 to 100 feet apart within the well pad and are drilled to a depth of approximately 4,000 to 8,000 feet below the surface. The piping subsystem begins downstream of the master shutoff valves at each wellhead and includes production, throttling, and isolation valves, and flow rate metering devices and instrumentation required for local or remote monitoring and control of each well. A rock catcher (rock particle separator) is installed immediately downstream of each wellhead. The subsystem includes a moisture separator that flashes the geothermal fluids into steam and brine fractions. A list of past and current wells is included in **Table 2-1**.

Table 2-1 Past and Current Wells at PGV

Well Number	Well Type	Status	Well Pad
KS-1	Plugged or covered	Out of Service	A
KS-1A	Injection	Out of Service	A
KS-2	Plugged or covered	Out of Service	B
KS-3	Injection	In Service	E
KS-4	Plugged or covered	Out of Service	E
KS-5	Production	Out of Service	E
KS-6	Production	Out of Service	E
KS-7	Plugged or covered	Out of Service	F
KS-8	Plugged or covered	Out of Service	D
KS-9	Production	Out of Service	A
KS-10	Production	Out of Service	A
KS-11	Injection	In Service	A
KS-13	Injection	In Service	A
KS-14	Production	In Service	E
KS-15	Injection	In Service	B
KS-16	Production	Out of Service	A
KS-17	Production	In Service	A
KS-18	Production	In Service	E
KS-19	Injection	Planned	E
KS-20	Injection	In Service	A
MW-4	Monitoring	In Service	B
MW-5	Monitoring	In Service	B

Source: EPA 2021

Monitoring Wells

Because groundwater monitoring wells MW-1, MW-2, and MW-3 were inundated by lava during a June 2018 eruption of the Kīlauea volcano, new groundwater monitoring wells were needed to maintain the number of monitoring wells at the site. Therefore, PGV replaced the inundated wells with two onsite monitoring wells, MW-4 and MW-5, and one offsite and downgradient monitoring well (Lippe Well at Pohoiki or MW-6).

Production and Injection Wells

Geothermal wells for the current operations are identified as either production or injection depending upon the performance of the well. Each production well has an approximate average flow rate of 90,000 pounds per hour of steam deliverable to the power plant. Injection wells are used to reinject brine and process fluids generated in the operation of the power plant back into the geothermal reservoir. Marginal geothermal production wells (wells that contained less than desired steam flow or steam fraction) can be converted into injection wells as needed.

Currently, PGV is permitted to operate six injection wells. An additional ten production wells could be converted to injection wells pursuant to the Environmental Protection Agency's (EPA's) Underground Injection Control (UIC) Permit (October 19, 2021) (EPA 2021). As of 2022, three production and five injection wells are in service. An additional eight injection wells were approved as part of the UIC Permit renewal.

The Project also operates under a State UIC permit, issued by the Hawai'i Department of Health (DOH) Safe Drinking Water Branch. The application for renewal of this permit was submitted in March 2020, and that renewal process is on-going with DOH.

2.1.2 Existing Operations: Gathering Systems

Three gathering systems—steam, condensate, and brine—are used to collect and transport fluids to the appropriate downstream processing units. All three gathering systems consist of independent piping networks that interconnect only where two streams are present. All pipes are engineered for stresses induced by thermal, pressure, dead, and seismic loads. The gathering systems generally follow the shortest route from the source to the destination; however, terrain, visual impacts, and existing road alignments partially dictate the layout. All pipelines are painted dark green or grey and vegetation is encouraged to grow around the pipes to minimize visual impacts.

The steam gathering system transports steam from the well pads to the turbine in the power plant. Steam pipelines begin as a single line from each well pad and join before reaching the power plant and include a moisture separator to remove any entrained water.

The condensate gathering system collects steam that condenses in the steam gathering pipelines at the two moisture separators and at low points in the steam gathering system. The condensate gathering system transfers the collected condensate, under pressure, to the steam turbine condenser.

The brine gathering system collects the brine generated at the well pad separator. The brine is transported to a heat exchanger in the power plant and then to the injection wells for reinjection into the geothermal reservoir.

2.1.3 Existing Operations: Power Plant

Electricity is generated in the steam power plant through the use of Ormat energy converters (OECs). PGV currently operates 10 OECs for power production. Geothermal steam powers the steam turbine which converts the energy into mechanical work, which is then used to rotate the generator, creating electricity. Depressurized steam leaves the turbine and enters into a heat exchanger where it boils pentane, a low boiling point hydrocarbon. In the process, the steam condenses and is collected into a holding tank at the bottom of the condenser. The vaporized pentane turns a binary turbine before being exhausted into an air cooler to be condensed. The liquid pentane then flows back into the heat exchanger to begin the 'closed loop' system again.

The steam entering the heat exchanger contains non-condensable gases (NCGs) including hydrogen sulfide (H_2S), carbon dioxide (CO_2), nitrogen gas (N_2), and hydrogen gas (H_2). These gases are removed using a steam ejector vacuum system, compressed, and piped into the reinjection system.

The hot geothermal brine is pumped to a heat exchanger located in an OEC. In the heat exchanger, the brine boils pentane, a low boiling point hydrocarbon. The lower temperature brine is collected and combined with the condensed steam before being piped into the reinjection system. The vaporized pentane turns a binary turbine and is then treated in a similar manner as described above.

Each turbine is equipped with a bypass system so that it can operate even during turbine upset conditions or plant start-up. Steam turbine bypass valves open and the pentane 'closed-loop' would continue to operate.

Integrated Two Level Units

PGV currently operates two integrated two level units (ITLUs) for power production. Each ITLU consists of two turbines coupled to a synchronous generator. Geothermal brine is diverted to the unit, where the brine flows through four heat exchangers, two vaporizers and two preheaters, which heat and vaporize pentane. Before entering the turbine, the vaporized pentane passes through a liquid separator which removes liquid from the vapor.

2.1.4 Existing Operations: Supporting Infrastructure

Additional infrastructure and ancillary facilities at the PGV facility include the maintenance building, an administration building, a control building, a machine shop, a warehouse facility, transformers, and chemical tanks.

Following damage during the 2018 Lower Puna eruption and in order to resume operations, PGV coordinated with HELCO to rebuild the substation and transmission lines. During this effort, HELCO and PGV each rebuilt their respective components of the substation (e.g., switches, breakers, meters) and coordinated to connect the components. The rebuilding effort was funded by PGV.

2.1.5 Existing Operations: Staffing

Current staff for the existing facility includes approximately 31 employees for operation and maintenance.

2.1.6 Existing Operations: Pentane Recovery, Pollution Abatement, and Hazard Control

The facility's principal pollution recovery and abatement systems and hazard controls for potential geologic hazards are described below. Pentane is a hydrocarbon used as a working fluid in a closed-loop system in the operations and is recovered as part of operations. Abatement for H_2S consists of reinjection into the geothermal reservoir. Reinjection is essentially a closed loop disposal system since the fluids are returned to the same geologic zone from where they originated. This section also describes mitigation for noise and potential geologic hazards.

Pentane Recovery

The Vapor Recovery Maintenance Unit (VRMU) is used to evacuate and recover pentane before venting NCGs from the pentane system (turbines, cooler, heat exchanger, etc.). The VRMU uses a four-step recovery and an activated carbon filtering system. Recovered pentane is returned to the pentane storage vessels.

The Vapor Recovery Unit (VRU) is normally used to remove pentane before venting NCGs from the pentane system (turbines, cooler, heat exchanger, etc.). The VRU uses a two-stage refrigeration cycle to recover the pentane, and then the recovered pentane is returned to the pentane storage vessels.

Pollution Abatement

The following H_2S abatement systems are summarized from PGV's Noncovered Source Permit No. 0008-02-N (PGV 2014).

Sulfa-Treat System: The Sulfa-Treat system collects and abates fugitive H_2S emissions which result from upset conditions of the steam turbine seals. The system operates on a vacuum to collect the fugitive emissions from the seals and then uses a system of abatement reactors in series to chemically abate the H_2S emissions.

Power Plant – NCG System: This system has the potential for fugitive H_2S emissions through leaking seals, flanges, valves, and other points. Sensors with alarms set for 10 parts per million are located on each turbine/generator unit. The alarms are activated in the control room and immediately alert personnel of fugitive H_2S emissions so that corrective action can be taken.

Wellfield Pads, Injection Wells, Production Wells, and Associated System: Wells and associated equipment have the potential for fugitive H_2S emissions. Sensors are located strategically throughout the wellfield. H_2S emissions during maintenance operations are abated using a portable H_2S abatement vessel.

Emergency Steam Release Facility (ESRF): This system, including associated tanks and equipment, is designed to handle emergency situations such as a problem with the electrical transmission line(s) out of the power plant, upset of the geothermal fluid injection system, or if the pressure in the steam line exceeds the set points. The ESRF is used for upset conditions to prevent a release of unabated H_2S to the atmosphere.

Solid Waste

Solid waste is generated from time to time from scale cleanouts of geothermal piping. PGV is considered an episodical generator. All scale is treated as hazardous waste and is disposed of in accordance with Federal requirements. Solid waste generated by employees and operations is collected weekly by a local solid waste contractor, and wastewater is disposed in a cesspool onsite.

Noise

Noise levels are monitored continuously, and results are posted on PGV's publicly accessible website. The facility adheres to Hawai‘i guidelines on noise.

Several steps are taken to reduce normal operation noise levels. These steps include:

- Insulating pipes, valves, and equipment;
- Enclosing equipment in structures, where feasible;
- Installing silencers on pressurized steam outlets; and
- Purchasing quiet fans and motors (PGV 1987).

Geologic Hazards

Volcanic and seismic hazards for the existing facility exist, with risks posed to engineered structures and installations. These risks have been significantly mitigated through procedures in facility siting, design, and operation as described in the 1987 Puna Geothermal Venture Project EIS (PGV 1987).

Risks from volcanic hazards include lava eruptions, lava flows, ash falls, splatter falls, and associated surface disruptions. The existing facility was sited on higher ground to avoid lava flows in the low area, which was demonstrated effective during the 2018 Lower Puna eruption. A layer of volcanic cinders was placed to protect the lower well pads and key elements of pipelines from lava flow. Each wellhead in low ground is protected from lava flow by a plan for the timely full closure of the master valves and by burying the cellar and wellhead with cinders (PGV 1987).

Potential seismic hazards are generated by earthquakes and include ground motion, ground ruptures, and subsidence. The strength and duration of motion from the strongest projected earthquake that might impact the Puna area can be largely mitigated by appropriate design. Critical components of the site (e.g., abatement equipment, above-grade pipe supports) were constructed to comply with the most stringent (Seismic Zone 4) seismic building requirements, even though the current vicinity area is officially in a Seismic Zone 3. This planning proved effective during the volcanic eruption in 2018 which inundated extensive areas surrounding PGV's facility.

Fluid pipelines are the structures most vulnerable to disruption from geologic hazards. This risk was mitigated by appropriate design of the piping system to allow flexibility and movement. Automatic shutoff of the power plant takes place under extreme conditions, and pipeline damage is repaired in the shortest practical period of time. PGV coordinates closely with Hawaii Volcano Observatory, the Hawaii Institute of Geophysics, and state and county officials to further reduce risk and ensure timely warnings of impending geologic hazards (PGV 1987).

2.1.7 Existing Operations: Monitoring and Maintenance

An important part of the operation of the facility is regular monitoring and maintenance of both the power plant and the wellfield. Qualified staff are on-site at all times when the plant is operating. Routine maintenance is conducted by workers during the normal daytime work shift. When operating units are out of service, maintenance work continues 24 hours per day, seven days per week, until full power output can be resumed. If all units are operating at approximately full power, the maintenance work is done by one shift per day, five days per week. The information in this section is summarized from the 1987 Puna Geothermal Venture Project EIS (PGV 1987).

Wellfield Monitoring

All wellheads are equipped with temperature and pressure gauges on the well casing below the master valves. Flow from each well is measured in the line downstream of each control valve. Flow indication is local, and operation of the flow control valves are capable in automatic or manual modes. The control valves at the steam release facility have air-piston operators that respond automatically to signals from the plant control room or upon sensing overpressure in the steam pipeline. The H_2S abatement system at the steam release bypass will operate automatically when steam is vented.

Wellfield Maintenance

Wellfield maintenance is generally performed without shutting off the flow of steam from any well. When this action cannot be taken or is unsafe, maintenance work for the wellfield would be phased to minimize the number and time that wells are shut down. Remedial drilling of wells is usually needed for proper wellfield maintenance and is anticipated every two to five years for each well.

Power Plant Monitoring

The power plant is designed with an automatic control system. The plant operator performs restart checks and manual valving, monitors the plant during operation, and regularly inspects the equipment. The power generating units are operated from a single control room, and control systems operate automatically to prevent injuries to plant personnel or equipment. Standby equipment starts automatically to avoid tripping a turbine-generator unit during normal operations. An independent, self-contained control system is associated with each generating unit.

Power Plant Maintenance

Scheduled maintenance is conducted at each generating unit at intervals of one to two years, as needed. Thorough maintenance procedures, such as turbine disassembly/inspection and condenser inspection/repair, are conducted during these planned outages. Scheduled maintenance periods require approximately one to two weeks for each unit and are coordinated with HELCO to ensure the maintenance of a reliable power system. Maintenance crews are engaged 24 hours a day, seven days per week during this maintenance and work crews work eight- to 12-hour shifts.

2.1.8 Existing Operations: Emergency Response Plan

PGV has developed an Emergency Response Plan (ERP) for the PGV facility in compliance with Condition #26 of GRP 87-2, and in conformance with discussions with the County of Hawaiʻi Civil Defense Agency (CDA), Hawaiʻi DOH, and the staff of the Hawaiʻi State Emergency Response Commission (ERC). The most recent version of the ERP was updated in 2022.

The ERP provides a plan of action to deal with facility emergency situations which may threaten the health, safety, and welfare of the employees and other persons in the vicinity of the facility site. This plan is the basis of all actions by PGV's personnel and management staff in responding to these situations and is updated appropriately when necessary. Site personnel also follow related site Safety, Environmental and Operating Procedures.

2.1.9 Existing Operations: Decommissioning

At the end of the useful life of the facility, the facility and the wellfield would be shut down and the structures and equipment would be removed. Economic and resource conditions would dictate when the facility should be decommissioned. As part of decommissioning, the facility site would be returned to its natural state and the following steps would be taken:

- Structures and piping would be removed;
- Dry or abandoned wells would be abandoned in accordance with existing permits and plugged with concrete, wellhead equipment and casing would be removed to below grade, well casing capped, and the surface restored;
- Roadways would be abandoned consistent with the lease agreement with the landowner; and
- The site would be regraded to approximate natural contours, and the site would be seeded or planted with vegetation.

2.1.10 Existing Operations: Existing Permits

Table 2-2 includes a list of existing permits for the facility.

Table 2-2 Existing Permits for the Current Facility

Permit Title	Agency
Federal	
Underground Injection Control (UIC) HI596002	Environmental Protection Agency
State	
Underground Injection Control (UIC) UH-1529	Department of Health, State of Hawaii
Authority to Construct 7 Geothermal Wells (UIC)	Department of Health, State of Hawaii
Noncovered Source Permit No. 0008-02-N	Department of Health, State of Hawaii
Noncovered Source Permit No. 0008-03-N	Department of Health, State of Hawaii
Plan of Operation	Department of Land and Natural Resources, State of Hawaii
County	
Geothermal Resource Permit (GRP 87-2), last updated on 02/06/2001 for up to 60 MW	Hawaii County Planning Commission

Permit Title	Agency
Building Permit	Hawaii County Planning Department
Grading Permit	Hawaii County Planning Department

2.2 Proposed Operations

The Project includes two phases, Phase 1 would increase the generating capacity to 46 MW (which is 8 MW more than the current approval) and Phase 2 would increase the generating capacity to 60 MW. The property boundary of 815 acres would remain the same under the Proposed Action.

The following description is based on the schematic plan for the Project. As required by the ARPPA, PGV would provide a complete set of detailed engineering, vendor and manufacturing and as-built drawings and calculations relating to the design and construction of the facility to HELCO for review after they are submitted to the appropriate government authority. Per the conditions in the ARPPA, construction work is subject to HELCO inspections and monitoring.

2.2.1 Proposed Operations: Power Generation

Phase 1

As described in the ARPPA to achieve this increase in Phase 1, the 12 existing OECs (combined power generating units) currently in use would be replaced with three new OECs which are designed to utilize the energy of geothermal steam and brine. The three new OECs would be identical in construction, and would be named OEC 41, 42, and 43. Each new OEC would utilize both steam at 678 kilo-pounds per hour (kph) and brine at 226 kph, producing together 52.5 MW gross power and 46 MW net power. Proposed units are shown on **Figure 3**.

Each new OEC unit includes a synchronous generator that is driven by an organic turbine, air-cooled condenser, cycle pump and control system. The gathering system conveys steam and brine from the existing separator to the facility. The steam and brine pass through the new OEC units and flow through the gathering system to the reinjection system which collects a mixture of the cooled brine and condensate that passed through the facility and reinjects it into injection wells by the facility's re-injection pumps. The operation of the gathering system as it currently exists will be the same for the new OECs.

Phase 2

During Phase 2, a fourth new OEC unit would be installed and connected to the infrastructure described in Phase 1 (OEC 44) (**Figure 3**). This would allow for the production of up to 60 MW of power.

2.2.2 Proposed Operations: Geothermal Wells and Wellfield Facilities

The Project would either use the existing well pads in their current location or construct new well pads in accordance with approved permits.

2.2.3 Proposed Operations: Gathering System

As part of Phase 1, PGV would utilize the existing gathering system to the extent possible and install new piping. In Phase 2, it is expected that there would be a 20 percent increase in piping infrastructure (above existing) to connect a fourth new OEC.

2.2.4 Proposed Operations: Supporting Infrastructure

Phase 1

Existing infrastructure associated with the facility that would remain for the Project, and includes the administration buildings, the control room, electrical substation and distribution lines, and maintenance areas.

Phase 1 would involve facility upgrades including reducing steel structures, piping, mechanical components, and associated flange connections.

The following supporting electrical equipment for the new OEC units would be installed as described in the ARPPA for Phase 1:

- 13.8 kilovolt (kV) circuit breakers;
- Three step-up transformers;
- Three lightning arresters mounted on the high voltage side of the step-up transformer;
- Three 69 kV circuit breakers (one per transformer);
- Three sets of 69 kV primary and secondary metering devices connected to one metering set of instrument transformers per transformer, to monitor each of three step-up transformers;
- Dial-up telephone line installed close to 69 kV metering cabinet to allow remote metering reading;
- Fiberglass or stainless-steel demarcation cabinet located along the switching station fence; and
- Underground cable and duct line from the switching station to the Facility.

As part of the Project, PGV would also comply with specific interconnection relays and relay settings, generation relays and generation relay settings, and specific features for the switching station which would be connected to the high-voltage circuit breaker.

Phase 2

It is expected that there would be a 20 percent increase in balance of plant (BOP) as part of Phase 2, with all supporting components of the facility contributing to overall power generation from the new OECs and power delivery increasing by approximately 20 percent.

2.2.5 Proposed Operations: Staffing

During construction of the Project, approximately 75 temporary employees would be utilized, of which approximately one-third would be local, and two-thirds would be from off-island, depending on availability and expertise. Operation of the Project would not be anticipated to increase the permanent staff at the PGV facility of 31 employees.

2.2.6 Proposed Operations: Pentane Recovery, Pollution Abatement, and Hazard Control

These systems would be the same as those described in Section 2.1.6. Even though as a result of new technology the new OECs are much quieter than existing OECs, PGV would still purchase and install quiet fans and motors.

2.2.7 Proposed Operations: Construction Schedule

In compliance with the Guaranteed Project Milestones identified in the ARPPA, PGV would complete construction of the proposed facility and associated infrastructure within 18 months after completion of the environmental review requirements set by the PUC.

2.2.8 Proposed Operations: Monitoring and Maintenance

Monitoring and maintenance under the Proposed Action would be consistent with the activities described for the existing facility (see Section 2.1.7). The reduced number of pipes associated with fewer generating units and the smaller footprint associated with the Project would reduce the amount of monitoring and maintenance equipment compared to the current facility.

2.2.9 Proposed Operations: Emergency Response Plan

The ERP described for the existing facility in Section 2.1.8 would continue to be implemented under the Proposed Action.

2.2.10 Proposed Operations: Project Closure

The 1987 Puna Geothermal Venture Project EIS (PGV 1987) stated that the decommissioning process refers to the shutdown of the wellfield and removal of structures and equipment at the end of the useful life of the facility. At that time, the facility was estimated to have an approximately 35-year useful life, with the actual useful life dictated by economic and resource conditions. The facility has now been commercially operating for almost 30 years and the economic and resource conditions make it feasible and desirable to repower the facility to extend its useful life beyond the 35 years estimated in 1987. As the term of the AARPA approaches its end in 2056, PGV will again evaluate whether, based on economic and resource conditions, the power plant and well field should be refurbished to further extend the useful life of the facility, or whether the facility should be decommissioned. When decommissioned, the site will then be returned to its natural state. The following steps will be taken during decommissioning:

- Structures (including wellfields, supporting structures, and OECs) and piping will be removed.
- Dry or abandoned wells will be plugged with concrete, wellhead equipment and casing removed to below grade, well casing capped, and the surface restored.
- Roadways will be abandoned to the extent agreed upon with the landowner.
- The site will be regraded to approximate contours that match the 2018 lava flow, and the area will be seeded or planted with natural vegetation.

3.0 Project Setting

The EIS will examine the pertinent features of the physical and natural environment. Existing data will be compiled from past environmental studies, and new studies will be completed to address the potential impacts within several discipline areas. This section describes the setting, or affected environment, in Project vicinity.

3.1 Geology

The Proposed Action is located near the eastern tip of Hawaiʻi Island. This region is on the eastern flank of Kīlauea Volcano, the southernmost of five volcanos that make up Hawaiʻi Island. Kīlauea is one of the world's most active volcanoes; since 1952, it has erupted dozens of times. From 1983 to 2018, eruptive activity was nearly continuous along the East Rift Zone. In 2018, the decades-long continuous activity on the East Rift Zone ended, and the summit lava lake drained following an intrusion into, and eruption from, Kīlauea's LERZ.

The East Rift Zone extends as a belt of land approximately one to two miles wide and 75 miles long, of which approximately 31 miles are on land. The rift is a constructive ridge consisting of surface features including open fissures, faults, small grabens, pit craters, cones, and vents. Most recently, flow thickness from the 2018 Lower Puna eruption ranged from 16 to 920 feet of lava (Houghton et al. 2021), with approximately 65 feet atop the pre-eruption ground surface at the site.

Below the ground surface is a system of closely spaced, vertical to steeply dipping dikes with an approximate width of 1.5 to 2.5 miles which intrude a sequence of layered Mauna Loa and Kīlauea lava flows. The dike complex is the primary heat source for the Puna geothermal system. Magma chambers below the surface, where storing and partial cooling of magma take place, may provide a supplemental heat source for the geothermal reservoir.

The existing facility is a geothermal energy conversion plant located above a natural geothermal reservoir in which geothermal fluids are brought to the surface by production wells, heat is extracted, and then cooled fluids are reinjected through the injection wells. Production flow rate and injection flow rates at the wells are equivalent. The injection pressure at the existing facility is just enough for the injected fluid to flow from the injection reservoir to the production reservoir and is not designed to significantly increase subsurface pressure. Conditions of the EPA's UIC permit includes injection pressure limits, which are based on formation testing, to reduce the potential for the creation of new fractures from current activities and to protect any potential underground source of drinking water (EPA 2021).

Volcanically and/or tectonically active areas have associated levels of risk to property and life. Kīlauea Volcano and its associated LERZ is one of the most seismically active areas in the world. Potential hazards within the rift zone include earthquakes, surface deformation, lava flows, eruptions, and subsidence associated with faulting. Earthquake activity in the vicinity of PGV has been attributed to two mechanisms: tectonically related faulting and volcanically related movements. Thousands of earthquakes occur in Hawaiʻi every year, though most are not strong enough to cause damage or impact residents. PGV is located within Lava Hazard Zone 1, indicating the highest potential risk where vents have been repeatedly active in historic time. The location of the Proposed Action is somewhat topographically protected from potential flows; however, several wells were damaged in the 2018 Lower Puna eruption.

In the event of a volcanic hazard with the potential to threaten the facility or block a well, all production and injection wells would be shut-in (i.e., pumps stopped and injection ceased) and PGV would implement the ERP.

The U.S. Geological Survey (USGS) notes that although there is minimal subsidence along the LERZ at a rate of approximately one centimeter per year (0.4 inch per year) since measurements began in 1958, there is no evidence that the activities at the existing facility are resulting in additional subsidence above the background level (USGS 2012, EPA 2021).

Additionally, the USGS did not find evidence that the 2018 Lower Puna eruption was triggered or influenced by human activities. The 2018 Lower Puna eruption was caused by injection of magma downrift from Puʻu ʻŌʻō and the summit of Kīlauea, and the event fits a pattern of activity that has occurred many times previously on the East Rift Zone and is within the range of normal behavior for Kīlauea Volcano. The 2018 Lower Puna eruption happened within Lava Hazard Zone 1 and the erupted lava flowed through that zone into Lava Hazard Zone 2. The high volume and eruption rate are commensurate with previous LERZ eruptions and the 2018 fissures were located in the same area that has hosted many past eruptions (USGS 2020).

Risks to PGV due to volcanic and tectonic activity have been mitigated by siting and design and engineering standards as described in the 1987 Puna Geothermal Venture Project EIS (PGV 1987). The EIS for the Project will provide additional information and analyze potential impacts from geology.

3.2 Hydrology

Groundwater in the vicinity of the Project area includes the geothermal reservoir and the groundwater aquifer. The geothermal reservoir is located at a depth of approximately 4,000 to 8,000 feet below the ground surface and is the deep volcanic rock formation from which PGV draws and into which it reinjects, geothermal fluids. As a result of its composition, depth, and temperature, the geothermal reservoir is not a source of drinking water. The geothermal reservoir is separated from the groundwater aquifer in the LERZ by a semi-permeable confining layer (or "cap rock") that is located at depth of between approximately 2,750 and 4,000 feet below the ground surface (EPA 2021).

The groundwater aquifer consists of the shallow basal groundwater body in the LERZ. The portion of the groundwater aquifer that serves as water supply in the area is at least 2,000 feet above the cap rock. The fluids injected into the geothermal reservoir do not migrate to the basal groundwater layer because injection pressures are too low to allow upward migration; rather, injected fluids flow towards the production wells used to produce the geothermal fluids and generate electricity (EPA 2021).

The groundwater aquifer in the vicinity of the Project area does not include potable water since the cap rock separating the reservoir and aquifer is not impermeable. Naturally occurring geothermal fluids leak into the shallow aquifer, naturally degrading water quality due to the high salinity of the geothermal fluids (PGV 1987).

The PGV Hydrologic Monitoring Program was initiated in 1990 and provided a plan to monitor water levels and water quality within the Project area and the vicinity (SAIC 1990). Proposed monitoring locations included the shallow aquifer at locations within the Project boundaries and downgradient of the Project. The monitoring plan scope included the establishment of baseline conditions and the implementation of quarterly monitoring thereafter. Samples collected as part of monitoring are analyzed for potential impacts from the facility from organic compounds (e.g., pentane, isopropanol). Sampling did confirm detection of pentane in one monitoring well near the power plant at a low concentration that was not indicative of source (and could be naturally occurring), and isopropanol was below detection in all samples except for three collected from the plant. In summary, the USGS determined that that there has not been shallow groundwater contamination by organic compounds from geothermal operations. However, the analysis did conclude that increased residential and agricultural activity has contaminated shallow groundwater and, by coastal seeps, the nearshore seawater (USGS 2020).

Conditions of the EPA's UIC permit includes injection pressure limits which are based on formation testing to reduce the potential for the creation of fractures, and well construction requirements to ensure that injected fluids do not migrate to and endanger underground sources of drinking water. As part of the UIC, there are continuous monitoring and systematic testing requirements to ensure that each injection well has mechanical integrity and groundwater is monitored for any potential indicators that suggest impacts to water quality from injection activities.

Per the GRP, the EPA's UIC permit and the Hawaii State Safe Drinking Water Branch UIC permit, PGV also conducts hydrological monitoring (according to a monitoring program reviewed by the State and EPA) semi-annually to ensure the existing facility does not contaminate groundwater and sends reports of this monitoring to the State Safe Drinking Water Branch, the EPA and the Planning Department. As stated in the GRP, if pollution of the aquifer is demonstrated to occur from Project operation or maintenance activities, as determined by the Planning Director in consultation with the Department of Water Supply and DLNR, PGV would need to act to abate these impacts and eliminate the source of pollution.

The EIS will evaluate impacts from the Proposed Action to hydrological resources.

3.3 Air Quality and Climate Change

Air emissions from the facility are subject to the requirements set forth in the HAR, Title 11 Chapter 60.1- Air Pollution Control. To obtain an air quality permit in Hawaiʻi, an industrial source must identify all potential air emissions of regulated pollutants associated with its operations, describe pollutant controls, identify applicable regulatory requirements, and demonstrate compliance with National Ambient Air Quality Standards (NAAQS) and Hawaiʻi State Ambient Air Quality Standards (AAQS) . Air pollutant emission sources that are listed in 40 Code of Federal Regulations (CFR) 60, New Source Performance Standards, may be required to meet the applicable performance standards identified for that source category. Air pollutant emission sources also may need to comply with National Emission Standards for Hazardous Air Pollutants, which limit hazardous air pollutants (HAPs) from specified processes if that process is listed in 40 CFR Part 63. The facility currently operates under an approved DOH non-covered source permit (a state air pollution control permit).

As part of the 1987 Puna Geothermal Venture Project EIS (PGV 1987), an air quality impact assessment was performed for the Proposed Action as part of the EIS submittal and to demonstrate compliance with the regulations. The assessment described emissions of H_2S, nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), total suspended particulates (TSP), radon (Rn), mercury (Hg) and some trace elements from various stages of the facility including the following: well drilling, venting, flow testing and workover; clearing and construction; power plant operation; and facility decommissioning. A dispersion modeling analysis was performed using then-EPA approved models (ISCST, MPTER and COMPLEX I) to assess the impacts of H_2S and TSP and were found to be in compliance with federal and state air quality standards. The dispersion modeling analysis was aided with the availability of on-site meteorological data, as well as background H_2S and TSP concentration data (PGV 1987).

A public health assessment was performed to examine the health impacts from Hawaiʻi Island geothermal operations, in particular from the lower Puna district operations. This study did not conduct a separate air quality assessment but reviewed existing independent studies/health risk assessments for the area. Existing studies concluded that PGV plant operations are unlikely to pose a threat to the air quality in nearby residential areas. Recommendations were made to substantially improve the existing monitoring systems and protocols which were found to be inadequate. The recommendations called for the availability of real time and reliable gas, particulate and meteorological data for citizens to view and make informed decisions to protect themselves from fugitive emissions (Adler 2013).

An Air Dispersion Modeling Report for PGV was prepared in April 2021 as an update to the analysis performed in 1991 for the 1992 ERP using AERMOD, which is currently approved by the EPA, and incorporating the USGS terrain files of the post-eruption terrain. The report analyzed the dispersion of H_2S, the emission of greatest potential health concern, and used the same 12 “worst case“ upset condition scenarios used in the original air dispersion modeling. The updated report concluded that the evacuation warning level for H_2S would not be exceeded under any scenario.

The systems utilized for pentane recovery and H_2S abatement are described in Section 2.1.6. In addition to control systems, PGV also conducts monitoring and reporting as required by its DOH noncovered source permit (a state air pollution control permit) for its current operations. These reports are provided to the DOH, DLNR, and the County of Hawaiʻi Planning Department. PGV publishes real-time data for H_2S and wind direction on their website: https://punageothermalproject.com/.

An air quality assessment will be prepared for this Project and will be included in the EIS. The assessment will analyze criteria pollutant emissions, conduct dispersion modeling, and evaluate greenhouse gas emissions and potential impacts to climate change from the Project.

3.4 Noise

The most prominent noise sources within the Project vicinity include the existing PGV facility operations, traffic noise, and environmental noise sources, such as wind, birds, and insects. PGV currently conducts continuous noise monitoring at three locations within the property boundary (**Figure 2**):

- Southeast Fenceline Monitoring Site A1 – This site was chosen due to a cluster of homes that are topographically downgradient from the existing operations.
- Southwest Fenceline Monitoring Site B1 – This site was chosen due to the proximity of the Nanawale Estates subdivision. This location was destroyed by the 2018 Lower Puna eruption but was rebuilt.
- West Fenceline Monitoring Site C1 – This site was chosen due to the proximity of homes at the Leilani Estates subdivision.

The DOH revised its noise regulation effective September 23, 1996. The new regulations identify Class C zoning districts, which include the PGV power plant, as all areas equivalent to lands zoned for agriculture, country, industrial, or similar uses. The maximum permissible sound level for Class C property is 70 dBA, regardless of the time of day. A data acquisition and storage computer located in the PGV plant operations center polls each data logger once every five minutes. The five-minute averaged data are checked for noise levels in excess of 68 dBA, and the computer generates an alarm if an exceedance is detected.

Data from PGV's continuous noise monitoring indicates that noise levels are generally lowest at Site B1 and highest at Site A1. Noise levels fluctuate throughout the day, with the majority of nighttime exceedances occurring from coqui frogs (*Eleutherodactylus coqui*) and daytime exceedances often occurring from the presence of wild pigs (*Sus* spp.) at the facility. As stated in the ERP, PGV notifies the CDA, County of Hawaiʻi Planning Department, and DOH Noise and Radiation Branch in the event that any upset of PGV's operations leads to an exceedance of the appropriate ambient noise levels and actions are taken at the site to stop the source of the noise. PGV will continue to coordinate with the CDA and other agencies to advise them of the anticipated duration of the upset and high noise level situation.

Additionally, PGV's operations department investigates every noise alarm, documents its possible source, and logs it in the control room logbook. If DOH is contacted by the public regarding a noise complaint for the facility, PGV is contacted to reveal the possible source and reports to DOH.

During regular operations at the existing facility, PGV applies Best Available Control Technology (BACT) for noise emissions to minimize noise from the facility and its activities. Noise emission surveys have been performed throughout the operational lifespan of the facility. These surveys have been performed by Acoustical Engineers, with results including BACT recommendations.

A noise assessment report is being prepared for this Project and will be included in the EIS. The report will analyze the construction and operational impacts of the Project to the existing noise conditions in the surrounding area.

3.5 Biological Resources

The additional disturbance for the Proposed Action would occur on areas recently covered by 2018 Lower Puna eruption or on previously disturbed areas. There are no known biological resources in the area of proposed disturbance, including vegetation, wildlife, and soil resources; however, primary succession on the lava flow (e.g., plant and animal colonization, soil development) is expected to continue in the surrounding areas.

Surrounding habitat includes some areas with native grasses and shrubs. In higher elevations, where the 2018 lava flow did not reach, there is a mixed forest. Biological surveys completed for the 1987 Puna Geothermal Venture Project EIS (PGV 1987) inventoried biological resources within a one-mile buffer of the existing plant site and found at that time that approximately one-third of the area was covered by the

1955 lava flow. A large portion of the area surveyed in 1987 had been modified by previous human activities and consisted of cultivated and fallow fields, and *Metrosideros* forest occupied most of the native vegetation types that were present in the area. Prior to its construction, the site of the existing power plant and well pad consisted of non-native scrub vegetation and abandoned papaya plants.

The EIS will evaluate impacts from the Proposed Action to biological resources.

3.6 Socioeconomics and Environmental Justice

The details below represent the best available information for the existing social and economic condition of the area of analysis using publicly available data. However, due to the uncertainties related to the ongoing COVID-19-related economic impacts and changes in regional economic and social conditions, the data below may be inexact.

The Project is located in Census Tract 15001021101 (211.01), which includes the area bounded to the west by Pāhoa Kalapana Road, to the north by Highway 132, and to the southeast by the Pacific Ocean. The Project area does not occur within a Census Designated Place (CDP); however, impacts to the adjacent Leilani Estates, Nanawale Estates, and Pāhoa CDPs may occur. Impacts to the entire County of Hawaiʻi are also discussed where appropriate.

3.6.1 Population and Demographics

The State of Hawaiʻi experienced growth from 2010 to 2016; however, population growth slowed from 2017 to 2019 and decreased in 2020 (**Table 3-1**). Estimates suggest that the population of Hawaiʻi will continue to decrease, largely driven by migration to the mainland U.S. because of the economic impact of the COVID-19 pandemic (USCB 2022). Since 2010, Hawaiʻi County has experienced a period of sustained growth, increasing by approximately 12 percent, making it Hawaiʻi's second fastest growing county after Kauaʻi County.

During the period from 2010 to 2020, the populations of Census Tract 211.01, and the Leilani Estates, Nanawale Estates, and Pāhoa CDPs fluctuated but ultimately increased in population. Most notably, populations decreased for these locations following the 2018 Lower Puna eruption but have since made modest recoveries.

Table 3-1 Population Characteristics

Year	Leilani Estates CDP	Nanawale Estates CDP	Pāhoa CDP	Census Tract 211.01	Hawaiʻi County	Hawaiʻi
2010	1,563	1,377	890	2,829	180,362	1,333,591
2011	1,634	1,500	983	3,012	182,997	1,346,554
2012	1,653	1,384	865	3,133	185,399	1,362,730
2013	1,749	1,316	879	3,111	187,044	1,376,298
2014	1,729	1,661	862	3,062	189,382	1,392,704
2015	1,557	1,714	826	3,117	191,482	1,406,299
2016	1,629	1,590	731	3,101	193,680	1,413,673
2017	1,655	1,766	772	3,196	196,325	1,421,658
2018	1,708	1,995	896	3,359	197,658	1,422,029
2019	1,576	1,707	805	3,054	199,459	1,422,094
2020	1,784	1,385	1,234	3,328	201,350	1,420,074
Percent Change 2010 to 2020	14%	1%	39%	18%	12%	6%

Sources: USCB 2019a, USCB 2020a

Census Tract 211.01 and the Leilani Estates CDP are considerably less racially diverse than both the State of Hawaiʻi and Hawaiʻi County with approximately 61 percent and 62 percent of the population identifying as white, respectively, as compared to Hawai‘i’s 23 percent and Hawai‘i County’s 34 percent. Similarly, both Asians and Native Hawaiian and other Pacific Islanders make up a smaller portion of the population in Census Tract 211.01 and the Leilani Estates CDP than in Hawai‘i and Hawai‘i County (**Table 3-2**).

Table 3-2 Race and Ethnicity

Race or Ethnicity	Leilani Estates CDP	Nanawale Estates CDP	Pāhoa CDP	Census Tract 211.01	Hawai‘i County	Hawai‘i
White	62%	34%	17%	61%	34%	23%
Black or African American	2%	3%	<1%	1%	1%	2%
American Indian and Alaska Native	1%	3%	1%	1%	1%	<1%
Asian	4%	20%	34%	8%	20%	37%
Native Hawaiian and Other Pacific Islander	8%	26%	20%	8%	14%	11%
Some Other Race	2%	3%	1%	2%	2%	2%
Two or More Races	22%	40%	27%	18%	30%	25%
Hispanic or Latino	10%	12%	9%	8%	11%	10%

Source: USCB 2020b

There would be no minority environmental justice population within the Project vicinity that exceeds 50 percent or more than ten percent of the reference population (i.e., Hawai‘i). Additionally, no American Indian environmental justice populations would be present. The percentage of the population identified as belonging to a minority group in the Project vicinity would not be equal to or greater than 50 percent, nor would it be more than 10 percentage points higher than that of the State of Hawai‘i reference population (**Table 3-2**).

3.6.2 Economy and Employment

Hawai‘i County’s primary economic driver is tourism, with approximately 16 percent of jobs in the arts, entertainment, recreation and accommodation and food services industry and 12 percent of jobs in retail trade. Other industries with substantial employment in Hawai‘i County include educational services and healthcare and social assistance services and public administration, with 20 percent and 11 percent of jobs, respectively (**Table 3-3**). Within the Puna region, agricultural jobs are the primary form of employment, with significant banana, papaya, macadamia nut, and flower production (County of Hawai‘i 2005).

Table 3-3 2019 Industry Employment

Industry	Leilani Estates CDP	Nanawale Estates CDP	Pāhoa CDP	Census Tract 211.01	Hawai‘i County	Hawai‘i
Agriculture, forestry, fishing and hunting, and mining:	4%	10%	1%	13%	5%	1%
Construction	18%	16%	10%	15%	8%	8%
Manufacturing	4%	3%	0%	8%	2%	3%
Wholesale trade	0%	0%	0%	0%	2%	3%
Retail trade	11%	8%	6%	11%	12%	10%
Transportation and warehousing, and utilities:	0%	7%	1%	0%	5%	6%
Information	1%	0%	0%	1%	1%	2%
Finance and insurance, and real estate and rental and leasing:	3%	10%	4%	3%	6%	7%
Professional, scientific, and management, and	16%	9%	11%	9%	11%	10%

Industry	Leilani Estates CDP	Nanawale Estates CDP	Pāhoa CDP	Census Tract 211.01	Hawaiʻi County	Hawaiʻi
administrative and waste management services:						
Educational services, and health care and social assistance:	33%	25%	41%	29%	19%	20%
Arts, entertainment, and recreation, and accommodation and food services:	5%	10%	9%	3%	16%	15%
Other services, except public administration	2%	2%	6%	1%	5%	4%
Public administration	4%	1%	11%	7%	8%	11%

Source: USCB 2019b

As of March 2022, Hawaiʻi County had an unemployment level of approximately 3.3 percent. Unemployment in Hawaiʻi has recovered since a peak in April 2020 at 21.9 percent due to the COVID-19 pandemic and was 3.5 percent as of March 2022. Unemployment in Hawaiʻi County also peaked in April 2020 at 21.9 percent (DBEDT 2022).

3.6.3 Income

Within Hawaiʻi County, the industries with the highest average wages include utilities ($104,696), management of companies and enterprises ($79,317), and finance and insurance ($74,750).

Jobs at PGV would fall under the power generation and supply industry. Average wages for the power generation and supply industry are the second highest for any industry in Hawaiʻi County, with an average salary of $110,657 for 2020. Power generation and supply salaries were the ninth highest for the State of Hawaiʻi at $110,684 annually (DBEDT 2020).

Estimates for 2019 indicate that both median household income and per capita personal income in Census Tract 211.01 lag behind the state average by approximately 61 percent and 13 percent, respectively (**Table 3-4**). Additionally, the poverty rate for the Leilani Estates, Nanawale Estates, and Pāhoa CDPs and Census Tract 211.01 is considerably higher than the reference population of Hawaiʻi. This would constitute a low-income environmental justice population within the Project vicinity.

Table 3-4 Median Household Income, Per Capita Income, and Poverty Rate of Individuals

	Leilani Estates CDP	Nanawale Estates CDP	Pāhoa CDP	Census Tract 211.01	Hawaiʻi County	Hawaiʻi
Household Median Income (dollars)	$31,734	$42,563	$27,708	$32,386	$65,401	$83,173
Per Capita Income (2019 dollars)	$27,431	$23,131	$23,518	$30,932	$30,542	$35,567
Percent Below Poverty Line	26.3%	16.7%	23.6%	29.5%	15.6%	9.4%

Source: USCB 2019c, USCB 2019d, USCB 2019e

3.6.4 Housing

Workers typically choose a residence location based on a combination of job proximity, housing availability, and access to public and private services. The Kīlauea Voluntary Housing Buyout Program was initiated in April 2021 and used federal funds to purchase properties impacted by the 2018 Lower Puna eruption. Eligible properties must have been impacted by the disaster, whether by inundation, or isolation, damage by fires caused by lava, or secondary effects of volcanic activity, such as heating or gasses. Acquired residences will be removed and properties will be managed as open space with the possibility of limited agricultural use. Large portions of the Project vicinity, including the eastern portion of the Leilani Estates

CDP were impacted by the 2018 Lower Puna eruption and are eligible for the buyout. A total of 612 homes, including 294 primary residences, were destroyed during the eruption (County of Hawai‘i 2022a). As a result, housing opportunities in the vicinity of the Project are limited.

Data from the 2020 Census indicates that Census Tract 211.01 has an estimated 415 vacant units out of 1,958 units for a total vacancy of 21 percent. Vacancy within the Leilani Estates CDP is estimated at 13 percent, with approximately 113 vacant units. These vacancy estimates likely include vacant properties that are eligible for the buyout program due to property damage or isolation; therefore, vacancy within the Project vicinity is likely lower than estimated. Housing near the Project is also available within the Nanawale Estates CDP and the Pāhoa CDP, with vacancy rates of 17 percent and 25 percent, respectively. These areas were unaffected by the 2018 Lower Puna eruption (USCB 2020c).

Short-term lodging opportunities within the Project vicinity are limited. There are no hotels in the Project vicinity. The establishment of new short-term vacation rentals is prohibited within much of the area surrounding the Project; however, exceptions for existing establishments apply, and there are several private residences available for rent, primarily in the south near the Kehena Black Sand Beach (Planning Department 2022).

Table 3-5 Housing Vacancy Rates within the Area of Analysis (2020 Estimates)

Location	Total housing units	Occupied housing units	Vacant housing units	Vacancy Rate (percent)	Vacancy Rate by Type (Percent)	
					Homeowner Units	Rental Units
Leilani Estates CDP	887	774	113	13%	0.0%	6.6%
Nanawale Estates CDP	691	573	118	17%	0.0%	4.7%
Pāhoa CDP	359	268	91	25%	6.6%	18.2%
Census Tract 211.01	1,958	1,543	415	21%	0.0%	5.6%
Hawai‘i County	87,824	69,453	18,371	21%	2.6%	9.6%
Hawai‘i	542,674	459,424	83,250	15%	1.4%	9.4%

Source: USCB 2020c

3.6.5 Community Development

A Geothermal Relocation Fund was created in 1996 and was subsequently expanded in 2008 to the Geothermal Relocation and Community Benefits Fund. The fund can be used for two primary purposes: to purchase property from owner/occupants near the PGV plant and for infrastructure and service improvements in Lower Puna. The Hawai’i County Planning Department administers the fund. This fund collects geothermal royalties for the “utilization of geothermal resources” (Kohala Center 2012). Examples of community benefits supported by the fund include the purchase of two 33-passenger buses for the region, Pahoa Pool and community center upgrades, and road upgrades (Planning Department 2010).

The EIS will evaluate impacts from the Proposed Action to socioeconomic conditions and Environmental Justice populations.

3.7 Historic Resources

Similar to the description in Section 3.5 (for biological resources), the additional disturbance for the Proposed Action would occur on areas recently covered by 2018 Lower Puna eruption or on previously disturbed areas. In 1984, a systematic inventory of the existing 17-acre facility and a review of resources in a one-mile radius of the facility was conducted and no historic resources were located. As part of the application for subsequent grading permits associated with the existing facility, PGV has complied with the Chapter 6E-42 (Historic Preservation Review) process to demonstrate that no subsequent work has affected historic properties.

The EIS will evaluate impacts from the Proposed Action to historic resources.

3.8 Cultural Practices

In Native Hawaiian culture, Pele's home is the Halemaʻumaʻu crater of the Kīlauea Volcano. Some Native Hawaiians recognize Pele as a goddess and her body includes forms of lava, magma, heat, and steam and believe Pele is responsible for volcanic eruptions and the landscape of the Hawaiian Islands. The Puna District has played an important role in local history, belief, and religion. Hawaiian chants and hula frequently focus on Pele and the Puna District, as well as Hawaiʻi Island. Numerous places in the Puna District are important to Pele, Native Hawaiian beliefs, and customs. These places are contained in Pele stories, chants, and legends (PGV 1987).

To ensure that consultation is conducted and potential cultural impacts from the Project are identified, a cultural impact assessment (CIA) will be prepared.

The EIS will incorporate the results from the CIA including the outcome of consultations with Native Hawaiian practitioners and Native Hawaiian organizations and discuss any impacts to cultural practices.

3.9 Aesthetics

The most prominent visual features within the proposed Project area and vicinity include the existing PGV operations and lava formations from the 2018 Lower Puna eruption.

The 1987 Puna Geothermal Venture Project EIS (PGV 1987) prepared for PGV evaluated views from eight viewpoints located along nearby roads or within subdivisions or public parks. They were:

- One view from the west of the power plant along Pāhoa-Pohoiki Road (Point 1);
- Two views from the north along Kapoho Road (Points 2 and 3);
- Three views from the southwest in Leilani Estates subdivision (Points 4, 5, and 6);
- One view from the south in Lanipuna Gardens subdivision (Point 7); and
- One view from the east along Highway 137 (Point 8).

The previous EIS (PGV 1987) concluded that “most, if not all,” visual impacts would be temporary, with views of the plant insignificant once planned landscaping matures and provides screening. Design considerations, including additional landscaping, painting of structures and pipelines, and site lighting treatment, were prescribed as mitigation through various county and state permit requirements. These measures were presented as further reducing visual effects or visibility of the existing operations.

The 2018 Lower Puna eruption significantly altered the visual landscape surrounding the Proposed Action by the creation of new topographic features and the destruction of potentially shielding vegetation. Additionally, many sources with aesthetic impact concerns (i.e., houses, roads, and public parks) in the area were destroyed. As a result, modified viewpoints (**Figure 6**) are proposed to assess the visual character in the Project area and vicinity. These include:

- One view from the southwest along the path of the Pāhoa-Pohoiki Road, which was destroyed during the 2018 Lower Puna eruption but will be rebuilt. This point will be modified from the original Point 1 to be located at the highest possible elevation on the lava flow.

- One view from the north along Kapoho Road (original Point 2)

- Two views southwest in Leilani Estates. The original Point 4 will assess impacts to the homes remaining in Leilani Estates and will serve as a proxy for any others that are rebuilt nearby. The original Point 6 will be modified to be located at the intersection of the potentially rebuilt roads, Leilani Avenue and Pāhoa-Pohoiki Road.

- One view from the south in Lanipuna Gardens. The original Point 7 will be modified based on topography and the visibility of PGV.

The EIS will evaluate impacts from the Proposed Action to aesthetics and visual landscape.

3.10 Hazardous Materials and Solid Waste

Hazardous materials currently utilized or present at the facility include lubrication and fuel oil, pentane, and H_2S. Lubrication and fuel oil are utilized for operating equipment, pentane is a hydrocarbon used as a working fluid in geothermal energy operations, and H_2S which is emitted as a gas result from volcanic activity and is managed and abated as part of operations at the facility. **Table 3-6** includes a summary of hazardous material storage at the facility.

Table 3-6 Onsite Hazardous Fuel Storage Locations

Material	**Quantity**	**Capacity (nominal capacity) in gallons**	**Notes**
Pentane	2	10,000	To support geothermal energy conversion activities
Pentane	1	10,000	Located at Pad D
Diesel	1	<100	For emergency water pump in the wellfield
Diesel	1	500	For diesel-driven emergency firewater pump at power plant
Diesel	1	1,500	For standby generator at power plant
Diesel	1	1,000	For vehicle use
Diesel	1	13,000	To fill day tanks for engines used for drilling rig
Diesel	4	40	Day storage tanks, one for each of three Waukesha engines (drilling rig) and one share for the two Caterpillar engines (drilling rig)
Diesel	1	3,000	Day storage tank, for top drive engine for drilling rig
Diesel	4	500	Day storage tanks, one for each of the engines listed as Stack #S-DR4 through #S-DR7
Unleaded gasoline	1	1,000	For vehicle use

The current recovery of pentane, H_2S abatement, and solid waste management are described in Section 2.1.6, Pollution Abatement and Hazard Control. The VRMU and VRU for pentane, as well as H_2S abatement, are described in Section 2.1.6. With these systems in place, injection fluids are designed to be contained. As stated in the ERP, if injection fluids were to escape containment, PGV would implement the ERP. The ERP includes steps to notify emergency response organizations (including the CDA and DOH, local fire and police departments, the DLNR, and the public), and evaluate any potentially hazardous situations. As part of PGV's UIC Permit with the EPA (Part III.D.1 and 2), if this situation were to occur, the EPA may also require an assessment of any endangerment, and if necessary, a remedial response.

As described in the DOH noncovered source air permit and the ERP, monitoring for H_2S occurs continuously at the site. Detectors for pentane, fire, and gas are located throughout the facility and monitored continuously as described in the ERP.

The ERP includes details regarding spill control and containment for spills or leaks of chemicals, including hydrocarbons, which could occur related to transfer or storage of pentane, caustic soda, treatment chemicals, diesel fuel, or unleaded gasoline. The EIS will include an analysis of potential off-site impacts from the proposed Project. Caustic soda is considered hazardous because of its corrosivity, but is otherwise not toxic, and the quantity stored on site will not be able to move off site under any upset condition.

As described in the ERP, although geothermal brine spills may occur, the brine from the wells at the facility does not contain levels of constituents which necessitate its classification as hazardous waste. Brine chemistry will be evaluated analytically each year to monitor any changes in brine characteristics.

Rubbish generated from operations and employees is collected regularly, and wastewater disposal is managed in a large-quantity septic system per state and federal regulations.

The EIS will evaluate impacts from the Proposed Action to hazardous and solid waste.

3.11 Transportation and Access

Access to the facility from Pāhoa is east along Highway 132. The 2018 Lower Puna eruption destroyed the portion of Highway 132 to the area known as Four Corners (intersection of Highway 132 and Highway 137) east of the facility, heading towards Kapoho. PGV restored the portion of Highway 132 near the existing operations in 2020 to regain access to the facility and also provide access to residents who had lost access to their properties with the lava flow.

As part of the Kīlauea Eruption Recovery effort, Hawaiʻi County proposes to utilize Federal Emergency Management Agency funds to restore infrastructure including roads and water lines along Pohiki Road and Highway 137. Hawaiʻi County expects construction for the projects to begin in the fourth quarter of 2023 following completion of an Environmental Assessment (EA) (County of Hawaiʻi 2022b).

The EIS will evaluate impacts from the Proposed Action to transportation and access.

4.0 Consistency with Government Plans and Policies and Relevant EAs and EISs Considered

4.1 Land Use Laws

The Project is consistent with Hawaiʻi Land Use Law (Chapter 206, HRS) since it is situated within the Kapoho Section of the Kīlauea Lower East Rift Geothermal Resource Subzone. Subzones were areas of significant geothermal potential where geothermal exploration and production is encouraged (see Section 1.5). Note that HRS Section 205-5.1 creating such geothermal subzones was repealed by Act 97 (2012).

4.2 Hawaiʻi State Plan and Hawaiʻi State Functional Plans

The Hawaiʻi State Planning Act (Chapter 226 HRS, as amended) establishes a set of themes, goals, objectives, and policies that are meant to guide the state's long-run growth and development activities. The Project supports and furthers the state's primary economic objective, to develop and diversify Hawaiʻi's economic base. A major goal of the state is to increase energy self-sufficiency. A second energy goal is to achieve dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people. The Project supports the state's major energy objective and policy of increasing energy self-sufficiency. By upgrading equipment and capacity of the facility, the Project would supply a large percentage of Hawaiʻi Island's renewable firm capacity and energy and would be another important step for self-sufficiency for the state. HELCO's forecast for an increase in the Hawaiʻi Island's energy needs would help to be met through the Project.

The Statewide Planning System identified in Chapter 226 HRS requires State Functional Plans, which implement state and county actions. The Department of Business, Economic Development & Tourism (DBEDT) originally developed the Energy Functional Plan in 1984 and updated it in 1991. The Project is consistent with DBEDT's 1991 Energy Functional Plan. One of five areas of concern addressed in the plan is alternate energy resource development. The objective is to promote alternate and renewable energy technologies through commercialization in order to shift demand from petroleum to indigenous renewable resources. In response to the state's dependence on imported petroleum, contribution of greenhouse gases from fossil fuel combustion, and possible disruption in oil supplies, the Functional Plan states:

> A reduction of our dependence on oil and fossil fuels can be achieved by a balanced combination of demand reduction through the development of conservation and energy efficiency resources and the displacement of fossil fuels with new energy sources through alternate and renewable energy resource development.

Objective B in the Energy Functional Plan: "Displace oil and fossil fuels consumption through the application of appropriate alternate and renewable energy resources and technologies."

The existing facility and Project are consistent with Action B(1): "Assist with the Development of Geothermal First to Serve the Island of Hawaiʻi, and then for Export if Economically, Environmentally and Socially Acceptable and Feasible."

4.3 Hawaiʻi Energy Policy

As described in Section 1.3, the HCEI was established to reduce the state's dependence on imported petroleum for energy production and locally produce more clean energy. In 2015, Hawaiʻi set a renewable energy goal of 100 percent by 2045 with interim targets of 30 percent by 2020, 40 percent by 2030, and 70 percent by 2040 (HCEI 2022). Additionally, Hawaiian Electric has committed to increasing Hawaiʻi's use of clean energy and reducing dependency on imported oil, with a goal to cut carbon emissions from power generation by 70% by 2030 and by 2045 to achieve net zero or net negative carbon emissions (Hawaiian Electric 2021a).

4.4 County of Hawaiʻi General Plan

The General Plan for the County of Hawaiʻi is a policy document expressing the broad goals and policies for the long-range development of the Island of Hawaiʻi (County of Hawaiʻi 2005). The plan was adopted by ordinance in 1989 and revised in 2005. The General Plan itself is organized into thirteen functional elements. In general, the Project would be consistent with the goals, policies and objectives, standards, and principles for several function areas. The Project is consistent with the following relevant energy goals and policies of the county.

Energy Goals:

- Strive towards self-sufficiency.
- Establish the Big Island as a demonstration community for the development and use of natural energy resources.

Policies:

- Encourage the development of alternate energy resources.
- Strive to assure a sufficient supply of energy to support present and future demands.
- Strive to diversify the energy supply and minimize the environmental impacts associated with energy usage.
- Continue to encourage the development of geothermal resources to meet the energy needs of the County of Hawaiʻi.

The Project is consistent with the energy goals and policies in the General Plan by continuing to provide renewable geothermal energy and helping the county achieve self-sufficiency.

4.5 Required Permits and Approvals

Table 4-1 summarizes the status of permits for the existing facility, existing permits which need to be amended for the Project, and new permits that are required for the Project. The amount of energy proposed for Phase 1 (46 MW) is covered under the ARPPA approved by the PUC, but PGV and HELCO would be required to amend the agreement to generate 60 MW of power prior to implementing Phase 2.

Table 4-1 Existing and Required Permits for the Current Facility

Permit Title	Agency	Existing, To be Amended for Proposed Project, or New Permit Needed for Proposed Project
Federal		
Under Ground Injection Control (UIC) HI596002	Environmental Protection Agency	Existing, courtesy notification for the Project
State		
Under Ground Injection Control (UIC) UH-1529	Department of Health, State of Hawaii	Existing, renewal in progress, courtesy notification for the Project
Authority to Construct 7 Geothermal Wells (UIC)	Department of Health, State of Hawaii	Existing
Noncovered Source Permit No. 0008-02-N	Department of Health, State of Hawaii	Existing, renewal in progress, Amendment needed for the Project
Noncovered Source Permit No. 0008-03-N	Department of Health, State of Hawaii	Existing
Plan of Operation	Department of Land and Natural Resources, State of Hawaii	Existing, courtesy notification for the Project
County		
Geothermal Resource Permit (GRP 87-2)	Hawaiʻi County Planning Commission, Last updated on 02/06/2001 for up to 60 MW	Notification for the Project

Permit Title	Agency	Existing, To be Amended for Proposed Project, or New Permit Needed for Proposed Project
Building Permit	Hawaiʻi County Planning Department	Need new
Grading Permit	Hawaiʻi County Planning Department	Need new

4.6 Relevant EAs and EISs Considered

The primary relevant Chapter 343, HRS document considered is the EIS prepared by PGV in 1987.

5.0 Consultation

Consultation with stakeholders to discuss potential impacts of the Project is a requirement prior to filing a Draft EIS under HAR Section 11-200.1-23. Accordingly, PGV will consult with elected officials, agency representatives, community leaders and neighbors throughout the duration of the process. Information gleaned from these meetings helped to identify important issues and provide guidance on the scope of the studies for the EIS. Agency and community issues will be considered in greater detail in the EIS.

Publication of this EIS Preparation Notice (EISPN) in the State of Hawaiʻi's Environmental Review Program's monthly publication *The Environmental Notice* starts a 30-day public review and comment period, within which agencies, groups and individuals have an opportunity to provide written comments regarding potential environmental effects from the Project. PGV will respond to substantive comments (defined as those pertaining to the scope of the EIS), with comments and applicable responses included in the EIS. Information collected during the scoping process will also be incorporated into the EIS to identify important issues and provide guidance.

HAR Section 11-200.1-23 also requires a public scoping meeting to be held during the 30-day EISPN comment period. Scoping serves as an opportunity to obtain input from the community, agencies, and other stakeholders regarding the issues and resources they would like to see addressed and analyzed throughout the EIS process. An in-person public scoping meeting will be held at Pāhoa Community Center on Wednesday August 17, 2022, from 5:00 – 8:00 PM.

5.1 Early Consultation

PGV holds quarterly meetings where public concerns and comments about the existing operations are regularly addressed. PGV provides regular reports to agencies as part of requirements for existing permits. Video recordings of previous quarterly meetings can be viewed at www.punageothermalproject.com.

5.2 Agencies and Parties to be Consulted

A list of agencies, organizations, and individuals that will be contacted during the publication of the EISPN and/or prior to filing the Draft EIS is provided in **Table 5-1**. Cultural practitioners will also be consulted as part of the cultural consultation process for the forthcoming CIA. Additional parties of interest may be identified during the review period of the EISPN.

Table 5-1 Agencies and Parties to be Consulted

Name	Affiliation
Elected Officials	
David Ige	Governor of Hawaiʻi
Mazie Hirono	Senator
Brian Schatz	Senator
Kai Kahele	US Representative, Hawaiʻi 2nd Congressional District
Joy San Buenaventura	Hawaiʻi State Senator, District 2
Greggor Ilagan	Hawaiʻi State Representative, District 4
Ashley Lehualani Kierkiewicz	Hawaiʻi County Council, District 4
Mitch Roth	Mayor, County of Hawaiʻi
Government Agencies	

Name	Affiliation
Environmental Protection Agency, Region 9	Federal
United States Geologic Survey, Hawaiian Volcano Observatory	Federal
United States Fish and Wildlife Service	Federal
U.S. Department of Energy	Federal
Public Utilities Commission	State of Hawaiʻi
Hawaii State Energy Office	State of Hawaiʻi
Department of Agriculture	State of Hawaiʻi
Department of Business, Economic Development, and Tourism	State of Hawaiʻi
Department of Business, Economic Development, and Tourism, Hawaiʻi State Energy Office	State of Hawaiʻi
Department of Defense	State of Hawaiʻi
Department of Education	State of Hawaiʻi
Department of Hawaiian Home Lands	State of Hawaiʻi
Office of Hawaiian Affairs	State of Hawaiʻi
Department of Health, Clear Air Branch	State of Hawaiʻi
Department of Health, Environmental Management Division	State of Hawaiʻi
Department of Land and Natural Resources	State of Hawaiʻi
Department of Land and Natural Resources, State Historic Preservation Division	State of Hawaiʻi
Department of Transportation	State of Hawaiʻi
Office of Capital Improvement	University of Hawaiʻi
Water Resources Research Center	University of Hawaiʻi
Environmental Center	University of Hawaiʻi
Department of Environmental Management	County of Hawaiʻi
Fire Department	County of Hawaiʻi
Department of Parks and Recreation	County of Hawaiʻi
Planning Department	County of Hawaiʻi
Police Department	County of Hawaiʻi
Department of Public Works	County of Hawaiʻi
Department of Research and Development	County of Hawaiʻi
Department of Water Supply	County of Hawaiʻi

Name	Affiliation
Non-Profit Groups	
Kamehameha Schools	NA
Nanawale Community Association	NA
Leilani Community Association	NA
Main Street Pahoa	NA
Pōhaku Pelemaka	NA
Men of Pa’a	NA
Nā Maka Hāloa O Waipiʻo	NA
ʻO Makuʻu Ke Kahua	NA
Hoʻoulu Lāhui	NA
Japanese Chamber of Commerce & Industry of Hawaiʻi	NA
Hawaii Island Chamber of Commerce	NA
Hawaii Island Economic Development Board	NA
Hawaii Leeward Planning Conference	NA
Native Hawaiian Chamber of Commerce	NA
Sustainable Energy Hawaii	NA
Earth Justice Warriors	NA
Puna Pono Alliance	NA
Malama O Puna	NA
Hawaiʻi Groundwater and Geothermal Resource Center	NA
Parker Ranch	NA
Ulupono Initiative LLC	NA
Blue Planet Foundation	NA
Sierra Club of Hawaiʻi	NA
Neighbors and Concerned Citizens	
Interested individuals will be identified in early consultation and throughout the environmental review process	
Other	
Hawaiian Electric Light Company	NA

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APPENDIX A
Figures

Legend

Parcel Number

- 140010010000
- 140010020000
- 140010190000

N

0 3,500 7,000 Feet

1 in = 7,000 feet

Stantec

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

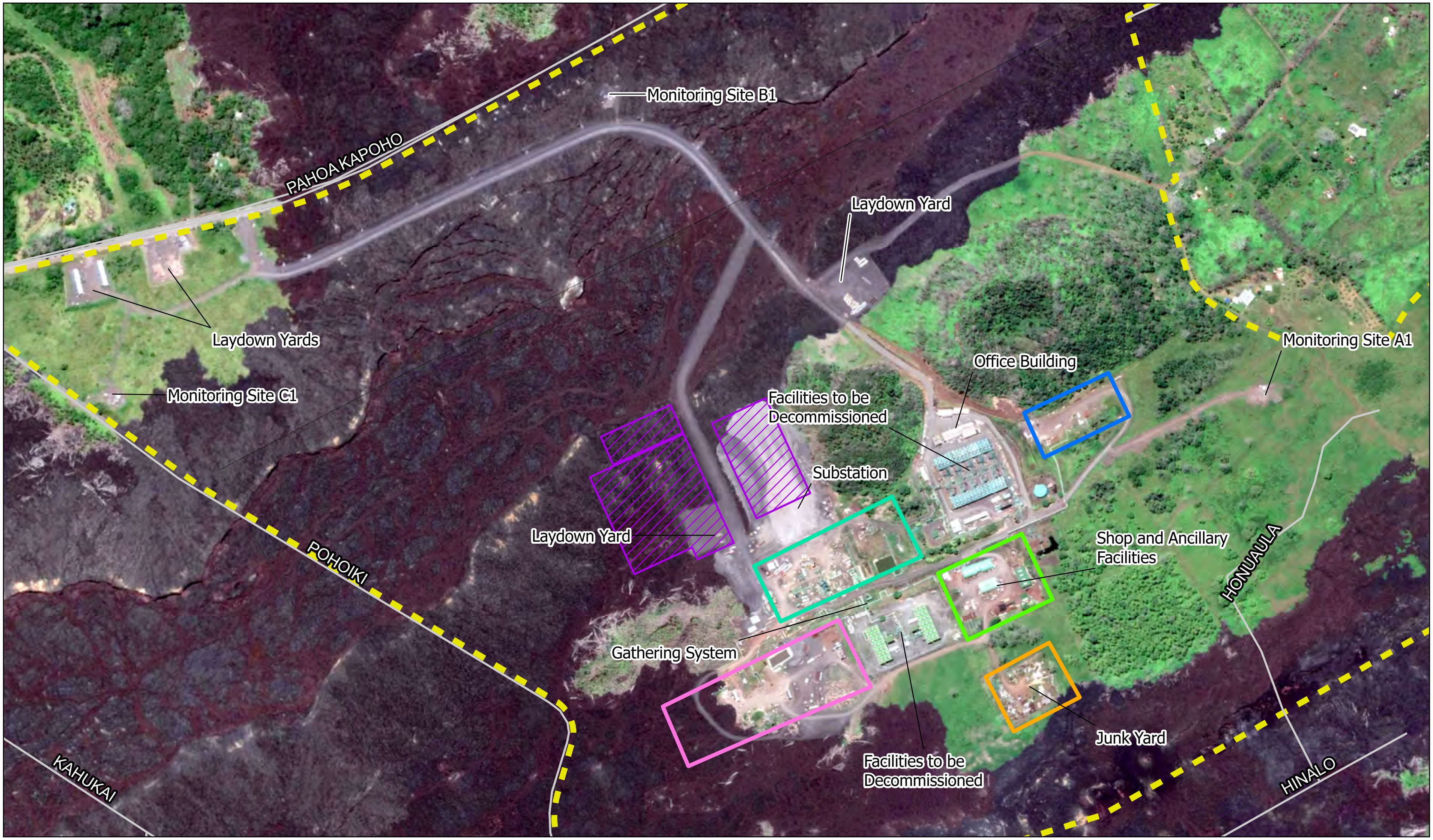
Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-06-23	PROJECT NO: 185805496	

Figure 1
Project Location

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-06-23 By: btaylor

Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Hybrid Reference Layer: Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, USDA
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

- Proposed Disturbance
- PGV Property Boundary

Existing Well Pads

- Pad A
- Pad B
- Pad D (no active wells as of 2022)
- Pad E
- Pad F (no active wells as of 2022)

N

Stantec

Feet
0 350 700
1 in = 700 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-05-11	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 2
Existing Facilities

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Legend

- Proposed Disturbance
- PGV Property Boundary
- Proposed Facilities

N

Stantec

Feet

0 200 400

1 in = 400 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-05-11	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 3
Proposed Project

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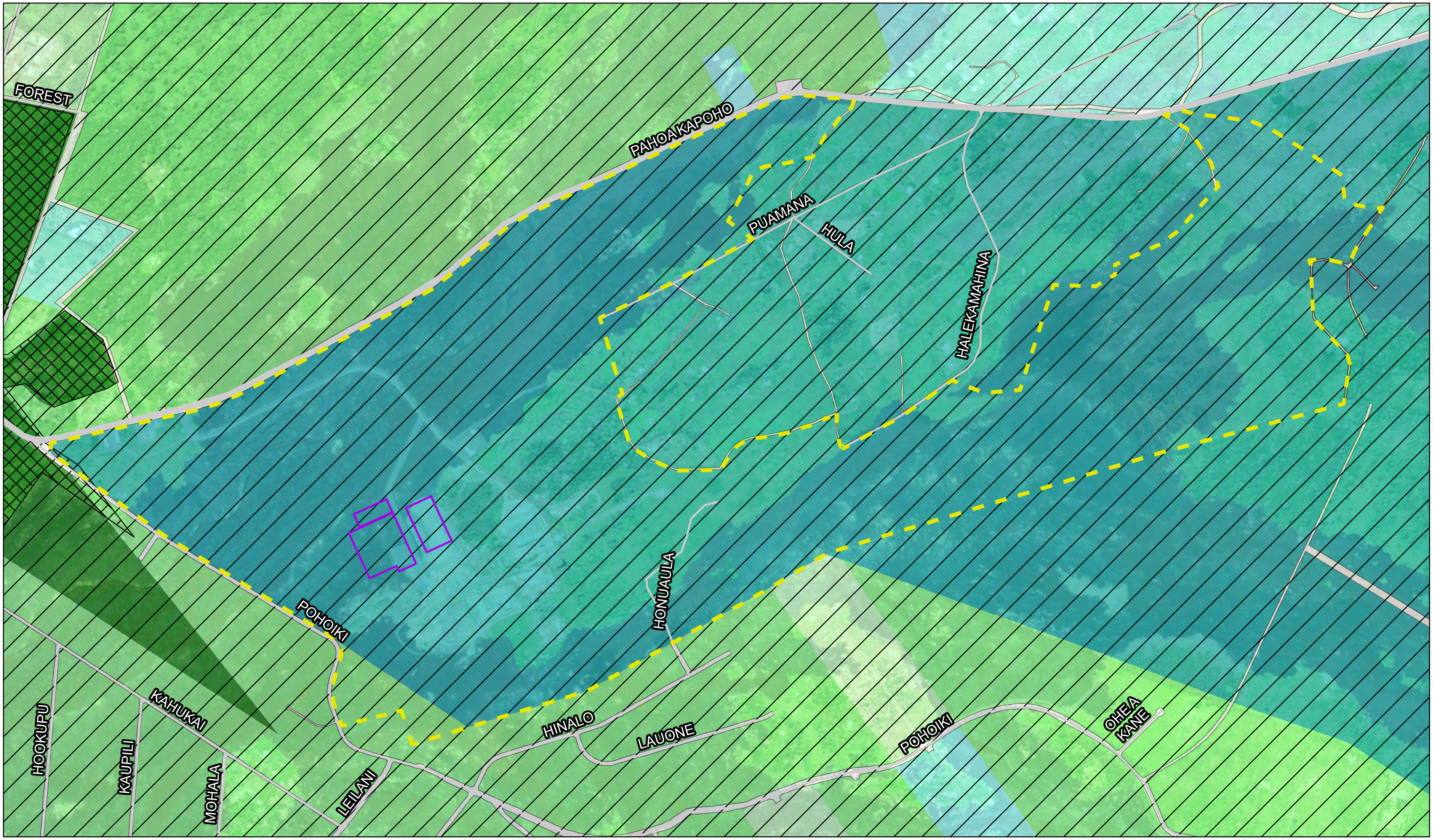
Service Layer Credits: Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
World Imagery: Resource Mapping Hawaii, Maxar



Legend

- Proposed Disturbance
- PGV Property Boundary

Land Use Code

- Agricultural
- Conservation

Zoning

- Road
- A-10a
- A-1a
- A-3a
- A-5a
- Open

N

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0 750 1,500 Feet

1 in = 1,500 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-06-23	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 4
State Land Use District

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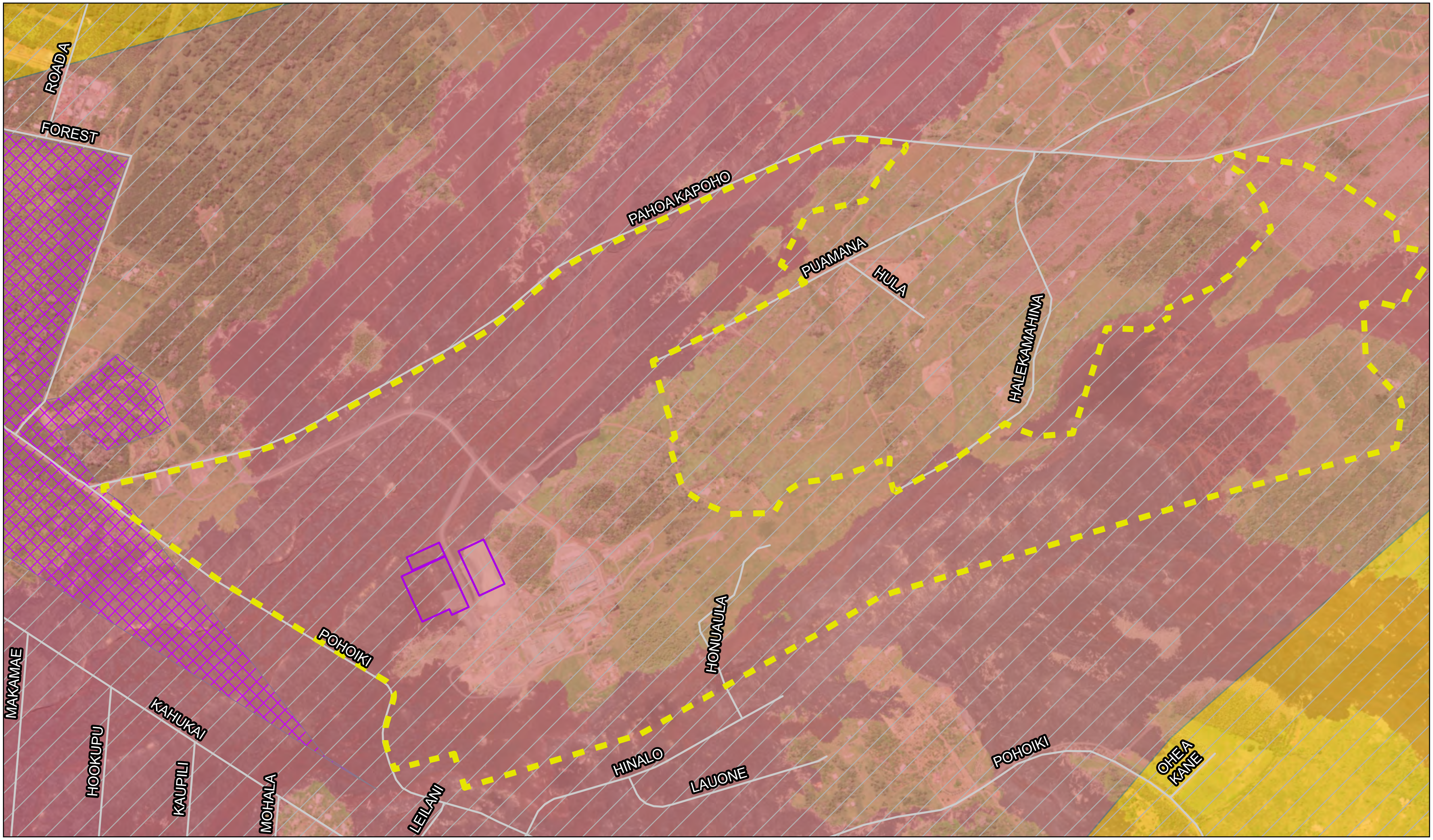
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend

Proposed Disturbance

Flood Hazard Zone

D

X

Lava Hazard Zone

1

2

N

Stantec

Feet

0 750 1,500

1 in = 1,500 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

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DATE: 2022-06-23	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 5
Flood Map

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-06-23 By: botaylor

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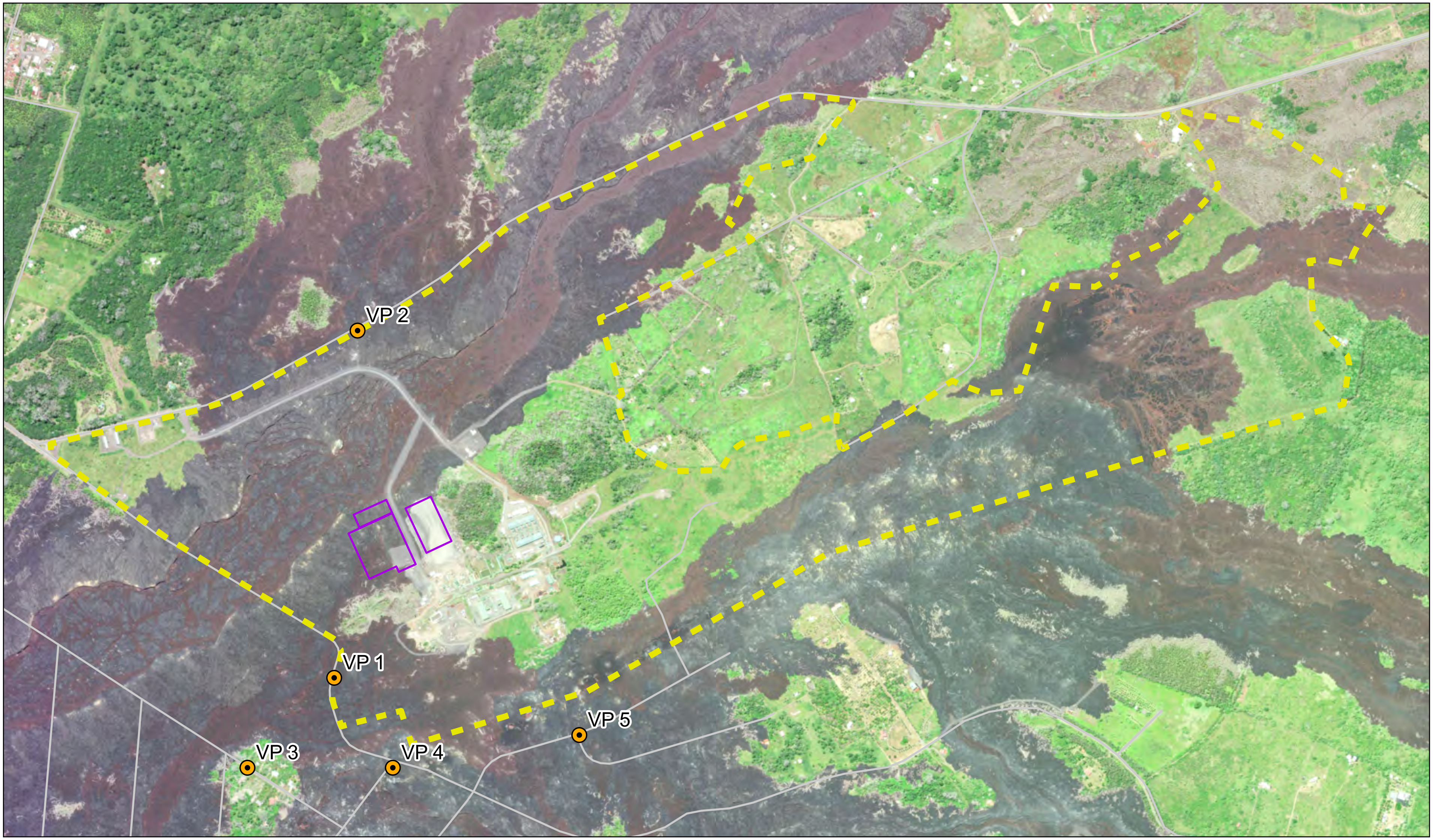
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA



Legend
- Proposed Disturbance
- Suggested Viewpoints

N

Stantec

0 750 1,500 Feet

1 in = 1,500 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-06-23	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 6
Suggested Viewpoints for Visual Analysis

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Direct Scoping Letter

Dear Participant:

This notice is to inform you that an Environmental Impact Statement Preparation Notice (EISPN) prepared pursuant to the EIS law (Hawaiʻi Revised Statutes, Chapter 343) and the EIS rules (Administrative Rules, Title 11, Chapter 200.1) is available for review. A digital copy of the EISPN is available for download by selecting the July 23, 2022, edition of the Office of Planning and Sustainable Development's Environmental Review Program at: https://planning.hawaii.gov/erp/.

Project Name:	Puna Geothermal Venture Repower Project
Island:	Hawaiʻi
District:	Puna
TMK:	(3) 1-4-001: 001, 002, and 019

Comments must be received or postmarked by: **August 22, 2022**

Please send original comments to the consultant:

Michele Lefebvre
Stantec Consulting Inc.
P.O. Box 191
Hilo, HI 96721-0191
Or by email to michele.lefebvre@stantec.com

Copies of the comments should be sent to:

Accepting Authority:

County of Hawaii Planning Department
Aupuni Center
101 Pauahi Street, Suite 3
Hilo, HI 96720
Or by email to planning@hawaiicounty.gov

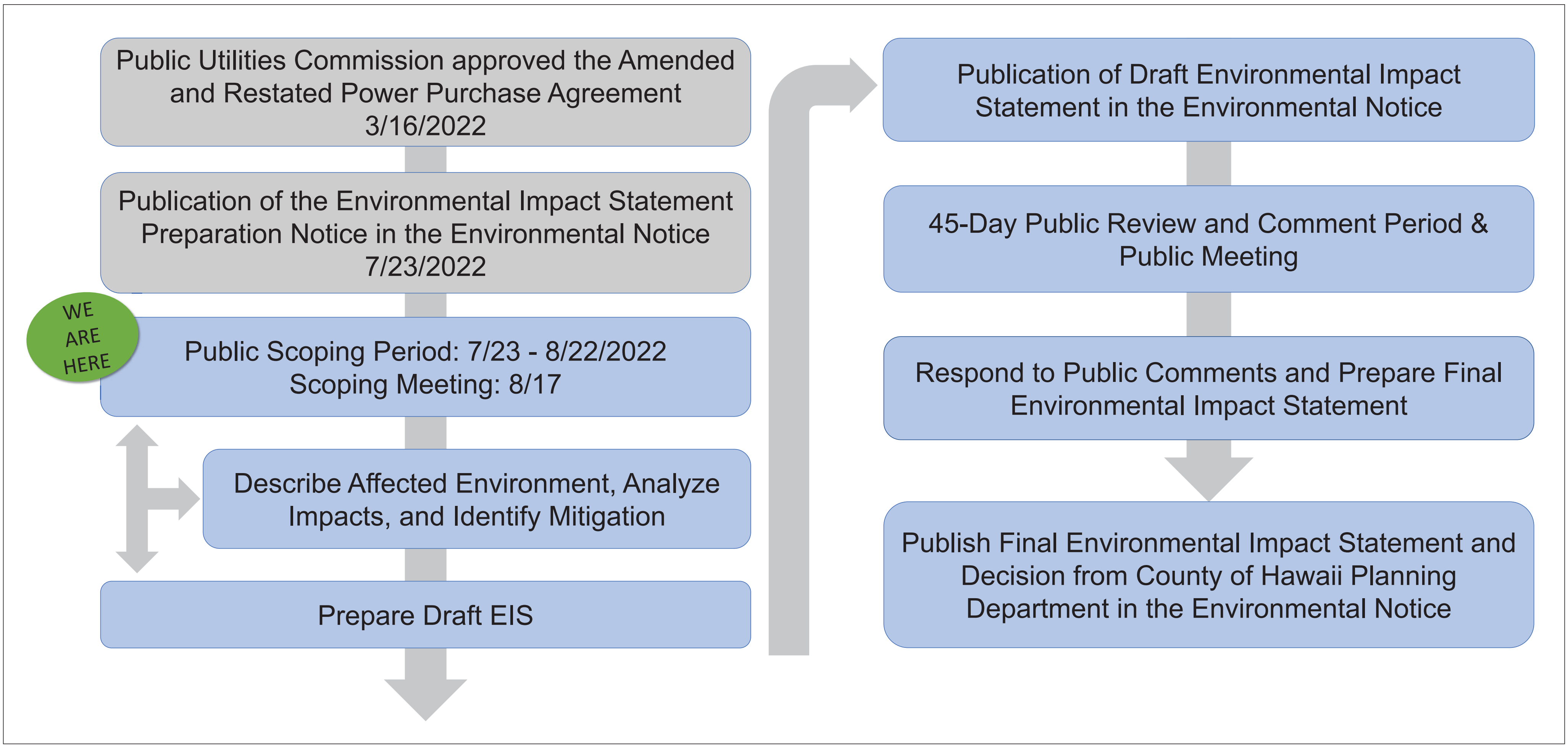
Thank you for your participation in the environmental review process.

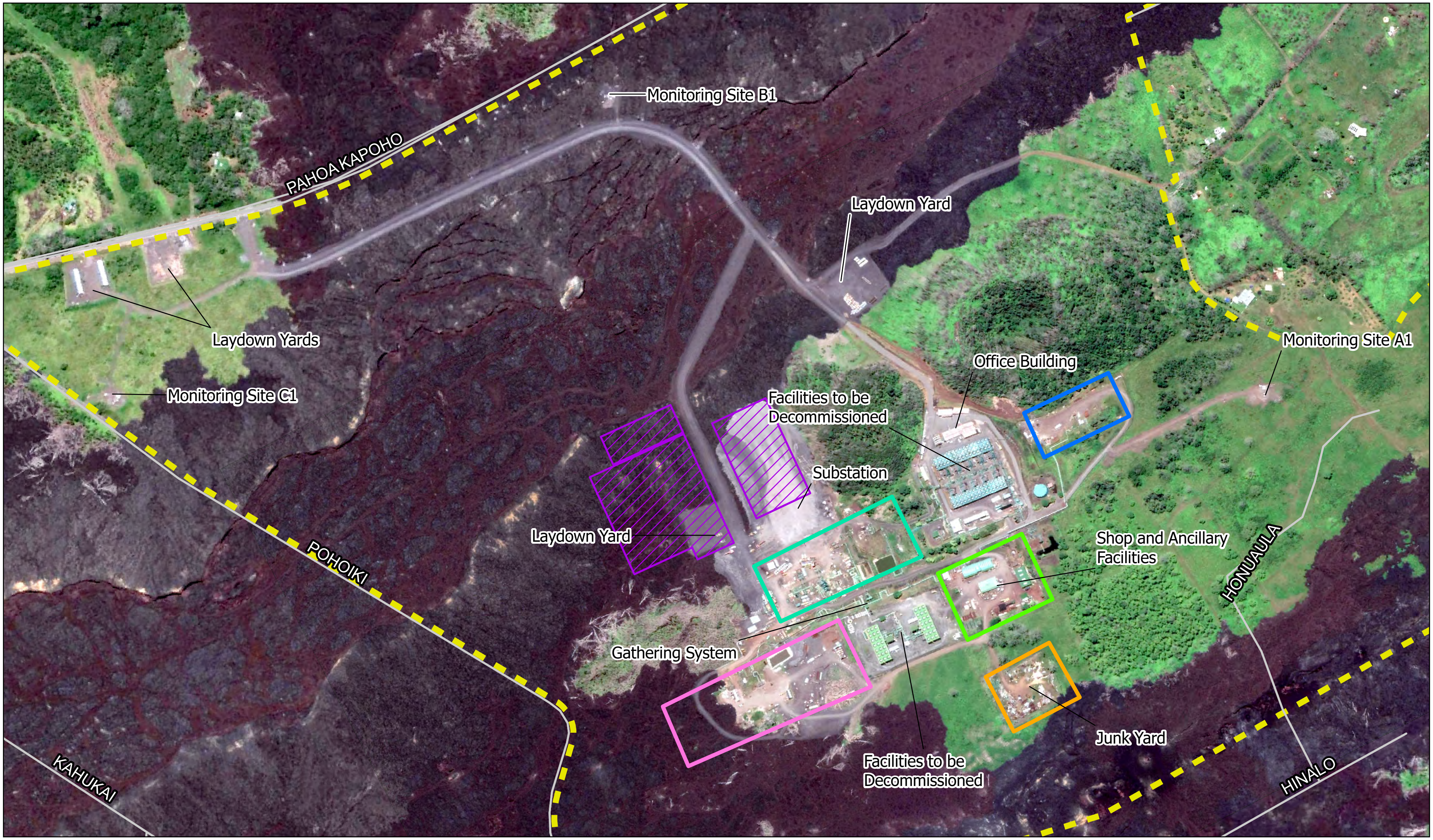
APPENDIX C

SCOPING MATERIALS

SCOPING MEETING POSTERS

Puna Geothermal Venture Repower Project Environmental Impact Statement Process





Legend

- Proposed Disturbance
- PGV Property Boundary

Existing Well Pads

- Pad A
- Pad B
- Pad D (no active wells as of 2022)
- Pad E
- Pad F (no active wells as of 2022)

N

Stantec

0 350 700 Feet

1 in = 700 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT | 1ST REVIEW: JT | 2ND REVIEW: ML

DATE: 2022-05-11 | PROJECT NO: 185805496

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 2
Existing Facilities

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-05-11 By: botaylor

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Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

Legend

Proposed Disturbance

PGV Property Boundary

Proposed Facilities

N

0 200 400 Feet

1 in = 400 feet

Stantec

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-05-11	PROJECT NO: 185805496	

Figure 3
Proposed Project

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-05-11 By: btaylor

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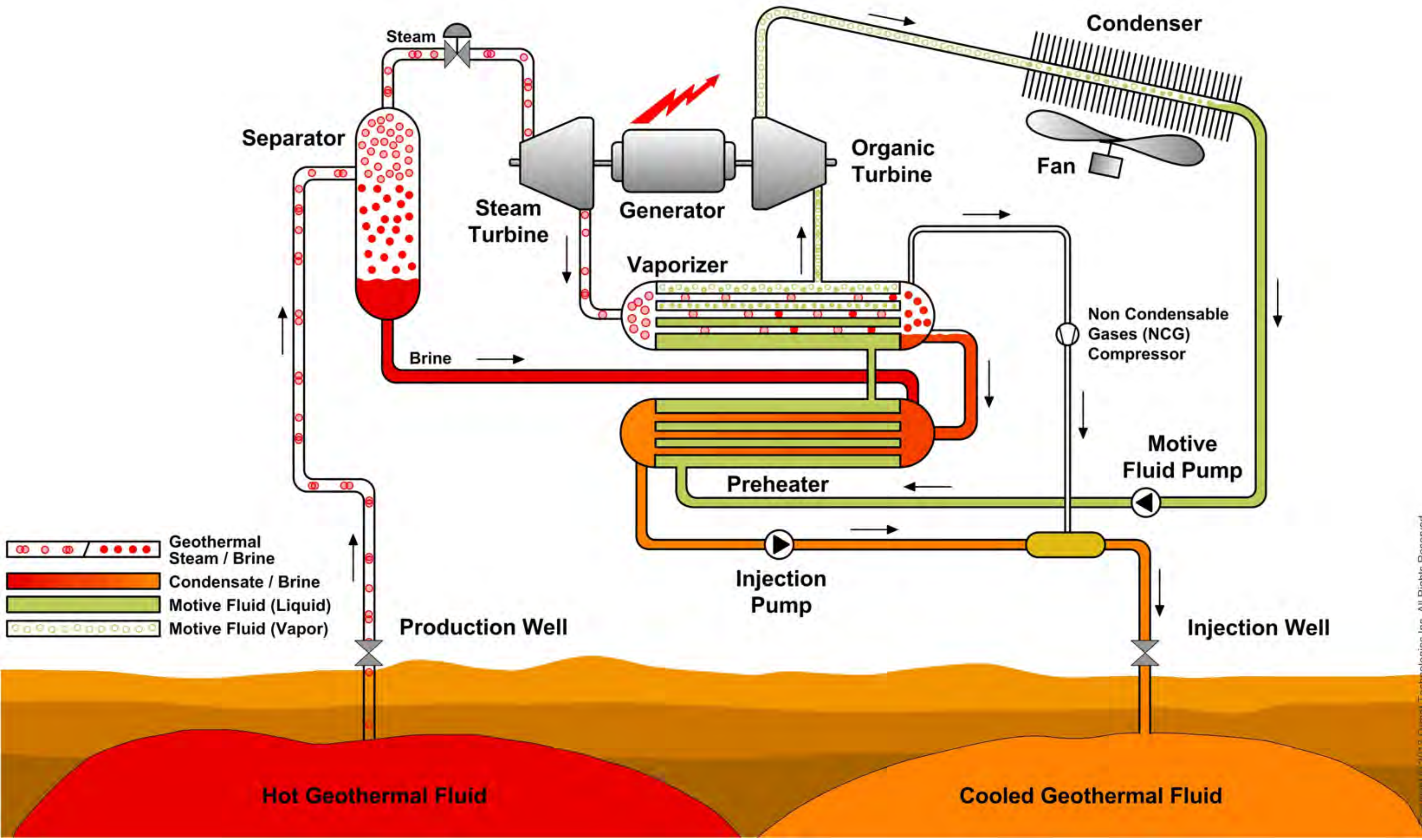
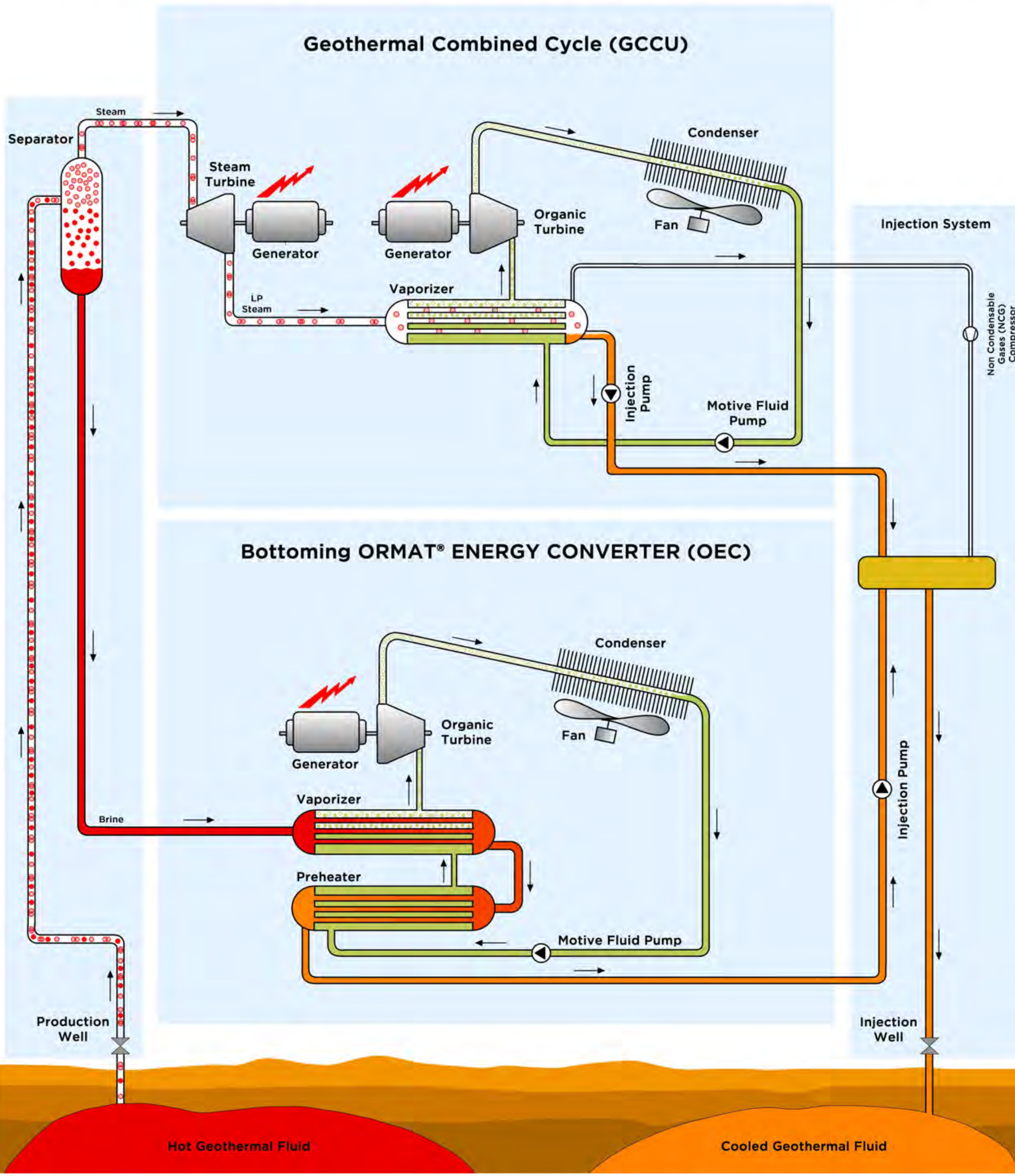
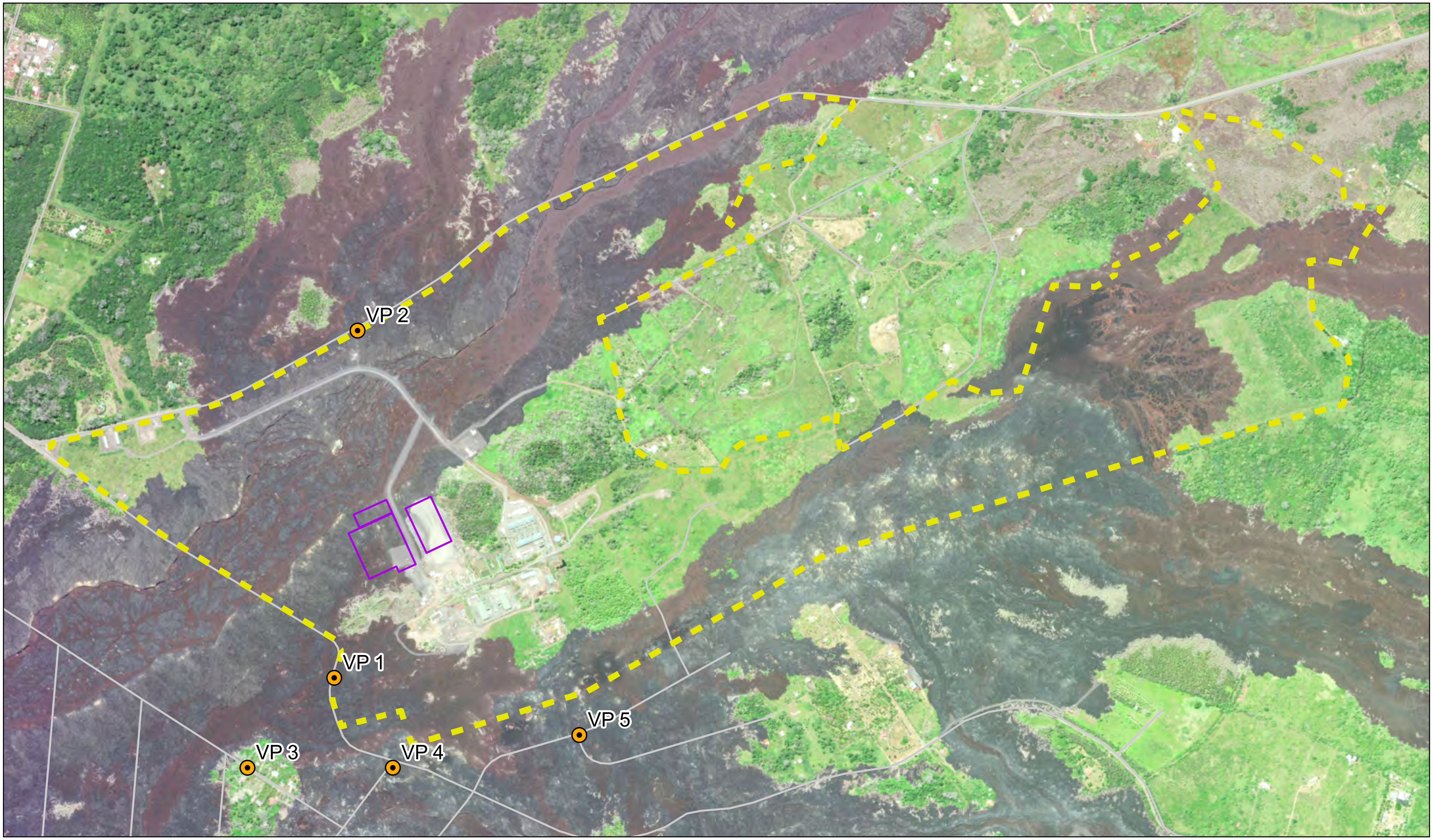
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
World Imagery: Resource Mapping Hawaii, Maxar

Geothermal Combined Cycle Power Plant (GCCU)



Integrated Geothermal Combined Cycle Power Plant (IGCC)





Legend

Proposed Disturbance

Suggested Viewpoints

N

Feet
0 750 1,500
1 in = 1,500 feet

Stantec

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-06-23	PROJECT NO: 185805496	

Figure 6
Suggested Viewpoints for Visual Analysis

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-06-23 By: botaylor

Service Layer Credits: SoH_Imagery\Vivid_2020: Web Map Service data provided by USDA-FPAC. Images provided © 2021 Maxar Technologies Inc.
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

How To Comment on the Environmental Impact Statement

Helpful or Substantive Comments

- Identify specific concerns and impacts from the project
- Identify potential Alternatives that should be considered
- Identify references or information that should be considered in the environmental analysis

Not Helpful or Non-Substantive Comments

- In favor or against the proposal without reasoning
- A vote
- Agree or disagree with previous approvals or decisions
- Doesn't pertain to the project or project area

If your comment doesn't identify specific concerns, it likely isn't substantive.

Information on how to submit comments is on the comment forms provided.

We value your input.

Provide comments on the proposed project and environmental concerns that should be analyzed in the Draft Environmental Impact Statement.

We want to hear from you.

Please ask questions today about current operations and the proposed project.

We are here today to answer your questions about the project and identify potential impacts.

SCOPING MEETING SCHEDULE

Puna Geothermal Venture Repower Project
Environmental Impact Statement

Public Scoping Meeting

Wednesday, August 17, 2022
Pāhoa Neighborhood Facility

SCHEDULE:

5:00 – 5:50pm Open House

5:50 – 6:00pm Welcome Presentation/Project Overview

6:00 – 8:00pm Oral Comment Session

MEETING PROTOCOL:

- Please sign up when you arrive if you would like to make an oral comment.
- If you prefer to make a written comment, information will be provided on how to do so.
- Oral commenters will be provided a set amount of time to speak.
- If after all oral commenters have had the opportunity to speak, and if there is still meeting time left, more comments may be heard.
- Be respectful.
- One voice at a time.
- Listen to oral commenters without interruption.
- Mahalo!

SCOPING MEETING

INFORMATION SHEET

Puna Geothermal Venture
Geothermal Repower Project Environmental Impact Statement
Public Scoping Meeting
August 17, 2022 – Pāhoa Neighborhood Facility

Proposed Action Information Sheet

Puna Geothermal Venture is currently authorized for and operating a geothermal power plant in the Puna District and proposes to replace the current operating power-generating units with up to four energy converters. The Project would increase the production of renewable energy at the existing facility (within the current site fence line) using new, more efficient units on a smaller land footprint compared to the existing units. The Project would increase power production from 38 to 46 megawatts in Phase 1 and further increase production to 60 megawatts in Phase 2.

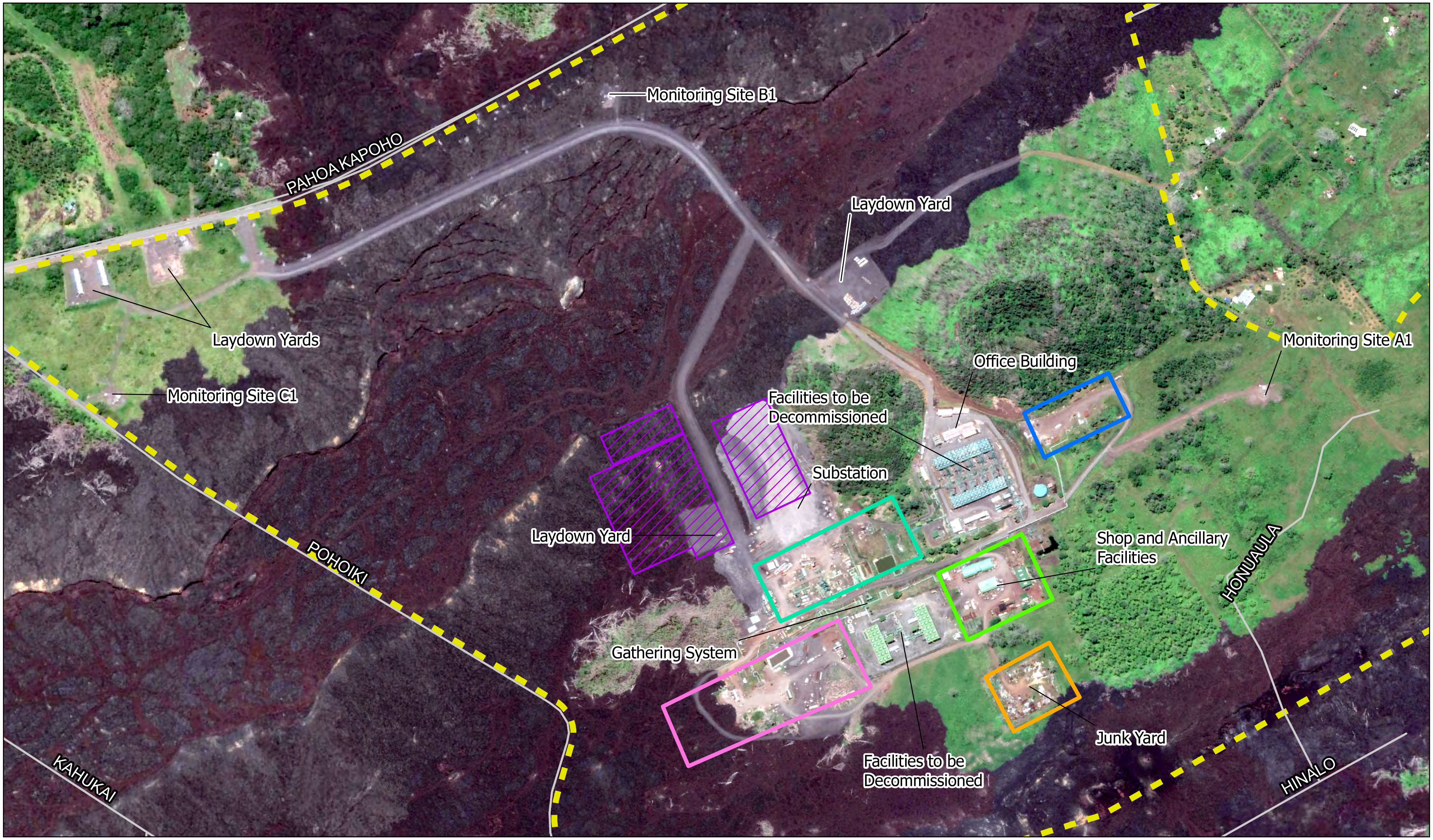
As part of the Project, the existing 12 steam and brine energy converters would be replaced with three new energy converters in Phase 1 (and one (1) additional converter in Phase 2) at a new location on the Project site. The amount of power generated in Phase 1 matches the amount approved in the Amended and Restated Power Purchase Agreement. Puna Geothermal Venture would need to further amend the agreement prior to implementing Phase 2 which would increase power generation to 60 megawatts.

The overall size of the Project site would remain the same. Most of the existing infrastructure and buildings would remain for the Project including administration buildings, the control room, maintenance areas, well pads, and the gathering system.

Why is this Environmental Impact Statement being prepared?

On March 16, 2022, the State of Hawaii Public Utilities Commission approved the Amended and Restated Power Purchase Agreement (Decision and Order No. 38276) with conditions that the “HEPA review” be complete prior to the commencement of Project construction. The County of Hawaiʻi Planning Department has been designated the approving agency for the Project’s Environmental Impact Statement.

The Environmental Impact Statement will be prepared in accordance with Chapter 343, Hawaii Revised Statutes and Chapter 11-200.1 Hawaii Administrative Rules.



Legend
Proposed Disturbance
PGV Property Boundary
Existing Well Pads
Pad A
Pad B
Pad D (no active wells as of 2022)
Pad E
Pad F (no active wells as of 2022)

N

Feet
0 350 700
1 in = 700 feet

Stantec

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-05-11	PROJECT NO: 185805496	

Figure 2
Existing Facilities

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\pro\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-05-11 By: botaylor

Service Layer Credits: Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

SCOPING COMMENT FORM

Puna Geothermal Venture Repower Project
Environmental Impact Statement

EARLY CONSULTATION: WRITTEN PUBLIC COMMENT SHEET

Where to provide comments: You can either

- Fill out and hand this comment form in at the public scoping meeting,
- Mail your written comment to P.O. Box 191, Hilo, HI 96721, or County of Hawaii Planning Department, Aupuni Center, 101 Pauahi Street, Suite 3, Hilo, HI 96720, or
- Email your written comment to the following email address(es): ***planning@hawaiicounty.gov, michele.lefebvre@stantec.com, or mkaleikini@ormat.com.***

Name ______________________________

Organization (if applicable) ______________________________

Mailing Address ______________________________

City ______________________________ State ______________ Zip ____________

Email ______________________________

Date ______________

☐ Please check box if you want to be on the mailing list for future updates and notifications for this EIS.

The Environmental Impact Statement Preparation Notice is posted here:
https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf

COMMENT *(use back side if you need additional space or attach additional sheets)*

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Comment must be postmarked by, or emailed no later than, August 22, 2022

APPENDIX D

SCOPING COMMENTS AND RESPONSES

SCOPING COMMENTS

Comment Letter 1

From: Surprenant, April
To: Steve Sparks
Subject: RE: PGV EIS
Date: Friday, July 29, 2022 11:44:54 AM

Aloha Mr. Sparks,

The EIS for this project is in the beginning stage and only the EIS Public Notice (EISPN) has been released. A digital copy of the EISPN is available by selecting the July 23, 2022, edition of the state's *The Environmental Notice* at: https://files.hawaii.gov/dbedt/erp/The_Environmental_Notice/2022-07-23-TEN.pdf

Once a Draft EIS is released, it will be available on the Office of Planning and Sustainable Development's Environmental Review Program website here: https://planning.hawaii.gov/erp/ea-and-eis-new-rules/

We hope this addresses your question.

Mahalo,
April

April J. Surprenant
Manager of Long Range Planning & Board of Appeals
Hawaii County Planning Department
101 Pauahi Street, Suite 3
Hilo, HI 96720
808-961-8125
www.planning.hawaiicounty.gov

From: Steve Sparks <asinsparks@gmail.com>
Sent: Tuesday, July 26, 2022 4:35 PM
To: Planning Internet Mail <planning@hawaiicounty.gov>
Subject: PGV EIS

Hello-

Where can I see the EIS for the PGV plant?

--
Steve Sparks
President
Mg Products, Inc.
13-1255 Malama St.
Pahoa, HI 96778
808-365-3386

Comment Letter 2

From: 'O Maku'u ke Kahua CC
To: Lefebvre, Michele
Subject: Re: Puna Geothermal Venture Repower Project: EISPN
Date: Wednesday, July 27, 2022 2:41:45 PM

Aloha Kāua,

The we decline the proposal set forth. I could not find the information with the given information. If direct access links can be provided that would be greatly appreciated.

mahalo nui,

'OMKKCC

On Sat, Jul 23, 2022 at 6:09 AM Lefebvre, Michele <michele.lefebvre@stantec.com> wrote:

> Attached please find a notice for the availability of the EISPN for the Puna Geothermal Venture Repower Project.
>
> Sincerely,
>
> **Michele Lefebvre** Ph.D.
>
> Project Manager, Environmental Scientist
>
> Mobile: 808 494-2039
> michele.lefebvre@stantec.com
>
> Stantec
>
>

Comment Letter 3

From: Cab General
To: planning@hawaiicounty.gov; Lefebvre, Michele
Subject: Puna Geothermal Venture Repower Project (EIS Preparation Notice)
Date: Thursday, August 04, 2022 5:57:25 AM

Aloha,

Thank you for the opportunity to provide comments on the subject project. Based on review of the *Puna Geothermal Venture Repower Project*, CAB has no further comments at this time.
Please see our standard comments at:

https://health.hawaii.gov/cab/files/2022/05/Standard-Comments-for-Land-Use-Reviews-Clean-Air-Branch-2022-1.pdf

Please let me know if you have any questions or concerns.

Kristen Caskey, EHS
Kristen.caskey@doh.hawaii.gov
Clean Air Branch
Hawaii State Department of Health

Standard Comments for Land Use Reviews
Clean Air Branch
Hawaii State Department of Health

If your proposed project:

Requires an Air Pollution Control Permit

- You must obtain an air pollution control permit from the Clean Air Branch and comply with all applicable conditions and requirements. If you do not know if you need an air pollution control permit, please contact the Permitting Section of the Clean Air Branch.
- Permit application forms can be found here: https://health.hawaii.gov/cab/permit-application-forms/

Includes construction, demolition, or renovation activities that involve potential asbestos and lead containing materials:

- Asbestos may be present in any existing structure. Prior to demolition, you must contact the Indoor and Radiological Health Branch, Asbestos-Lead Section. Testing may be required to determine if building materials may contain asbestos, such as: drywall, vinyl floor tile, mastic, caulking, roofing materials, insulation, special coatings, etc.
- Structures built prior to 1980 may also contain lead paint. Prior to demolition, contact the Indoor and Radiological Health Branch, Asbestos-Lead Section. Testing may need to be conducted to determine if building materials contain lead.
- Some construction activities have the potential to create excessive noise and may require noise permits. For DOH Noise Permits and/or Variances and for more information on the Indoor and Radiological Health Branch, please visit: https://health.hawaii.gov/irhb/

Includes demolition of structures or land clearing

- Department of Health, Administrative Rule: Title 11, Chapter 26, Vector Control, Section 11-26-35, Rodents; Demolition of Structures and Clearing of Sites and Vacant Lots, requires that:
    - No person, firm or corporation shall demolish or clear any structure, site, or vacant lot without first ascertaining the presence or absence of rodents which may endanger the public health by dispersal from such premises.
    - Should such inspection reveal the presence of rodents, the person, firm, or corporation shall eradicate the rodents before demolishing or clearing the structure, site, or vacant lot.
    - The Department may conduct an independent inspection to monitor compliance, or request a written report.
- The purpose of this rule is to prevent rodents from dispersing into adjacent areas from infested buildings or vacant lands during demolition or land clearing.
- Contractors may either hire a pest control firm or do the job themselves with a qualified employee. Rodenticides must be inspected daily and replenished as necessary to provide a continuous supply for at least one week prior to the start of any work.

- To submit notifications or for more information, contract the Vector Control Branch: https://health.hawaii.gov/vcb/

Has the potential to generate fugitive dust

- You must reasonably control the generation of all airborne, visible fugitive dust. Note that construction activities that occur near to existing residences, businesses, public areas and major thoroughfares exacerbate potential dust concerns. It is recommended that a dust control management plan be developed which identifies and mitigates all activities that may generate airborne, visible fugitive dust. The plan, which does *not* require Department of Health approval, should help you recognize and minimize potential airborne, visible fugitive dust problems.
- Construction activities must comply with the provisions of Hawaii Administrative Rules, §11-60.1-33 on Fugitive Dust. In addition, for cases involving mixed land use, we strongly recommend that buffer zones be established, wherever possible, in order to alleviate potential nuisance complaints.
- You must provide reasonable measures to control airborne, visible fugitive dust from the road areas and during the various phases of construction. These measures include, but are not limited to, the following:
    - Planning the different phases of construction, focusing on minimizing the amount of airborne, visible fugitive dust-generating materials and activities, centralizing on-site vehicular traffic routes, and locating potential dust-generating equipment in areas of the least impact;
    - Providing an adequate water source at the site prior to start-up of construction activities; Landscaping and providing rapid covering of bare areas, including slopes, starting from the initial grading phase;
    - Minimizing airborne, visible fugitive dust from shoulders and access roads;
    - Providing reasonable dust control measures during weekends, after hours, and prior to daily start-up of construction activities; and
    - Controlling airborne, visible fugitive dust from debris being hauled away from the project site.
- If you have questions about fugitive dust, please contact the Enforcement Section of the Clean Air Branch

Increases the population and potential number of vehicles in an area:

- The creation of apartment buildings, complexes, and residential communities may increase the overall population in an area. Increasing the population in an area may inadvertently lead to more air pollution via vehicle exhaust. Vehicle exhaust releases molecules in the air that negatively impact human health and air quality, as they are known lung irritants, carcinogens, and greenhouse gases.
- Ensure that residents keep their vehicle idling time to three (3) minutes or less.
- Provide bike racks and/or electric vehicle charging stations for residents.
- Ensure that there are sufficient and safe pedestrian walkways and crosswalks throughout and around the development.
- Conduct a traffic study to ensure that the new development does not significantly impact traffic in the area.

Clean Air Branch (808) 586-4200 cab@doh.hawaii.gov	Indoor Radiological Health Branch (808) 586-4700	Vector Control Branch (808) 586-4400

Comment Letter 4

From: Dave Kisor
To: planning@hawaiicounty.gov; Lefebvre, Michele; mkaleikini@ormat.com
Subject: PGV EIS
Date: Sunday, August 07, 2022 6:37:31 PM

Aloha Humans

County of Hawai`i Planning Department
Attn April Surprenant
101 Pauahi Street, Suite 3
Hilo, HI 96720

Stantec Consulting Services Inc.
c/o Michele Lefebvre
P.O. Box 191
Hilo, HI 96721

Puna Geothermal Venture
c/o Mike Kaleikini
P.O. Box 30
Pahoa, HI 96778

What comes out of the ground is more than hydrogen sulfide. “The sampling and testing of the resource shall be preformed once upon experiencing the first steam release, and at least once during abated well cleanout and flow testing operations. Gasses to be tested:

ammonium (total), cadmium nitrates, arsenic carbonate, non-methane hydrocarbons, asbestos, fluorides (total), radionuclides, (a & b), benzene, hydrogen sulfide, radon, beryllium lead sulfates, bicarbonate, mercury (total), vinyl chloride, boron (total), methane”

Lucky me, I have elevated levels of arsenic, mercury, lead and cadmium, which should be no more than a trace, as found on my hair tissue mineral analysis. During the storm, while in the eye, I used a handheld weather station and recorded a maximum wind velocity of 16mph, which was ideal for the distribution of gas.

To believe H2S is the only gas that can cause physiological problems and only travels one mile is pure and unadulterated fantasy. I knew someone who has since moved back to Oahu who lived in Tangerine Acres, by the intersection of HWYs 130 and 132 who was knocked down for 4 hours just after the lights went out, at approximately 2.5 miles past your magical one mile limit.

In absolute and unequivocal disgust,

David J. Kisor

||||||||||||||| >^.^< |||||||||||||||
Cats & computers. Bring them into your home and your life is no longer your own.
Don't get upset when things don't work, but rather be amazed when they do!
If the Cat won't come to the mountain, then the mountain must perforce come to the

Cat!

Comment Letter 5

Mitchell D. Roth
Mayor

Paul K. Ferreira
Police Chief

Kenneth Bugado Jr.
Deputy Police Chief

County of Hawai`i

POLICE DEPARTMENT

349 Kapi'olani Street • Hilo, Hawai'i 96720-3998
(808) 935-3311 • Fax (808) 961-2389

August 10, 2022

Michele Lefebvre
Stantec Consulting Inc.
P.O. Box 191
Hilo, HI 96721-0191
michele.lefebvre@stantec.com

Dear Ms. Lefebvre:

SUBJECT: PROJECT NAME: PUNA GEOTHERMAL VENTURE REPOWER PROJECT; ISLAND: HAWAII; DISTRICT: PUNA; TMK: (3) 1-4-001:001,002, AND 019

Staff, upon reviewing the provided documents, does not anticipate any significant impact to traffic and/or public safety concerns and acknowledges support of the contingency plan.

Thank you for allowing us the opportunity to comment.

Should you have any additional concerns and/or wish to discuss this matter further, please contact our Puna District Commander, Captain Scott Amaral, at (808) 965-2716 or via email at Scott.Amaral@hawaiicounty.gov.

Sincerely,

KENNETH A.K. QUIOCHO
ASSISTANT POLICE CHIEF
AREA I OPERATIONS

SA:lli/22HQ0886

c: planning@hawaiicounty.gov

Comment Letter 6

DAVID Y. IGE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION

HAWAII DISTRICT OFFICE
50 MAKAALA STREET
HILO, HAWAII 96720
TELEPHONE: (808) 933-8866 • FAX: (808) 933-8869

JADE T. BUTAY
DIRECTOR

Deputy Director
ROSS M. HIGASHI
EDUARDO P. MANGLALLAN
EDWIN H. SNIFFEN

IN REPLY REFER TO:
HWY-H 22.2.0082

August 10, 2022

VIA EMAIL: michele.lefebvre@stantec.com

Ms. Michele Lefebvre
Stantec Consulting Inc.
P.O. Box 191
Hilo, Hawaii 96721-0191

Dear Ms. Lefebvre:

Subject: Environmental Impact Statement Preparation Notice
Puna Geothermal Venture Repower Project
Route 130, Mile Post 12.136
TMK: (3) 1-4-001: 001, 002, 019
Kapoho, Puna, Hawaii

Thank you for the opportunity to provide comments.

Please elaborate on what changes to plans and operating conditions have been implemented since the 2018 lava flow.

If there are any questions, please contact Mr. Harry Takiue, Hawaii District Engineer, Highways Division, Hawaii District Office, at (808) 933-8866 or by email at harry.h.takiue@hawaii.gov.

Sincerely,

HARRY H. TAKIUE
Hawaii District Engineer

Comment Letter 7

Puna Geothermal Venture Repower Project
Environmental Impact Statement

EARLY CONSULTATION: WRITTEN PUBLIC COMMENT SHEET

Where to provide comments: You can either

- Fill out and hand this comment form in at the public scoping meeting,
- Mail your written comment to P.O. Box 191, Hilo, HI 96721, or County of Hawaii Planning Department, Aupuni Center, 101 Pauahi Street, Suite 3, Hilo, HI 96720, or
- Email your written comment to the following email address(es): ***planning@hawaiicounty.gov, michele.lefebvre@stantec.com, or mkaleikini@ormat.com.***

Name April Spencer

Organization (if applicable)

Mailing Address PO Box 1272

City Kurtistown State HI Zip 96760

Email 2016AprilRenee@gmail.com

Date 8-17-22

☑ Please check box if you want to be on the mailing list for future updates and notifications for this EIS.

The Environmental Impact Statement Preparation Notice is posted here:
https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf

COMMENT *(use back side if you need additional space or attach additional sheets)*

My Concerns is the effects of Fracking on the Enviroment, air Quality, earthquakes, and Volcanic Erruptions

Everytime I drive down the Hwy PGV is located off of. I develop a migrain. Something is not right there.

Comment must be postmarked by, or emailed no later than, August 22, 2022

Comment Letter 8

Puna Geothermal Venture Repower Project
Environmental Impact Statement

EARLY CONSULTATION: WRITTEN PUBLIC COMMENT SHEET

Where to provide comments: You can either

- Fill out and hand this comment form in at the public scoping meeting,
- Mail your written comment to P.O. Box 191, Hilo, HI 96721, or County of Hawaii Planning Department, Aupuni Center, 101 Pauahi Street, Suite 3, Hilo, HI 96720, or
- Email your written comment to the following email address(es): ***planning@hawaiicounty.gov, michele.lefebvre@stantec.com, or mkaleikini@ormat.com.***

Name Chuck Barker

Organization (if applicable)

Mailing Address 4 Kamehameha Avenue

City Hilo State HI Zip 96720

Email chuck.kuleana@gmail.com

Date 8/17/2022

☑ Please check box if you want to be on the mailing list for future updates and notifications for this EIS.

The Environmental Impact Statement Preparation Notice is posted here:
https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf

COMMENT *(use back side if you need additional space or attach additional sheets)*

The proposal to implement advanced-technology equipment such as will allow an increase in generating capacity from the current 25-38 mW to 60 mW is to be applauded and encouraged. We are fortunate that Ormat is willing to make this investment in capital improvements, as their economic return will take quite a few years to recover.

While there are certain (often quite vocal) dissenting persons who complain of "emissions" the actual statistics reveal that geothermal power plants emit 97% less acid rain-causing sulfur and 99% less CO_2 than fossil power plants, per total mWh of electricity produced.

Comment must be postmarked by, or emailed no later than, August 22, 2022

And the dissenters go home, switch on their lights, open their refrigerators and plug in their computers.
Geothermal power generation is environmentally safe & economic.

Comment Letter 9

Puna Geothermal Venture Repower Project
Environmental Impact Statement

EARLY CONSULTATION: WRITTEN PUBLIC COMMENT SHEET

Where to provide comments: You can either

- Fill out and hand this comment form in at the public scoping meeting,
- Mail your written comment to P.O. Box 191, Hilo, HI 96721, or County of Hawaii Planning Department, Aupuni Center, 101 Pauahi Street, Suite 3, Hilo, HI 96720, or
- Email your written comment to the following email address(es): ***planning@hawaiicounty.gov***, ***michele.lefebvre@stantec.com***, **or** ***mkaleikini@ormat.com***.

Name KUHANA / NOIANI K IOPA

Organization (if applicable) ____________________

Mailing Address ____________________

City ____________________ State ____________________ Zip ____________________

Email ____________________

Date ____________________

☐ Please check box if you want to be on the mailing list for future updates and notifications for this EIS.

The Environmental Impact Statement Preparation Notice is posted here:
https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf

COMMENT *(use back side if you need additional space or attach additional sheets)*

i use to work at Geo could you help the
people that got or has medical Bill from
the gas an the people that live around
the area iam a native Hawaiian an respect
our AiNA the water that was down there is
gone at times i smell it wen i was working
at geo i got paid pretty good i maid 3,000
a week But one day i seen a litto Boy Holding
a asmam pump in His Hand i stop an ask
Him why are you holding it ~~He~~ He point at
geo Where i work i Got Hurt in my
Heart so i Quite My JOB i HAVE a

Comment must be postmarked by, or emailed no later than, August 22, 2022

lot more to say i wish u guys
could help the people with some
money for there medical Bills an
life we are all Horting in a way
Becuse of the water, air land
An wish u guys could help us
with some money for water
going OK

PS

CAN We Help
each other An love
one An other

Comment Letter 10

Puna Geothermal Venture Repower Project
Environmental Impact Statement

EARLY CONSULTATION: WRITTEN PUBLIC COMMENT SHEET

Where to provide comments: You can either

- Fill out and hand this comment form in at the public scoping meeting,
- Mail your written comment to P.O. Box 191, Hilo, HI 96721, or County of Hawaii Planning Department, Aupuni Center, 101 Pauahi Street, Suite 3, Hilo, HI 96720, or
- Email your written comment to the following email address(es): ***planning@hawaiicounty.gov, michele.lefebvre@stantec.com, or mkaleikini@ormat.com.***

Name Steve Sparks

Organization (if applicable) self

Mailing Address 13-1255 Malama Street

City Paloa State HI Zip 96778

Email asinesparks@gmail.com

Date 4-16-21

☐ Please check box if you want to be on the mailing list for future updates and notifications for this EIS.

The Environmental Impact Statement Preparation Notice is posted here:
https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf

COMMENT *(use back side if you need additional space or attach additional sheets)*

Why is the Planning Dept to only approving agent. Why not include the Health Dept. and the Civil Defense?

Comment must be postmarked by, or emailed no later than, August 22, 2022

Comment Letter 11

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAI'I
345 KEKŪANAŌ'A STREET, SUITE 20 • HILO, HAWAI'I 96720
TELEPHONE (808) 961-8050 • FAX (808) 961-8657

August 15, 2022

Ms. Michele Lefebvre
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, HI 96721

Dear Ms. Lefebvre:

Subject: Publication of the Environmental Impact Statement Prep Notice for the Proposed Puna Geothermal Venture Repower Project
Applicant: Puna Geothermal Venture
Tax Map Key 1-4-001:001, 002, and 1-4-001:019

We have reviewed the subject Environmental Impact Statement Preparation Notice, and we have no comments at this time.

Should there be any questions, please contact Mr. Ryan Quitoriano of our Water Resources and Planning Branch at (808) 961-8070, extension 256.

Sincerely yours,

Keith K. Okamoto, P.E.
Manager-Chief Engineer

RQ:dfg

copy – Planning Department

Comment Letter 12

From: Lisa Roach
To: Lefebvre, Michele; planning@hawaiicounty.gov
Subject: "Puna Geothermal Repower Project EIS"
Date: Friday, August 19, 2022 3:05:18 PM

I am a property owner within less than one mile from the proposed new well sites, I would like to submit my comments after reading the EIS preparation notice.

I want to say, first of all, that I am very much an advocate of renewable, non-fossil fuel based energy sources. PGV has been a good neighbor and geothermal energy is a gift we should utilize.

The concerns of many who testified at the input meeting on August 17th, however, need to be addressed. In-real-time air monitoring stations that can be accessed by the public is not too big of a request.

Per the report: An Air Dispersion Modeling Report for PGV was prepared in April 2021 as an update to the analysis performed in 1991 for the 1992 ERP using AERMOD, which is currently approved by the EPA, and incorporating the USGS terrain files of the post-eruption terrain. The updated report concluded that the evacuation warning level for H2S would not be exceeded under any scenario. AERMOD was not in the list of acronyms and I would like the updated report to be accessible.

Furthermore, This study (Adler 2013) did not conduct a separate air quality assessment but reviewed existing independent studies/health risk assessments for the area. Existing studies concluded that PGV plant operations are unlikely to pose a threat to the air quality in nearby residential areas. I would like access to these independent studies/health risk assessments. Is there a link to this study? It would seem that, with past releases, you're going to have a hard time convincing opponents of PGV that this statement is true.

Recommendations were made to substantially improve the existing monitoring systems and protocols which were found to be inadequate. The recommendations called for the availability of real time and reliable gas, particulate and meteorological data for citizens to view and make informed decisions to protect themselves from fugitive emissions. I agree.

The use of pentane was adequately explained. Thank you.

Scientists/geologists were able to address, post eruption, that PGV did not cause the 2018 eruption. Conspiracy theorists will likely never be convinced, but publishing an article or two related to this would help your cause and more rational thinkers would benefit.

I hope PGV is successful and that the new wells are incorporating the most modern technology available. If you had better PR, (I may be missing your PR statements, as I don't use technology much) you may be more successful in minimizing distrust.

Good luck!

PS, and I don't mean to be mean, but...

As to the Hawaiian cultural concerns, I have a question for them: Did they protect the religion of and include the Marquesans in the decision-making process? The Marquesans were the "host culture" upon the early Hawaiians' arrival.

--

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May the World appreciate organic farmers as much as organic farmers appreciate the World!

Comment Letter 13

Testimony in Support of Puna Geothermal Ventures Repower Project

To whom it may concern:

As a resident and homeowner on the Big Island of Hawai'i, I want to voice my support for Puna Geothermal Ventures' (PGV) continued operations, execution of the pending Amended and Restated Power Purchase Agreement (Docket No. 2019-0333) and its planned capacity expansion to 60MW under its ongoing Repower Project.

While I agree that PGV must be held to the highest standards of safety, the service that PGV provides to Hawai`i Island is invaluable to the residents, businesses, and our pursuit of mitigating the effects of climate change and resource depletion.

Furthermore, geothermal power production involves one of the two sustainable, renewable energy systems capable of producing firm, dispatchable, baseload power for our community. The other is hydroelectric power generation. The latter is limited in its capacity on Hawai`i Island due to the small scale of individual generation sites.

All the remaining renewable, utility scale energy systems we're currently employing have limited lifecycles and require raw materials that are in high demand and experiencing stressed supplies. This means that they likely will not be economically replaced at the end of their useful lifespan.

Geothermal systems use mostly base metals and can be maintained over many decades as has been witnessed in Iceland, New Zealand and the oldest continuously producing facilities in Larderello, Italy.

With the perfect storm of climate change, global resource depletion and a still growing population, leveraging a long-lasting source of power that does not require imported energy carrying feedstocks, I feel that it is essential that PGV continue to operate and that we consider developing additional geothermal power generation capabilities here on Hawai`i Island.

Sincerely,

Peter Sternlicht
PO Box 1058
Pepeekeo HI 96783

+1-818-317-8684

Comment Letter 14

From:	Christopher Biltoft
To:	planning@hawaiicounty.gov
Cc:	Lefebvre, Michele; Michael Kaleikini
Subject:	Comment on PGV Repower Project EIS Prep Notice
Date:	Sunday, August 21, 2022 12:16:14 PM

Aloha! Ms. Surprenant:

The Environmental Notice of 23 July 2022 states that the PGV Repower Project EIS Preparation Notice includes a 30-day public review and comment period. Please note that I intend to follow this EIS process and request that I be included in all future notifications and opportunities for public comment. My comments on the PGVRP EIS Preparattion Notice are as follows:

1. **2.1.6 Existing Operations**. Please note that the ESRF is used for upset conditions, but does no "prevent a release of unabated H2S to the atmosphere."The ESRF is essentially a pile of rocks into which steam containing high levels of H2S and other toxins are dumped during emergency conditions. Sodium hydroxide is sprayed over the ESRF in an attempt to neutralize the H2S, but is only marginally successful. PGV failed to shut down power production in a timely fashion during Hurricane Iselle and had to use the ESRF to dump its toxic steam after power lines went down. The result was the wind-borne dispersion of both H2S and caustic soda through the nearby community. No H2S measurements were available for this incident because the monitoring system went down when the power was shut off. PGV received a slight slap on the wrist for this incident.

2. **3.3 Air Quality and Climate Change** PGV continues to operate under an outdated non-covered source permit (NSP 0008-02-N) that expired in 2019, and the DoH has refused, for some unknown reason, to update this permit to include current wells (as shown in Table 2.1 of this notice) and other facilities. Compliance with existing laws and regulations pertaining to H2S is also missing in the draft DoH NSP. This Notice correctly states in Table 4.1 that the current NSP requires amendment for the Project.

3. **3.3 Air Quality and Climate Change** Existing studies, for example the 1992 ERP as well as the April 2021 updated ERP, do NOT conclude that PGV plant operations are "unlikely to post a threat to the air quality in nearby residential areas." The early dispersion modeling done for the PGV Emergency Response Plan (ERP) using ISCST and the recent ERP modeling done using AERMOD are consistent in showing that H2S disperses into public space in concentrations well in excess of acute exposure guideline level 1 (AEGL1), posing a hazard to both nearby residents and to the public traveling along roads past PGV. It is worth noting that these models are gaussian dispersion models which provide ensemble averages, not peak concentrations. Peak concentrations can be many times greater than the reported ensemble averages. Evacuation warning levels for H2S can be exceeded during toxic gas dispersion scenarios at PGV.

4. **3.3 Air Quality and Climate Change** It is true that PGV publishes "real time data" for H2S and wind direction" (along with wind speed and other variables) with 5-minute updates from three sites near the PGV perimeter. However, publishing the data and publishing **correct and meaningful** data are different things. Studies such as Meder (2013) have shown that data quality, particularly the H2S data quality, is poor, with missing data and negative concentrations (which are impossible) rendering the data unusable. Data from the Hilo Airport, not PGV data, were used for the latest AERMOD modeling of the PGV site, presumably due to poor quality and missing data at PGV. The Adler Report (2013) also notes that "existing monitoring systems and protocols" were found to be inadequate. PGV uses various sensors near flanges, seals, valves and other points to alert staff when significant H2S emissions occur, yet this is not included in the NSP even though laws clearly state that emissions should be measured at the source. The refusal of PGV to provide real emissions information, compounded by the refusal of the DoH to require adequate H2S measurements in their NSP, constitutes a serious threat to public health and safety.

I hope that the comments presented above help inform the development of the PGV EIS. Please keep me "in the loop" as the EIS is developed.

Christopher A. Biltoft
biltoftc@yahoo.com
801 364 5729
674 16th Avenue
Salt Lake City, Utah 84103

Comment Letter 15

From: Noel Morin
To: Lefebvre, Michele; planning@hawaiicounty.gov
Subject: Repower Project EIS
Date: Sunday, August 21, 2022 12:40:40 PM

Dear Michele Lefebvre and Hawaii County Planning team,

I'm a resident of Hilo and a climate action advocate. I lead several organizations focused on sustainability, clean transportation, and clean energy. I am supportive of the PGV's operations and its RePower Project. The resulting reduced system complexity (the number of wells) while increasing power generation capacity to 60MW is a welcome development.

Of course, relevant community concerns must be addressed, and attention to environmental consequence mitigation must be maintained.

Hawaii Island must aggressively decarbonize its economy, and geothermal plays an important role in this goal. Intermittents are providing value and are critical for our decarbonization efforts. However, for a truly sustainable and resilient energy ecosystem, we need diverse solutions, including geothermal. With its relatively small physical footprint, high potential for abundant renewable energy access, and lower reliance on minerals and metals, geothermal offers Hawaii an opportunity to deliver firm, clean, and sustainable energy for future generations.

There are geothermal plants across the globe, including in geologically active locations, e.g., New Zealand, Philippines, Indonesia, Italy, and California. Some have been in operation for many, many decades. One of Italy's plants has delivered benefits for over a century. There is precedence.

Importantly, geothermal energy production requires much less resource-dependent inputs (minerals, metals, and fossil fuels) than other clean energy solutions.

For a truly resilient Hawaii Island, we have many types of energy solutions. Geothermal has been an important part of this diversity. The planned changes will make it a bigger contributor to energy capacity with fewer wells deployed. This will be a boon for an economy that has an ever-increasing need for clean energy.

Thank you,

Noel Morin

Noel Morin

(808) 987-7428

noelgmorin@gmail.com

Comment Letter 16

August 21, 2022

County of Hawai`i Planning Department
Attn April Surprenant
101 Pauahi Street, Suite 3
Hilo, HI 96720
email: planning@hawaiicounty.gov

Stantec Consulting Services Inc.
c/o Michele Lefebvre
P.O. Box 191
Hilo, HI 96721
email: michele.lefebvre@stantec.com

Puna Geothermal Venture
c/o Mike Kaleikini
P.O. Box 30
Pahoa, HI 96778
email: mkaleikini@ormat.com

Aloha:

Puna Pono Alliance, a Hawai`i non-profit association, having been listed as a consulted party in the environmental impact statement (EIS) preparation notice published by the County of Hawai`i (COH) on July 23, 2022, for an ***Environmental Impact Statement for the Proposed Puna Geothermal Venture Repower Project***, submits these initial comments regarding potential impacts of the proposed action. We request that Puna Pono be confirmed as a consulted party and be provided documents and information relevant to this process pursuant to the Hawaii Environmental Policy Act (HEPA) – Hawaii Revised Statutes (HRS) Chapter 343 and related Hawaii Administrative Rules (HAR) Title 11 Chapter 200.1. Please address the following matters in the draft EIS (we reserve the right to supplement these requests).

During the Public Scoping Meeting on August 17, 2022, testimony was overwhelmingly critical of harmful impacts experienced for decades by residents of the community. One speaker acknowledged how PGV was supportive of community needs after the 2018 Kilauea Volcano eruption. PGV has shown that it can do the right thing when it must, yet too often lax regulatory oversight has allowed PGV to take a lesser path that appears more profitable yet ultimately proves harmful to its neighbors. That essence of much testimony – harm to PGV's neighbors and lax regulatory oversight – is an important topic that is of interest to most people involved in this process. Also important were the repeated calls for cultural and psycho-social impact studies with respect to Hawaiian traditional spiritual values.

The meeting was conducted in an objectionable manner. Those participating virtually by way of an internet broadcast were often not provided with comprehensible audio, and captioning delivered as people spoke was virtually useless. Further, the moderator did not plainly emphasize that written or emailed comments were acceptable by Monday August 22, but tended instead to limit or discourage more expansive participation (such as by telling the audience that it they had heard some comments similar to what they wanted to say, they could skip testifying). That constriction of public participation is contrary to the spirit and letter of HEPA and represents procedural error.

One of the later online speakers, Shannon Rudloph, spoke about the death of her friend trapped at home near PGV as unabated hydrogen sulfide escaped from a plant valve during Tropical Storm Iselle. PGV made the tragic mistake of not shutting down before the storm made landfall and many community residents paid the price for that error. Community knowledge of such events is far more widespread than governmental regulatory agencies are willing to recognize, and that gap in perception accounts for much of the distrust the community feels toward government and PGV in geothermal related matters. PGV's EIS consultant spoke to her intended objectivity during this process and some speakers encouraged her to try to actually be unbiased to the point that she could accommodate the basis for feelings of resident resentment, while some speakers seemed to expect nothing more than typical paper-churning pablum.

The notice begins by saying:

> Puna Geothermal Venture (PGV), a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant in the Puna District on Hawai'i Island and proposes to replace the current 12 operating power-generating units with up to four upgraded power-generating units (Project).

The notice, at page 1-2, says:

> Under a recent new interpretation of statutory definitions of "land" by the PUC [Public Utilities Commission], the heat extracted from the geothermal fluid beneath the site, a resource to which the State of Hawai`i claims title, is state "land," so the Project's use of the geothermal resource triggers environmental review.

However, the PUC correctly recognized how HRS § 171-1, with regard to management and disposition of public lands, defines *land* as "includ[ing] all interests therein and natural resources including water, minerals, and all such things connected with land, unless otherwise expressly provided". HRS § 182-1 defines *minerals* as "including all geothermal resources" and defines geothermal resources as "the natural heat of the earth, the energy, in whatever form, below the surface of the earth ...". Therefore, the PUC's recognition that PGV's use of geothermal resources is a use of state land (a HEPA trigger) may be recent, but it is *the correct – rather than a novel – reading of those statutes*.

As the notice says at page 1-7 "the State of Hawai`i owns all mineral rights (including geothermal resources) in the state, including those for the Project, and has issued a Geothermal Resources Mining Lease for the existing PGV facility under which the Project would continue to operate." About February 20, 1981, pursuant to HRS Chapter 182, Reservation and Disposition of Government Mineral Rights, State of Hawai`i Geothermal Resource Mining Lease No. R-2 (Lease R-2) was issued to Kapoho Land Partnership (owner and lessor of land leased by PGV where the subject geothermal facility is located). PGV's use of state minerals (as defined by HRS § 182-1) pursuant to Lease R-2 is a use of state land (as defined by HRS § 171-1) subject to HRS § 343-5(a)(1) regarding environmental review. Yet the notice, at page 1.1, erroneously says that "[i]n August 1987, *although there was no statutory trigger*, an [EIS] for the now operating power plant was voluntarily prepared by PGV" (emphasis added).

State owned mineral rights, including the geothermal resources formally leased for use by PGV, always have been part of the geothermal project's existence. Thus, reference to the 1987 EIS by Thermal Power accepted by Hawai`i County (with regard to a planned geothermal project that Thermal Power then sold to PGV) as having been *voluntarily prepared* – a statement that is so common as to have become a rote part of the PGV myth – simply reflects, at best, how there was a regulatory omission by oversight in earlier HEPA situations. That myth should be noted and corrected by the EIS, not perpetuated by baseless repetition (*e.g., no statutory trigger*).

HAR § 11-200.1-2 defines Supplemental EIS (SEIS) as an "an updated EIS prepared for an action for which an EIS was previously accepted, but which has since changed substantively in size, scope, intensity, use, location, or timing, among other things". The PUC, recognizing the fact that PGV's use of state land invoked HEPA, ordered that an SEIS must be prepared. On the other hand, on September 23, 2020, the Office of Environmental Quality (OEQC), published the following contrary determination in *The Environmental Notice*:

> Department of Health (DOH), State of Hawai`i has determined that additional environmental review is not required for the permit renewal for Puna Geothermal Venture (PGV)'s non-covered source permit NSP No. 0008-02-N. As noted in the linked document, numerous records, documents, demands, opposition to demands, and comments are incorporated into the record for this decision. The DOH has carefully reviewed and considered all of these filed and/or submitted demands, and documents in support of, and in opposition to, the demands, along with the January 8, 2020 PGV response in opposition to these demands, and has also reviewed and incorporates into the record the Department of Land and Natural Resources' (DLNR) previous decision of September 8, 2019 that a new or supplemental environmental review is not required for PGV's operations.

The DOH determination, like that of DLNR relied upon by DOH, was substantially based on an erroneously supposed absence of the HEPA state land use trigger. In all the proceedings referenced herein, Puna Pono has continually asserted how state constitution Article XI § 9 protects its members' interests in a clean and healthful environment. Determinations by DOH and DLNR regarding HEPA issues based on the erroneously supposed absence of a HEPA trigger violate those constitutional rights. Harm to PGV's neighbors relating to lax agency regulatory oversight has been frequently (but not exclusively) attributed to specific DOH defalcations (such as the fact that PGV's air pollution permit expired in December of 2014).

On October 6, 2014, pursuant to HAR 11-60.1-74, PGV applied to the DOH for renewal of Non-Covered Source Permit No. 0008-02-N dated December 15, 2009 (the previous 5 year permit expired December 14, 2014). That application led to the contested case proceeding that at this date is still unresolved, after nearly eight years. Demands for an SEIS in the contested case led to the previously noted September 23, 2020, publication of a DOH determination that no additional environmental review is required for the renewal of permit NSP No. 0008-02-N. As said in the DOH determination, DLNR had decided on September 8, 2019, that a new or supplemental environmental review was not required for PGV's applications to drill new geothermal wells. Both DOH and DLNR determinations relied heavily on PGV's argument that it did not use state land. After the determinations in 2019 by DLNR and 2020 by DOH, the PUC applied correct statutory law in a March 31, 2021, order requiring PGV to complete an SEIS. The PUC ruling is correct, the DOH and DLNR rulings are not.

The PUC order, at page 11, said, "Puna Pono explains that many changes have occurred in the decades since the 1987 EIS, including geological changes related to the 2018 Kilauea eruption, associated seismic activity, and greenhouse gas considerations". Yet the PUC's order said (page 25) that it could not be the accepting authority for PGV's supplemental environmental review. "Given the presence of at least three agencies with authority and relevant expertise, the Commission directs Hawaiian Electric to work with PGV, DOH, DLNR, and the County of Hawaii to determine the appropriate accepting authority for supplemental environmental review". Hawaiian Electric sought reconsideration, arguing that if HEPA applies then "the Commission would be both the Approving Agency and the Accepting Authority":

> The Commission may not take the position that it cannot be the Accepting authority. Under the definitions set out in HAR §11-200.1-2, "accepting authority" for an application means "the agency that initially received and agreed to process the request for approval, that makes the determination that the EIS fulfills the requirements for acceptance." "Approving agency" means "an agency that issues an approval prior to implementation of an applicant action." Similarly, under HAR § 11-200.1-7(c):
>
> > Whenever an applicant proposes an action, the authority for requiring an EA or EIS, making a determination regarding any required EA, and accepting any required EIS shall rest with the approving agency that initially received and agreed to process the request for an approval.
>
> Here, the only agency that will consider HELCO's application for approval of the power purchase agreement is the Commission. There are no other agencies that will review this Applicant's "action." Accordingly, even assuming, arguendo, that the application is subject to Chapter 343, the Commission is both the Approving Agency and the Accepting Authority. There is no provision within HEPA or applicable law that allows the Commission to opt out.

The County of Hawai`i has no discretionary permit jurisdiction. The only agency acknowledging such jurisdiction in this matter, as shown by the record, is the PUC. While the County of Hawai`i once had discretionary permit authority for geothermal projects (at the time it accepted the 1987 EIS) that authority was repealed by the Legislature in 2012 (Act 97). The EIS should address this aspect ot the procedural background as well as matters relating to the legitimacy of the County serving as the final accepting agency for a project involving the use of state land (*see* HRS § 343-5(d)(1) providing the final authority to accept an EIS shall rest with "[t]he governor, or the governor's authorized representative, whenever an action proposes the use of state lands or the use of state funds...").

As a precursor to those HEPA rulings, in May of 2018, Kilauea Volcano substantively impacted the Puna environment by an extraordinary eruption in its lower east rift zone, resulting in widespread destruction, damage, and creation of a new topography and shoreline. The PGV facility was damaged, shut down and isolated from public roads by the eruption, with some infrastructure and equipment having been destroyed and covered by lava. At page 1.1, the County notice says "[i]n May 2018, approaching lava from the 2018 eruption of Kilauea on the Lower East Rift Zone (LERZ) inundated the main access road to the power plant, the wellheads of two geothermal wells, the substation of the complex, and an adjacent warehouse that stored a drilling rig". That damage led to the wrongful issuance of a new DOH air permit relating to the lost equipment, a step taken by DOH without notice and, in fact during (as DOH has admitted, because of) the pending contested case considering renewal of the 2014 air permit that covered the lost equipment. The EIS should review the administrative record of that stealth permit to disclose how blatantly wrongful DOH issuance of the new eruption-related air permit (without HEPA review) actually was.[1]

Geothermal resources used by PGV in its operations include the natural heat of the earth and energy derived therefrom in the form of ground water, brine and steam found in hot porous rock that is brought to the surface through wells drilled by PGV used to run electricity generators. Waste from used geothermal resource liquids is re-injected into the ground through wells drilled by PGV. During the 2018 Kilauea eruption, magma and lava flow affected the geology, structure and heat in the area around PGV. Ormat, PGV's owner, acknowledged the significance of that situation in an SEC Annual Report pursuant to the Securities Exchange Act for fiscal year ending December 31, 2018 (https://bit.ly/2viCKXe) at pages 75 and 76 of *Item 1A. Risk Factors* where Ormat said the May 3, 2018, Kilauea eruption "covered the wellheads of three geothermal wells, monitoring wells and the substation of the PGV complex and an adjacent warehouse storing a drilling rig also was consumed by the lava" (the equipment being the subject of DOH's wrongful stealth permit that intentionally circumvented an ongoing 2014 permit contested case proceeding) and noted "significant physical damage to the geothermal resource and continued shut-down following the stop of the lava flow could have an adverse impact on the power plant's electricity generation". Further:

> Absent any additional geologic/hydrologic studies, increased power generation, failure to reinject geothermal fluid or improper maintenance of the hydrological balance may affect the operational duration of the geothermal resource and adversely affect PGV's ability to generate electricity.

The PUC record reflects how prior to the 2018 eruption PGV's well KS-14 had a production temperature of 596°F, approximately 22% steam and 78% brine. In December of 2019, KS-14 had a temperature of 632°F, approximately 86% steam and 14% brine. Eruption related heat increase resulted in nearly four times more steam and five times less brine. That is why PGV needs to replace those original generating units with units designed to match the new steam dominant resource. PGV's ability to generate electricity was affected by the eruption. PGV told the PUC that the decision to reconfigure the facility "was based on the higher steam fraction in the geothermal resource," and the "higher production temperature is thought to be a result of magma moving near the geothermal reservoir and causing an influx of hotter fluid". PGV also said "Ormat never before experienced a situation where steam fraction was changed by volcanic eruption." PGV has been unable to generate electricity at the present facility's stated capacity. It is important to recognize how the eruption substantively changed the circumstances of PGV's situation, how regulatory agencies avoided facing those matters, and all in the context of the well known harm suffered by community residents over decades.[2]

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[1] In such maters as wrongful regulatory procedures, PGV's EIS consultant should not be drawn into the trap of thinking that regulatory errors can be considered only when proven in court. The Puna community and organizations that support it are not wealthy, yet well-paid, full-time, clever attorneys represent PGV and state agencies, setting attempts by volunteers and their underpaid or *pro pono* lawyers to obtain judicial remedies on a steep uphill path. It is well recognized in the community that court efforts are expensive and unlikely to succeed.

[2] Harm to the community can be illustrated by events surrounding PGV's uncontrolled release of hydrogen sulfide (summarized at http://punapono.com/index.php/ts-iselle) relating to Tropical

Hawaiian Electric told the PUC on August 12, 2021, that "replacing the original twelve (12) steam/binary Ormat Energy Converter ('OEC') units with three (3) new, more efficient OEC units" would involve DOH approval of renewal of PGV's present air permit [the subject of an on-going contested case] followed by amendment of the renewed permit "promptly after" the DOH approves the renewal. In other words, the only thing keeping PGV from applying to amend the permit now is its incongruous delay for approval of the older permit that will then require prompt amendment. However, PGV's amendment of its pending application to renew the DOH air pollution permit to include the plans for repowering PGV's facility with replacement units necessary to accommodate the production afflicting eruption related heat increase should be submitted without delay pursuant to HAR § 11-60.1-64 titled *Duty to supplement or correct permit applications*, that provides "[a]ny applicant for a noncovered source permit who fails to submit any relevant facts or who has submitted incorrect information in any permit application shall, upon becoming aware of such failure or incorrect submittal, promptly submit such supplementary facts or corrected information...". PGV's consultant should recognize the inherent fallacy of omitting the DOH air pollution permit renewal from the scope of this HEPA proceeding. Important considerations in the DOH permit are of significance in any HEPA review, especially considerations relating to the monitoring of PGV pollution and the community's right to be informed of emissions. The eight year record of the ongoing contested case regarding the DOH permit renewal is informative in greater detail.

In the PUC, PGV's May 14, 2021, joinder in an April 12, 2021, motion filed by Hawai`i Electric Light Company (at page 5) said that "when the [new power purchase agreement] becomes effective upon the Commission's approval, PGV will then be able to undertake the work to repower its geothermal power facility". The PUC has approved the new HELCO-PGV power purchase agreement and this HEPA EIS effort is part of PGV's undertaking to accomplish the repowering of its facility. It is well past the appropriate time for PGV to have submitted supplementary facts and corrected information that would conform its pending DOH permit renewal application with more accurate material that is relevant to the on-going repowering effort.

Kon v. DOH, Intermediate Court of Appeals (ICA) No. CAAP-21-0000389, is an appeal from a declaratory judgment action regarding HEPA requirements in PGV's pending application to renew its DOH air pollution permit. The answering brief filed by PGV on December 30, 2021, notes that "full scale output has not yet been fully restored following the 2018 eruption" and a planned repowering of the Facility will require modification of the DOH permit. It quotes DOH saying when "PGV's [repowering] plan is sufficiently finalized and before any construction is commenced, PGV will need to submit an application to amend its permit". DOH also said the renewed permit will "not authorize construction of a new facility or expansion of the existing Facility" because "PGV has not accounted for the proposed changes in the instant permit renewal application". PGV noted "repowering of the Facility will be the subject of further environmental review" but notes that "any change to the Facility could arguably jeopardize PGV's permit shield, pursuant to which the terms and conditions of the 2009 NSP ... 'shall remain in effect and not expire until the application for renewal has been approved or denied'" – acknowledging that if PGV admits the facility is in need of improvements in the pending permit renewal

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Storm Iselle (including Ms. Rudolph's late friend being unable to recover after being knocked down by PGV's hydrogen sulfide while trapped at home by fallen trees). One person was similarly knocked down close to the community shelter at Pahoa High School.

application, it could jeopardize the ability to continue operation while agency matters are pending. An Alice in Wonderland suspension of reasoning is an integral part of the ongoing DOH contested case.

The *Kon vs. DOH* case, originally filed as Civil No. 3CCV-20-0394, a civil declaratory action demanding an SEIS, resulted in the following ruling: "Plaintiffs' Motion seeks a ruling that PGV's use of geothermal resources is a use of 'state land,' one of the 'triggers' under HRS § 343-5a). ... [¶] The Court finds that PGV's use of geothermal resources involves the use of state land". That ruling became final and was not appealed. Therefore, PGV's use of state land has been established by a final state court ruling as well as by PUC's administrative ruling. While the DOH and DLNR continue to process PGV applications as if no state land use HEPA trigger was present, those regulatory oversights are plainly erroneous. At page 4-2, the County notice refers to PGV's DOH permit that is the subject of the eight year old ongoing contested case proceeding as "Existing, renewal in progress, Amendment needed for the Project" – but DOH's determination of the absence of a HEPA trigger remains stubbornly unchanged.

PGV and DOH have been playing an inappropriate shell game with permit proceedings. The contested case for PGV's renewal application has continued for eight years while PGV has enjoyed the benefit of a permit shield based on its 2014 renewal application, while admitting that amendment of the 2014 renewal application could jeopardize its permit shield. Thus, clinging to the illusion that the PGV repowering plan is not yet sufficiently finalized, DOH has indulged PGV by not requiring amendment of the application in the contested case and allowing PGV to continue to operate while that agency matter is pending. Excluded information about planned changes at the PGV facility (and actual changes for replaced equipment covered by the stealth permit*) deprives the contested case parties of opportunities to review and examine relevant facts in violation of their constitutionally protected due process and environmental health rights.

> ** On December 9, 2018, PGV applied for a modification of its existing permit because of lava "inundating Drill Rig 51 engines and associated equipment". Expressly recognizing how the existing permit was in a contested case, without revealing PGV's modification application, and without applying HEPA in the obviously changed circumstances, on January 25, 2019, DOH in secret, without public notice and without informing contested case parties, issued a new permit to PGV (amending the 2014 permit) that was subsequently expanded to include further changes.*

An issue that should be addressed by the EIS is how many community residents see DOH serving as a handmaiden for PGV's economic interests – with the attitude that the Constitution and applicable environmental statutes and regulations intended to protect the public be damned. Some contested case parties have expressed resentment at how they feel the agency's disrespect, and long-standing feelings of community resentment arise from continual adverse impacts since the poorly regulated geothermal experiment began several decades ago. The September 9, 2013, final report of a study of geothermal health and safety issues funded by the County of Hawai`i (the Adler Report) includes these statements:

> Events during the HGP-A era and during the 1991 blowout provided exposures associated with adverse health effects. This knowledge, along with other information contained in this report ... has led the Study Group to conclude there is evidence that there were health effects from the exposures during the development of geothermal before 1993. The full extent and severity of those effects has not been documented. ...

Risks from geothermal energy production in Lower Puna exist. The actual extent and impacts of those risks remains unresolved. What is known is that hazardous chemicals are brought up by PGV. PGV adds industrial chemicals to the mix in the process and then sends the composite fluid back down. However, fluids inevitably escape to air, water, or at surface level. Harmful effects can only be understood through better monitoring and reliable health data.

A list of emergencies declared by the Hawai`i County Civil Defense Agency at Puna Geothermal Venture between June 1991 and August 1999 (that is not a complete list of incidents at the facility) is included as table 3 in *Geothermal Energy in Hawai`i: An Analysis of Promotion and Regulation,* Annie Szvetecz (University of Montana 2001), an informative resource. PGV has admitted many dozens of hydrogen sulfide releases it acknowledges while the community has noted many additional events. PGV is believed to have settled hundreds of claims by residents and its employees for injuries and damages relating to its facility's operation. These specific facts of upset conditions and injury (including death) should be thoroughly reviewed in the draft EIS.

The 1987 EIS contemplated categorical potential impacts including geology, hydrology, meteorology and air quality, noise, biological resources, land use and infrastructure, public health and safety (including emergency plans), socioeconomics, cultural resources (including native Hawaiian religious beliefs and practices) and aesthetics. Those are fundamental categories, but in this case they deserve careful review for what they missed and what has changed since the 1987 EIS was accepted.

At page 2.4 the notice says "[v]olcanic and seismic hazards for the existing facility exist, with risks posed to engineered structures and installations. These risks have been significantly mitigated through procedures in facility siting, design, and operation as described in the 1987 Puna Geothermal Venture Project EIS (PGV 1987)". The 1987 EIS said "[t]he risk of the site being overrun by lava from a vent located outside the project area is largely a function of topography.... Review of historical eruptive events shows an average lava thickness of approximately 18 feet with a range of 37 feet to a few feet .... The project site is situated on relatively level ground at an elevation of over 40 feet above the surrounding terrain". The value of the facility's relative elevation was self-evident in the 2018 lava flow, but the flow consumed the buffer. Now the facility has no such protection be elevation relative to the existing topography. The image on the cover page of the County notice (left) plainly shows how the formerly elevated site is now on a level plane with surrounded by new lava. The risk of being overrun by lava in a future eruption, especially based on the present topography, must be addressed by the draft EIS.

At page 2.5 the notice says "potential seismic hazards are generated by earthquakes and include ground motion, ground ruptures, and subsidence". The EIS must also address induced seismicity resulting from PGV's operations.

At page 1.6, the notice says “[t]he HGP-A plant operated for approximately eight years and demonstrated the technical and economic feasibility of geothermal energy in Hawai`i”. That experimental facility is notorious in the community for open and unabated venting of steam and hydrogen sulfide that gassed the community, including children (photo, right) traveling to school. The EIS should carefully, accurately and thoroughly review the history of the HGP-A facility to provide not only a historical perspective but also a background story for the profound community opposition demonstrated at the recent scoping session.

The 1987 EIS said that “two principle potential biological impacts are the safety and preservation of the native Hawaiian hawk population, and rare or endangered plant species”. During the blowout dead birds were found lying in the street in Pahoa, 4.1 miles away from the plant. Birds have been used for hundreds of years in coal mines to act as early warning systems to miners of the presence of noxious gasses. There was a survey and study of native birds and the Ope'ape'a (Hawaiian Hoary Bat) conducted by Michelle H. Reynolds, Brian A. Cooper and Robert H. Day in 1997, published in Pacific Science, Vol. 51, University of Hawaii Press. One area surveyed was the PGV area. The presence of listed biota were documented. Endangered Newell's Shearwater nests and fledges in Pualena Crater, across the street (Kapoho Rd.) from PGV. Since the study was done there have been several hurricanes and 2 lava eruptions that have destroyed prime habitat. We no longer know if these species are still present in the area, or in what numbers. HRS 342 3-1 defines air pollution as including substances that may endanger plant or animal life. The EPS has described the toxicity of hydrogen sulfide on human and non-human species. H2S rules are set for healthy adults and do not factor in the impact of such pollution on the wildlife in the area, particularly listed endangered species. That birds are more sensitive to these gasses has not been considered by DOH in setting allowable levels in their air permit, nor was it discussed in the original EIS. These matters need to be addressed in the draft EIS.

Notice page 1.6 says, “[n]either PGV nor Ormat have additional land positions for geothermal energy that would give them the ability to utilize other locations on Hawaiʻi Island or elsewhere in the state to commercially produce energy using geothermal resources.” However, in February of 2012 DLNR published an Environmental Impact Statement Preparation Notice for Ormat titled *Ulupalakua Geothermal Mining Lease and Geothermal Resource Subzone Modification Application*. Also in 2012, Hawaii Electric Light Company requested proposals for new geothermal energy production that resulted in the selection of Ormat to provide an additional 25 MW of geothermal energy for Hawai`i Island (but Ormat eventually withdrew from the negotiation of that contract). In 2019, Ormat announced that it had commenced commercial operation of its first geothermal and solar hybrid project, a 7MW solar expansion of its Tungsten Mountain geothermal project in Nevada. Further, Act 205, signed June 22, 2022, appropriated $500,000 dollars to the department of Hawaiian home lands for the investigation, exploration, and identification of geothermal resources on Hawaiian home lands. Public events on February 5 and 19, 2022, covered topics relating to geothermal energy exploration and development, featuring, among others, Mike Kaleikini identified as Director of Hawai`i Affairs for PGV/Ormat and also a Commissioner of the Department of Hawaiian Home Lands. Given these facts, it is misleading to suggest PGV and Ormat have no potential interest in geothermal or related energy development beyond the present facility. An update to the PUC from Hawaiian Electric dated July 1, 2022, said:

> PGV notified the Company that changes in market conditions have transpired since the terms of the ARPPA were negotiated and has indicated its desire to negotiate an amendment to the ARPPA to mitigate the impacts. At this time the Company is still reviewing PGV's request.

The EIS should disclose and discuss these circumstances, including the practical and existing alternative of a solar energy generating and battery storage component and revised economic factors due to PGV's recent notice regarding changed market conditions. There are numerous practical alternatives to the action as proposed and the discussion should not be limited to a no-action alternative.

The notice frequently refers to the installation of new OECs designed by Ormat to utilize steam and brine from the geothermal resource. Please discuss the development and design of the OECs intended for use at PGV, particularly to what degree was their design specifically intended to address post-eruption PGV conditions and where else, if anywhere, these specific types of units are also (or will be) in service. Also, the draft EIS should address whether the project is actually an expansion of PGV's existing facility or, rather, is it a new generating facility, including matters such as: use of a unique new generator type; the capacity of the new generators relative to the existing post-eruption production; physical and spatial factors such as the size and location of the new equipment relative to the existing equipment (the 10 existing steam-binary energy converters will be replaced with 2 new energy converters placed in a new location, with new piping). As the present generating capacity is closer to 23 MW, a repowered generating capacity increase to 46 MW will be a 100% increase.

Puna Pono's members have varying points of view with regard to appropriate electricity production. Some Native Hawaiian members are more concerned with spiritual and cultural matters. Members with backgrounds in science and technology, usually concerned with Native Hawaiian issues, may also focus on environmental and economic impacts of energy production in their evaluation of various alternatives. It seems to be a generally held view that PGV has been the subject of lax regulatory oversight while operating in Puna, and that laxity has burdened the community. It also is a common view of PPA's members that placing a large power production facility serving the entire island on top of an active rift zone of Kilauea should be a non-starter. The recent eruption is a lesson not to be ignored: the plant was damaged and totally cut off from land access and connection to the utility company's grid, and could be again.

Many Puna Pono members live off of the grid, relying on their own electricity generation and storage, and therefore have no need for electricity in any quantity from PGV. As noted, there is a generally held view is that regulatory oversight of PGV has been so lax over the years as to be a burden on the community. This seems to trace back to early days of geothermal development when U.S. Senator Daniel Inouye embraced the subject enthusiastically, providing political and financial support for geothermal development in Hawai`i. Despite the passage of several decades it seems that initial badge of political sanction at the highest level of the state political hierarchy set the tone, and subsequent years have done little to change the tone, of treating geothermal developers as most favored clients of state agencies. PGV has shown that when it wants to take steps to provide greater protection for the community and matters that affect the environment, it can. As a profit driven enterprise, PGV has a primary need to satisfy and sustain its investors, and from time to time it seems to have taken advantage of lax regulatory conditions to avoid certain expenditures, sometimes at the expense of the community and environment. Therefore, an essential necessity for continuing PGV's operations is to assure that greater protection for the community and the environment on a continuous basis has a higher priority.

On the other hand, it may not be possible for PGV to operate in an appropriate manner, because it is abusing natural resources. The Hawaiian chant *E komo maloko o Halema`uma`u* speaking in the first-person voice of the deity Pele, declares that whatever is hot is sacred to her. In the chant, the first-person voice representing the deity invites listeners to go to Halema`uma`u and see her display and her movements. The listener is invited to view her parts and how she dances and moves – but the listener is admonished not to take what belongs to the deity, and whatever is hot belongs to the deity. In other words, where the earth is hot it still belongs to the goddess and is sacred. The sacred heat of the earth is Pelehonuamea's realm, it is not meant for human exploitation.

Seeking an appropriate balance between spiritual concerns of significant parts of the Puna community and the perceived needs of PGV's politically favored commercial enterprise and closely related needs of Hawai`i Electric to survive in both political and economic terms is the actual discussion of the moment. Interruption of PGV's production by upset conditions, natural incidents, and degradation of the quality of the geothermal resources to an extent that declines in geothermal well capacity mean PGV cannot meet obligations under any PPA, self-evident serious risks to the Puna community and environment, including induced seismicity, related repercussions on resiliency and grid costs, the fact that any actual need for new electricity generation is located on the west side of Hawai`i Island and the substantial costs of transmission from the PGV Puna site to the locations of actual need unnecessarily adding to consumers' cost of electricity, existence of economical alternative options for energy production and the inhibiting effect of PGV's large industrial generating plant in Puna on those options, the unexpected withdrawal of Ormat from previous PPA negotiations for financial reasons, regulatory snafus in administration of DOH permits required for the operation of the PGV's facility that foretell extended litigation, PGV's need to obtain constant and continuous supply of necessities for operations and maintenance from off-Island sources, and further matters, from Puna Pono's perspective, make plans for PGV to operate a new 46 MW facility an uncertain prospect, at best. All of these concerns need to be addressed individually and cumulatively in the draft EIS.

Eruption related changes in the geology, topography, configuration and demography around PGV's site are self-evident. Those chnages and related effects on resource and risk exposure and assessment, emergency planning and response and environmental matters must be subjects of environmental review.

The following non-exclusive summary list includes additional matters for the draft EIS.

is PGV using enhanced geothermal

preventative maintenance generally and specific schedules

pentane risks, emissions and emergency plans

re-injection statistics and risks

monitoring I'o nests and endangered species studies

Albezia along the transmission line corridor and access to HELCO drone footage maintenance toxic gas emergency plans (including evacuation)

real time monitoring and indication and public warning of H2S leaks

Emergency Planning and Community Right-to-Know Act (EPCRA) compliance

risks of reinjection of H2S into the ground

drinking water impacts

monitoring of heavy metals and impacts

real time meteorological data with modeling to show public direction and concentration of gas plume during an emergency

incident and emergency notification system and evacuation plan for neighbors

DOH record of investigating incidents and impacts of upset conditions

data measurement of facility noise and drilling noise

PGV staffing, including during storms

County emergency response, no PGV specific emergency response plan

PGV's ownership for accountability purposes

Lack of roads and infrastructure in lower Puna, effect on response times and exit routes for emergencies

changes in biological topography, population, infrastructure, geology, wind patterns, ecological environment, numbers of trees and their effects

Pentane amount, location, hazards and tracking of escaped Pentane

risk of pentane explosion and impact it could have on wellheads

impacts of geothermal drilling, accidents and injection on geology, fresh water lens, and reefs

risk of drilling into magma and lack of emergency response plan to mitigate that risk

community impacts of the stress from living with the risk of PGV incidents

impact on neighbors of not being able to safely take shelter in their home during winds storms and hurricanes when there are not enough shelters available on the island and no shelters for animals left behind cooling of the hot eruption field causes cracking and breaking of the rocks that changes the impedance of the rocks to the flow of water

changed situations regarding subsurface water, rock structure and temperature, geothermal resource fluids and the fresh water lens

changes in demographics and the transportation and utilities network

PGV's emergency procedures, hazard mitigation and response planning

effects on groundwater used for non-PGV purposes (such as whether any groundwater sources have been cut off or whether residual heat is causing sources such as wells and springs to dry up)

By this reference, Puna Pono refers to and incorporates all comments on the scope of the draft EIS, whether or not they duplicate or expand upon the issues noted above.

DATED: Pahoa, Hawai`i, August 21, 2022.

Robert Petricci, President
Puna Pono Alliance
email: nimo1767@gmail.com

Comment Letter 17

August 21, 2022

Testimony in Strong Support for Puna Geothermal Venture's Repower Project

Aloha,

As a lifelong resident of Hawaii, I support Puna Geothermal Venture's plan to increase its power production to 60 MW and replace its current power-generating units with upgraded ones.

Supporting Puna Geothermal Venture (PGV) will support the State of Hawaii in reaching its 100% renewable energy source mandate by 2045. As Hawaii's only commercial geothermal power plant, PGV produces about 20 percent of the Hawaii Island's electricity. PGV's contributions to the Hawaii Island's renewable energy was made obvious during the 2018 lower Kilauea eruption. After the eruption shuttered PGV's power plant, as a result, the Hawaii Island increased its fossil fuel use.

We should encourage geothermal energy production because it benefits the people of Hawaii by offering the following:
- Create local professional jobs
- Lower the cost of electricity
- Greatly reduce carbon emissions involved with creating energy
- Serve as a consistent, stable source of energy compared to other energy sources
- Provide baseload power, or the minimum amount of power that a utility company must generate for its customers, and doing so ensures reliability of the electricity grid and reduces costs.
- Generate revenues for the betterment of Native Hawaiians
- Increase the self-sustainability of the Hawaiian islands and reduce the import of oil

Hawaii still has a long way to go in terms of reaching its 100% renewable source mandate by 2045, and geothermal energy will play an important role in making that happen. With Hawaii's volcanism, limited landmass, and fragile natural resources, we should support PGV's plans for expansion and upgrading its facilities. Furthermore, we should encourage the use of geothermal, Hawaii's only cost-effective baseload renewable energy source.

Thank you for your time and consideration,

Alice Kim
alicekim53@gmail.com

Comment Letter 18

Mori, Ashley

From:	selah levine <selahbit@gmail.com>
Sent:	Sunday, August 21, 2022 4:36 PM
To:	Planning Internet Mail; michele.lefebvre@santec.com; mkaleikini@ormat.com
Subject:	Puna Geothermal Repower Project EIS

Aloha Michele,

I attended the meeting on Wednesday August 17, 2022. I do not like public speaking so I did not give my comments at the meeting. However, I would like to communicate my comments and concerns in this email.

I have lived approximately 3 miles downwind from PGV for the past 10 years. Personally, my 2 biggest "enviornmental" concerns are the hazardous chemicals released by PGV and the noise. During hurricane iselle I was terrified when there was a release of hydrogen sulfide. Being downwind without windows in my living space was frightening. I had no way to protect myself and was unable to evacuate during the storm. PGV is the only geothermal plant in the world located in close proximity to homes and schools. This alone should be reason enough to shutdown this plant. My second concern is the noise. This is a daily problem. Being downwind I can clearly hear the engines and drilling all night, every night. I would also like to note that since the 2018 eruption leveled most of the homes and vegetation that was a buffer between my home and PGV, the noise is now even worse. These are the concerns that affect me personally, though the damage to the natural environment is also a huge concern. It is impossible that PGV does not have detrimental effects on the health and safety, of wildlife and ground water respectively, in the area.

The alternative to renewing this contract is to not renew it. I support not renewing the PGV contract as well as shutting down the facility ASAP.

Lastly, after attending the meeting it was clear that there are many in the community who feel threatened and uneasy about living near PGV. There was only one positive comment given in regard to PGV in a room full of people. Many very angry and almost in tears. These people are a part of this environment. It was obvious that PGV has has damaged the health and wellbeing, if not physically than mentally, of the people in this community.

Thank you for your concern.

Sincerely,
Selah Levine

Comment Letter 19

From: Paul Kuykendall
To: planning@co.hawaii.hi.us; Lefebvre, Michele
Cc: Mike Kaleikini
Subject: Comment on PGV Repower Project EIS
Date: Sunday, August 21, 2022 8:50:24 PM

August 21, 2022

County of Hawai`i Planning Department
Attn April Surprenant
101 Pauahi Street, Suite 3
Hilo, HI 96720

Stantec Consulting Services Inc.
c/o Michele Lefebvre
P.O. Box 191
Hilo, HI 96721

Puna Geothermal Venture
c/o Mike Kaleikini
P.O. Box 30
Pahoa, HI 96778

Re: Environmental Impact Statement for the Proposed
Puna Geothermal Venture Repower Project

Aloha:

My name is Paul Kuykendall and I am a farmer whose ohana is one mile makai of PGV in Keahialaka. I am also co-founder of the Waihu O Puna Watershed Coalition and am commenting on our coalition's behalf. Please note that I intend to follow this EIS process and request that I be included in all future notifications and opportunities for public comment. My comments on the PGVRP EIS Preparation Notice are as follows:

This PGV repowering proposal looks forward to increased power production and promises minimal impact on the community and the ʻāina. But if you look back at the history of PGV's 35 years of geothermal power production and the minimal regulation by the county and state of Hawaii, you can easily see the probable future unless there is a significant change in the way geothermal power is conducted and regulated.

Noise When geothermal started in Puna, the EPA recommended 45 dBA during the day and 55 dBA at night for noise regulation. Since then the state and the county have increased the limit to 70 dBA, 5 times higher than the previous limit, the noise level of a busy freeway, day and night in what once was a quiet agricultural district.

I live a mile from the plant. There is lava on three sides of my home and lava in the direction of PGV. This means no trees or plants to mitigate the noise and the noise bounces off the lava walls which are higher than the house. This makes the noise louder than before the 2018 lava flow. The noise is louder than the coquis, louder than the wind, louder than the ocean waves–first thing in the morning, during dinner and in the middle of the night. PGV's noise monitors are on the opposite side of the plant from my home, so they do not reflect the noise from the plant when the noise is at its worst–when the wind is blowing in my ohana's direction.

Each 10 dB increase represents a 10x increase in sound intensity. As far as the sound volume is considered, we perceive a 10x sound intensity as a 2x increase in sound volume.

Although Hawai'i state law says that noise levels can be up to 70dBA during the day or the nighttime, with which PGV justifies their noise output, HRS §11-46-13 also says that ***The council of any county may adopt and provide for the enforcement of ordinances regulating any matter relating to excessive noise. No ordinance shall be held invalid on the ground that it covers any subject or rule of the State; provided that in any case of conflict between the statute or rule and ordinance, the law which affords the most protection to the public shall apply.***

The first county Geothermal Resource Permit (GRP) followed the EPA guidelines 45 dBA during the day and 55 dBA at night except it allowed the allowable noise levels to be exceeded by a maximum of 10 dBA 10 percent of the time. DBA is a logarithmic scale so that Every 3-decibel increase in a sound actually represents a doubling of the sound's intensity so the allowed exception was three times higher.

In 2012, the county, after an upswell of complaints about 24/7 drilling that kept keiki from sleeping, passed an ordinance that banned nighttime drilling. Though that ordinance is still on the books, PGV simply ignored it and the county never enforced it, saying they might be sued if they enforced it. PGV has drilled many wells 24/7 since then. The county has done nothing.

Noise pollution has a negative impact on the health and well-being of people, animals and birds that live near the plant. It increases stress, interferes with sleep and eating. Disrupts activities such as meditation, farming, yoga exercises and daily life. It has a particularly large impact on those of us who dwell in buildings that do not have air conditioning because we have to choose between breathing and heat with less noise.

Some additional aspects associated with drilling and plant operational noise include:

Audible noise spectrum
Low-frequency noise spectrum
Intensity, frequency & timing
Geometry of noise sources
Impact on specific local wildlife, communication, threat detection, stress
Changes in temporal patterns, behavior, vigilance of surrounding neighbors & wildlife
Impacts on neighbors, chronic noise stress, sleep disturbance
Physiological stress
Increases in noise intensity at night/with prevailing wind patterns

Light Pollution Light pollution impacts people, birds, and animals. PGV says they shield lights, but they light up the sky for miles around the plant. This has a negative impact on birds who navigate the night sky. Petrels and other birds have been shown to reduce populations near light and noise. It hurts people and animals too. We love stargazing at the night sky. When PGV returned, we could no longer see constellations that we could see before the light pollution. It makes sleep more difficult for people, animals and birds. Why does PGV need to light up the night sky?

H2S Steam releases The 1987 PGV EIS talks about smell. Of course it's not the smell, but toxic H2S gas that can kill you at 100 parts in a million. In 30 years, there have been more than 70 documented geothermal release emergencies. That averages one in less than every 6 months. Because the monitoring is so poor this is a fraction of the actual incidents.

Over and over, there is a leak of toxic gas and no alert until neighbors call 911 when they get sick. Then the fire department comes out with monitors. The other neighbors aren't notified while the county waits for the report from the fire department. Meanwhile PGV has sensors at their well pads, but they don't share that data with the public or the county. Afterwards, PGV calls in their numbers to DOH and DOH says there was not enough H2S to affect neighbors. The next accident is not only likely, but predictable, and so is the lack of alerts and the gaslighting.

Tropical storm Iselle is a recent example. I had toured the PGV plant twice and thought that we were too far away to be affected by the H2S leaks that emanated from PGV. When Tropical Storm Iselle hit in 2014, I found out I was wrong. My wife, her 80-year-old mother and I were all nauseous, had severe headaches and trouble breathing. More than a hundred of my neighbors were sickened, some passed out. The fire department never made it out to the plant due to albizias down on the road and people couldn't flee the toxic plume. The director of DOH, from the safety of

Honolulu, told the star advertiser that there wasn't enough H2S released to sicken anyone–based on numbers given to them by PGV. The EPA fined PGV $76,500, not even a parking ticket for a company that makes millions each month. The EPA found that PGV had failed to take necessary steps to prevent accidental releases of hydrogen sulfide.

The lava flow made a potentially deadly change: There are no trees or plants on the lava-covered areas to mitigate H2S flows. Since our homes are located in the kipukas (areas not covered in lava), it means the homes are lower than the surrounding lava, which can be 30-50 feet higher. This creates low areas inhabited by families where H2S would pool, since it is 20 percent heavier than air. These kipukas would collect and limit the dispersion of H2S by wind, and would turn our homes and gardens into death traps in concentrations as low as 100 ppm.

PGV's monitors are on the opposite side of the plant from my ohana, so they would not reflect a H2S plume that flowed downhill toward my ohana. They are worthless for my ohana. There would be no alert of an H2S plume.

Risk of toxic geothermal steam releases also bring risk to gardens, forests, animals and birds.

Water Contamination PGV drills through the freshwater lens that our drinking water wells draw from. If their injection wells are compromised, toxic heavy metals in geothermal steam, anti-corrosives which PGV adds to injectate and the pentane that PGV uses will contaminate our drinking water and the near shore ponds and springs, including fishponds that have been malama-ed by my Hawaiian friends for more than 13 generations, more than 300 years.

Even if the wells stay intact, every geothermal steam release sends toxic heavy metals and caustic soda onto our roofs and water catchment systems. The toxics that land on the ground end up in the freshwater lens as well. PGV likes to say that the quality of our freshwater lens isn't very good in lower Puna. That might have something to do with the 1991 PGV well blowout that spewed toxic geothermal steam for a 10 mile radius for 31 hours.

I also am concerned about oil and grease contamination of freshwater lens. According to PGV well monitoring reports it has already happened.

Geothermal power uses large amounts of water in the life cycle for geothermal power production. Please disclose the amount of water that will be consumed during this life cycle both for construction and for operation and drilling so we can assess the impact on the ‘āina and the watershed. Use of large amounts of water could affect wells citizens use in the area as well as the content and temperature of nearshore springs and ponds. In assessments of water use at power plants, two water quantities are commonly listed: water withdrawn and water consumed. The former is defined as water taken from ground or surface water sources mostly used for heat exchangers and cooling water makeup, whereas the latter is water either consumed in the process or evaporated and hence no longer available for use in the area where it was withdrawn. Supplemental water is also added to injectate. Water consumption also includes water withdrawals related to construction stage activities (e.g., in drilling muds and cement). Please quantify water use for each activity during the life of this project.

During the drilling process, fluids or “muds" are used to lubricate and cool the drill bit, to maintain downhole hydrostatic pressure, and to convey drill cuttings from the bottom of the hole to the surface. To accomplish these tasks, drilling muds contain chemicals and constituents to control factors such as density and viscosity and to reduce fluid loss to the formation. Operators formulate muds on site and alter the recipe according to the physical conditions and chemical properties of the site and as conditions change during drilling. Muds are screened to remove cuttings brought to the surface, and are periodically changed during drilling in response to changing conditions. The mud remaining in the circulation system after drilling may be disposed of. These processes both use water and have the potential to contaminate the soil and the freshwater lens. Please disclose how much water is used for a well and what chemicals, minerals, polymers and pfas are used in drilling, and how drilling mud is handled and disposed of for each well.

Similar concerns exist for well casing and the cementing of casing. How much water and what additives are used for the cement. Since the cement will run the length of the well bore, additives and cement will come in contact with the freshwater lens. Please list how much water and what additives are used for this process.

We know that since the eruption, the resource that PGV uses is higher temperature. If not handled responsibly, geofluids are a potential source of water and soil contamination due to elevated TDS and the presence of toxic minerals. Proper well drilling processes and blowout prevention controls are extremely important for minimizing these risks. We already experienced a blow out in 1991 at PGV, after PGV said it was a small possibility. Well casing failure, pipeline leakage, and other surface spills are also possible pathways for contamination.

Comparison of the geofluid composition with U.S. drinking water standards will show that geothermal fluids pose a large potential risk to water quality. To allow us to analyze the potential risk posed by the release of geofluids, please compare the geofluid composition data from PGV with U.S. drinking water standards and share the results. That way we can see what is at risk to the freshwater lens and to local catchment systems if another blow out, drilling accident or well casing failure occur.

Because Hawaii County water systems were destroyed in the lava flow, local residents rely on water catchment and private wells for their drinking and agricultural water. Rainfall has changed radically since the lava flow due to the destruction of rainforests in the affected areas. For these reasons, groundwater is the last resort drinking water source for the people and animals living in the area when rainfall is inadequate. To simply say that the injection is done below the water table does not take into account the fact that the injected fluids can contaminate along the entire pathway to the bottom of the injection wells. It is unconscionable to risk fouling this water source without studies to determine the geological impact of injecting millions of gallons of geologic fluids into the earth.

The comparison with the drinking water standards clearly shows that there is a risk from the release of geofluids into drinking water, especially in terms of toxics such as antimony, arsenic, lead, and mercury. In general higher concentrations of contaminants were observed in the high-temperature than the moderate-temperature geofluids. The resource at PGV is known to be high-temperature.

Use of anti-corrosion fluids such as Chemtreat, inject chemicals into the geothermal fluids that are acutely toxic to aquatic life, such as the fish, limu and shrimp that live in nearshore ponds and reefs. We know that at one point PGV was injecting about one 55 Gallon barrel of this toxic anti-corrosive fluid into the ʻāina every day. What anti-corrosives or other contaminants are injected in wells and how much per MW? Please provide Safety Data Sheets (SDS) for all chemicals used at PGV so we can determine the risk to the watershed.

Even though PGV describes its production system as “closed-loop” in addition to corrosion inhibitors, PGV also injects Pentane into the aina every day, as noted in the USGS 2015 study, “Groundwater Chemistry in the Vicinity of the Puna Geothermal Venture Power Plant, Hawaiʻi, After Two Decades of Production.” Please quantify fugitive emissions of pentane and quantify how much is injected into wells and how much escapes into the air yearly for the past 35 years and the estimate for future production levels. Pentane was also detected in a monitoring well.

Well casing failure, pipeline leakage, and other surface spills are also possible pathways for contamination.

There would be the possibility of gas breakout from injection wells into shallow aquifers.What are the long-term effects of gas accumulation in injection zones, which for the PGV well field is located below the production zone.

Wells can be damaged even if the surface lava doesn't reach the plant, if an eruption shears off the wells underground. If the wells are damaged, they could blow out. They would release steam that could contain hydrogen sulfide and CO_2, and whatever else is underground. That happened at a place called Krafla in Iceland in the 1970s. This may have happened at PGV when they doused the wells with water before the lava flow, but didn't cement the wells. What is the status of the wells that were covered by lava? What is happening below the service? Are they contaminating the freshwater lens now?

Apparent changes at PGV water monitoring wells demonstrate the potential for contamination of the ground-water system from geothermal wells, and suggests the need for long-term hydrologic monitoring to identify cause-and-effect relations. Changes since the lava flow have increased the probability of contamination.

A degree of hydrologic connection between the ground-water system and the underlying geothermal system is indicated by the occurrence of hot, saline ground water at several locations within and south of the LERZ. Potential effects include (1) changes in water level in wells caused by pumping of groundwater to support geothermal development and/or operation of geothermal production and injection wells, (2) contamination of the groundwater system from leakage of geothermal fluids and gases, and (3) changes in discharge characteristics of warm anchialine ponds along the coast.

Hydrologic connections between such reservoirs and thermal groundwater discharging along the southeast coast are possible. Under such circumstances, pressure changes induced by development of geothermal reservoirs could cause decreases in flow and temperature of this thermal water. Warm waters from the anchialine ponds along the southeast coast appear to be mixtures of fresh groundwater and heated seawater derived from sources either within the LERZ or south of the surface expression of the rift.

Opae Ula are small red shrimp that can only be found in the wild in the Hawaiian islands. They naturally live in pools near the shore filled with brackish water called anchialine pools. I am especially concerned about heavy metals which bio-accumulate and could contaminate the freshwater lens, and thus wells citizens use for drinking water and agriculture. They could also contaminate near shore fresh water ponds and springs as well as brackish ponds which have been used by

Hawaiians for many generations as fish ponds and to water and feed animals near the coast. The temperature, ph, TDS and content of near shore ponds could be affected by contamination of geothermal fluids.

Geothermal power uses large amounts of water in the life cycle for geothermal power production. Please disclose the amount of water that will be consumed during this life cycle both for construction and for operation and drilling so we can assess the impact on the ‘aina and the watershed. Use of large amounts of water could affect wells citizens use in the area as well as the content and temperature of nearshore springs and ponds. In assessments of water use at power plants, two water quantities are commonly listed: water withdrawn and water consumed. Water consumption also includes water withdrawals related to construction stage activities (e.g., in drilling muds and cement).

During the drilling process, fluids or “muds” are used to lubricate and cool the drill bit, to maintain downhole hydrostatic pressure, and to convey drill cuttings from the bottom of the hole to the surface. To accomplish these tasks, drilling muds contain chemicals and constituents to control factors such as density and viscosity and to reduce fluid loss to the formation. Operators formulate muds on site and alter the recipe according to the physical conditions and chemical properties of the site and as conditions change during drilling. Muds are screened to remove cuttings brought to the surface, and are periodically changed during drilling in response to changing conditions. The mud remaining in the circulation system after drilling may be disposed of. These processes both use water and have the potential to contaminate the soil and the freshwater lens. Please disclose how much water is used for a well and what chemicals, minerals and polymers and pfas are used in drilling and production.

Similar concerns exist for well casing and the cementing of casing. How much water and what additives are used for the cement? Since the cement will run the length of the well bore, additives and cement will come in contact with the freshwater lens. Please list how much water and what additives are used for this process.

Contamination of ground-water resources from accidental release of geothermal fluids into shallow aquifers could result from casing leaks in the geothermal wells and accidental well blowouts. Subsequent contaminant migration could be rapid because of relatively high groundwater velocities in parts of the region.

Ground-water velocities in the dike-free parts of the rift zone might be as great as 10 ft/d or more. Under such conditions, contaminants could move distances of several miles in a period of a few years. We are already seeing increased chloride in monitoring wells.

PGV's application for additional injection permits uses 30 year old studies of the hydrological resource. Cited in their application:

Cox, M. and Thomas D., 1979, Cl/Mg ratio of Hawaiian ground water as a regional geothermal indicator in Hawaii, Hawaii Institute of Geophysics Technical Report, HIG-79-9, 51 p.Druecker, M., and Fan, P., 1976, Hydrology and chemistry of groundwater in Puna, Hawaii, Groundwater, V. 14, No. 5, pp. 328-338.Fetter, C., 1980, Applied Hydrogeology, Merrill Publishing Co., Columbus, Ohio, pp. 299-301, 155-153.Iovenitti, J., 1990, Shallow Ground Water Mapping in the Lower East Rift Zone Kilauea Volcano, Hawaii, Geothermal Resources Council Transactions, V. 14, Part 1, pp. 699-703.Thomas, D., 1987, A Geochemical Model of the Kilauea East Rift Zone, in Volcanism in Hawaii, USGS Professional Paper 1350, pp. 1507-1525.

While it is egregious to use 30 year old data to support a permit to inject millions of gallons of fluids that could affect groundwater, when coupled with the fact that a lava flow in 2018 radically altered the geological landscape, rainfall and water flows, it is reckless to do so without current studies of the current geology and environment.

With the recent lava flow, it is possible and perhaps likely that the injected fluids would contaminate the groundwater and coastal navigable waters in the area. We don't know because no recent studies have been done.

A method has been developed to prevent calcium carbonate scaling that involves continuous down-well injection of scale inhibitors, typically specialized and proprietary polymers. Does PGV use any polymers or PFAS in its operations?

PGV’s application for injection wells states:

Injectate into the Existing Wells and any authorized Proposed Wells covered by this Permit is limited to the following materials: geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal non-condensable gases that are produced during the operation of the well field and the geothermal power plant located on the Permittee’s property (the PGV Power Plant); chemical additives for process system and well casing biofouling, corrosion, and scale control; and supplemental water.

PGV does not include pentane in that list of additives which is known to exist in the injectate in the PGV system. Please quantify the amount of Pentane and other contaminants, and in the injectate. Please quantify the supplemental water used in injectate.

Chemical additives "for process system and well casing biofouling, corrosion and scale control" will damage the health of any living being they encounter. They must be studied before they are released into the earth and water that flows through it.

The draft permit continues:

“Supplemental water may consist of steam turbine seal water, rinsate from the water softener system, sulfatreat heat exchanger cooling water, raw/quench water,production well bleed system, abatement fluids, sulfatreat system vacuum pump seal water, condensate from the sulfatreat system, periodic produced drilling fluids, and fluids from the plant water storage tank and the emergency steam release facility (ESRF). Some of these fluids may contain the additives. . . .”

Unfortunately for the local community, these fluids would cause egregious and long-lasting harm if they were allowed to foul drinking water. Further, they could foul local near-shore water and harm the fish and aquatic life which lives there.

Studies must be conducted to evaluate the impact on coral reefs, fish and plant life. Tracer studies must be conducted to determine how these toxic materials could flow through the freshwater lens and to coastal waters. These studies would help us evaluate their impact on life there.

Another concern is how much "supplemental water" and other material will PGV pump into the earth? With 16 wells (5 existing and 11 new wells) each capable of injecting, under pressure, millions of gallons of water per day, the impact on both the geological structure and fresh and coastal waters could be severe. If enough "supplemental water" is pumped into 17 injection wells, it could break up existing geologic structures and cause fouling of the freshwater lens.

Where will the "supplemental water" come from? If it comes from PGV's recently drilled water wells into our fresh water lens in large enough amounts it could affect the quality and quantity of the freshwater drinking water wells. It could also affect how much fresh water flows to the ocean. If they draw thousands or millions of gallons of fresh water from a few hundred feet, then inject it at 6000+ feet, this could have a huge impact on the local ecology. We must know the source of the "supplemental water" to be injected and the quality and quantity before the safety can be evaluated.

PGV has 5 existing injection wells. They applied for 11 additional wells. This would increase their injection wells by more than 200 percent. What will be the plant design and justification for such a radical increase in injection wells? I asked PGV what they needed the new wells for and they said they could accommodate their production with current wells. Again with the lava flow, and no studies, the impact on the local community and drinking water is impossible to predict.

Due to the lava flow, the underlying geologic structure, rainfall, wind patterns, the egress routes in emergencies, the local population and county infrastructure have all changed radically. PGV is essentially drilling wells into an unknown geological structure using new technology in their power plant.

In September, 2012 the Hawaii Island Mayor asked Peter S. Adler, PhD to conduct an independent “joint fact finding” Study Group that would examine the type and extent of health impacts from Hawaii Island Geothermal Operations. The group recommended that any future geothermal development should do baseline studies to determine the water resource and ecological and health impacts prior to future geothermal drilling and development. The study stated:

Geothermal development can affect the health and wellbeing of people surrounding the plant during dramatic accidents like the KS-8 blowout in1991 and potentially during smaller upsets and operational releases such as occurred in 1997 and 2005. By establishing a baseline health study, future health studies can more easily establish the magnitude and responsibility of health effects. Further, geothermal development may affect water wells downstream from the development area as well as the coastal basal brackish groundwater and the ocean near the geothermal plant. By establishing a baseline, future water studies will be able to more easily establish the magnitude and possible responsibility for environmental impact from geothermal development.

The baseline water study conducted by USGS, while it did show that Petane was in the injectate, did not test wells makai of PGV and only tested one pond below the pond. A baseline study that establishes baselines for well makai of PGV and nearshore ponds and offshore springs needs to be conducted to determine the safety of an increase in geothermal power production.

Other drilling impacts There must be a full account of all of the other impacts of the drilling processes as well as the environmental cost in terms of use of fossil fuels for drilling, pollution from drill rig equipment, machinery etc. including
Diesel engine emissions from drill rigs & associated equipment, effect of lighting of the construction site on wildlife, birds, associated chemicals, additives, muds etc. and methods and costs of proper disposal in terms of shipping etc. and accountability of leakages and other issues associated with incomplete removal and disposal.

Financial accountability Puna Geothermal Venture is owned by two partners: ORNI 8 LLC and ORPUNA LLC. ORNI 8 LLC is an LLC registered in Hawaii. ORNI 8 LLC is owned by ORTP LLC, a limited liability company registered in Delaware. It is clear that Ormat is taking extraordinary steps to insulate itself from liability in the case of a well blowout, as happened in 1991, or if they foul our fresh water aquifer. I am concerned about their financial accountability in the event of an ecological disaster.

Regulatory capture DOH and the State of Hawaii have enabled geothermal power polluters in Puna to operate, poorly regulated, for more than 50 years–a classic example of regulatory capture. DOH actions and decisions have been clearly erroneous in view of the reliable, probative, and substantial evidence on the whole record, with predictable detrimental impacts on citizens health, well-being and happiness. In the process they have violated local citizen's rights under state constitution, air pollution control laws and regulations and EPCRA.

DOH resisted regulation of hydrogen sulfide from the beginning of geothermal exploration, until compelled to do so by the courts. A Geothermal Public Health Assessment final report, published on September 9, 2013, by Peter S. Adler PhD, states,

> In 1990 after legal objections and court proceedings, the State of Hawai'i DOH issued air permits to PGV for the construction of a 25 MW power plant and geothermal well field. The air permits required the installation of three ambient air monitoring stations to measure concentrations of H2S in neighborhoods near PGV and on the fence line surrounding the power plant. Following a lawsuit initiated by community members against DOH, the State established legal H2S limits of 25 ppb for a one-hour average and 10 ppb for a 24-hour average.

That was in 1990. Well before then, Puna's first geothermal plant was open-venting toxic hydrogen sulfide and heavy metals into the air near homes and children's bus stops and dumping heavy metals into unlined ponds that seeped into groundwater. When the first geothermal plant in Puna, HGP-A, was drilled in 1976, the project was presented as a strictly experimental, two-year demonstration project and not a production well. The project was presented to the public as a two year project, but the EIS for the project, published in 1976, stated it would only be a six month test. This is significant, because the EIS identified mercury as a major toxin in the geothermal brine that would be open-vented and stated that since it was a 6 month test, the load on the environment would be acceptable. The "Environmental Assessment of the Hawaii Geothermal Project Well Flow Test Program," published in November 1976, states:

> Heavy metals, notably mercury, are also evolved in an aerosol state from geothermal fluids. Sampling by the staff of the Hawaii Geothermal Project has given high priority to geotoxicology of mercury. Representative plant species in the area of the well yielded mercury levels that were relatively

> uniform in the various species and individuals. The mean levels at the site were somewhat lower than concentrations found at Volcano House and SulfurBanks. Mercury tends to accumulate over long periods of time in plants and can be concentrated in higher levels of the food chain. (my emphasis) Nevertheless, no significant accumulation is expected during the six-month well test. " (my emphasis).

The six-month test went on open-venting geothermal toxins, which included heavy metals that were known risks to plants, people and animals, for five years. In 1982, despite commitments to the public that the test would be 2 years and experimental, a three-megawatt commercial power plant went on line, run by HELCO. No community meetings were held explaining the change. The geothermal power plant continued for eight years and was shut down in 1989. HGP-A dumped the toxic geothermal brine into unlined ponds that fouled the air, land and water. The site eventually became an EPA superfund site.

Though the presence of heavy metals in geothermal brine was known at the very beginning of the geothermal program, DOH, over more than 50 years, has assiduously avoided protecting citizens and the public from them. These heavy metals, which were deposited in unlined ponds with geothermal fluids by HGPA and have blanketed Puna Makai with every release of geothermal steam over 50 years, have flowed with rain into neighbors drinking water catchment tanks, it has flowed into the freshwater lens that sits below the porous rock that defines Puna makai's landscape. This puts neighbors at risk if they drink catchment or well water from the lens. It puts coastal and nearshore springs at risk. There are past and potential impacts of geothermal releases and injection on Hawaiian cultural practices. This includes the opae ula and fish ponds in Keahialaka that have been in the care of Hawaiian ohana for tens of generations.

There was a major accident at PGV in 1991, when a well blow out vented more than 2,200 pounds of hydrogen sulfide (along with heavy metals) over a 31 hour period, killing animals and forcing the evacuation of at least 75 Puna residents.

Adler reports,

> Since the blowout, DOH has recorded six incidents when permitted H2S limits were exceeded by PGV, including KS8 well drilling, well clean out activities, seal leaks, and equipment malfunctions. The one-hour limits ranged from 31 ppb to 789 ppb with the permit limit being 25 ppb on a one-hour average. Fines totaling $55,200 were assessed. These violations occurred from 1991 to 2005. As of February, 2013 PGV has

> reported 70 upset conditions involving H2S, 41 of which resulted in written reports to DOH, 28 involved verbal or courtesy notifications, and one resulted in a permit violation for exceeding the 25 ppb hourly average.

How does a regulated plant have 70 upset conditions? More than any other power plant in the state of Hawaii. How does this keep happening?
Through the willful neglect of state regulatory agencies.

Repeatedly, DOH has relied on internal “experts” that contradict the experience of local citizens and mainstream science to reach conclusions that geothermal power plants do not risk citizen health. One of many examples was reported by the Environmental Reporter in May 1993 in the aftermath of the 1991 geothermal well blow-out at PGV:

> A “Health Risk Assessment‘” prepared by epidemiologist Barbara Brooks for the state Department of Health concluded that the public would not experience any adverse health effects from accidental releases of hydrogen sulfide from the geothermal wells at Puna Geothermal Venture’s facility on the Big Island. The DOH risk assessment would appear to fly in the face of the Goddard report, which found that “estimates of 10-mile impacts of H2S within the plume cloud centerline are high enough to yield observed symptoms” of hydrogen sulfide exposure. (my emphasis) Further, a worst-case impact event with the same emissions as the [June 1991] uncontrolled venting where winds were near calm or at 1.0 mph would have increased impacts an estimated four to 10 times. Under worst-case conditions, the distance to where health complaints were reported would be extended several fold. . .
>
> The DOH report does not refer to the Goddard & Goddard study, nor does it reference any of the health effects reported by residents following any of the several “unplanned” releases of geothermal steam by PGV over the last three years. (my emphasis)

The DOH Health Risk Assessment is also inconsistent with well-documented modeling results presented in Appendix H of the PGV Emergency Response Plan. This modeling, done using the Industrial Source Code Short Term (ISCST), was "state of the art" in the 1980's. This is no longer on the "approved" model list, being supplanted by more recent models, but the results are reasonably accurate, at least at that time. The current situation is unknown, as there has been no updated modeling results presented to the public. Hence, the need for updated environmental documentation, to include modeling.

The Environmental Reporter continues to quote Goddard:

> “The 17-year history of repeated adverse upsets associated with the HPG-A and PGV attempts to develop geothermal energy at the Puna site indicates that, in this location, development is beyond the current engineering ‘state of the art,'” Goddard wrote. He called on the EPA to convene a panel of experts on underground injection control wells from its own staff and from the geothermal industry which “should review in detail each Puna geothermal well, direct the appropriate abandonment studies, prepare abandonment plans, and supervise proper well abandonment. His concluding statement described the Puna District East Rift Zone as “not an appropriate setting in which to develop the Island of Hawai’i geothermal energy resources.” (my emphasis, a major concern)

The DOH pattern of ignoring EIS reports, facts, independent consultants, and the impacts on residents has continued for 50 years.

After local citizens were gassed by a PGV hydrogen sulfide release during Tropical Storm Iselle, they were gaslighted by DOH in the local media. Even though the DOH had received 10 complaints by sickened residents, Deputy Director for Environmental Health Gary Gill’s first action was to tell the Star Advertiser, "In a hurricane, cyclone or tropical storm with winds going 50 mph, any kind of long-term exposure to hydrogen sulfide would be nearly impossible," of course Gill did not mention the fact that hydrogen sulfide is heavier than air and it traveled downhill under the treeline during the storm.

Deputy Director Gill, from his safe perch in Honolulu, based his comments on reports by PGV without any independent data and no investigation on his part. Deputy Director Gill was not present in Puna Makai during Iselle (we were). Iselle came ashore as a hurricane, but quickly broke up into a series of violent squall lines interspersed with periods of relative calm. There are no wind records because PGV was not in compliance with backup power requirements and the monitoring systems were down. Dangerous quantities of hydrogen sulfide gas could easily have wafted into communities surrounding PGV, with residents trapped by fallen trees and debris. PGV could have shut down prior to storm arrival to avoid catastrophic consequences. They chose not to do so.

This was during a time when residents were still recovering from the storm and could not respond because they were sick from the gas and dealing with the damage from the storm including poor cell phone reception, lack of internet or passable roads.

More than a week later, a young DOH investigator visited our farm after Tropical Storm Iselle. Of course there was nothing to investigate a week after the incident. My wife and I gave the investigator a tour of our farm which was 1 mile from PGV. Over fresh goat milk and cookies, I asked him why DOH has sent a relatively new investigator for such a major incident. He responded, "I am the only one in the office who wanted to make the trip." Then I asked, why did DOH wait a week before sending out an investigator. He responded, "It's part of the DOH '*no look, no find*' policy." This policy has been the hallmark of 50 years of regulatory neglect.

This consistent lack of DOH regulatory oversight has led to PGV's cavalier approach to safety regulation. The EPA was so concerned about PGV's H2S release during Iselle, while the air monitors were not functioning and the subsequent maintenance on wells without monitors, that they inspected PGV's site. KHON 2 reported:

> The EPA conducted a chemical facility inspection in August 2013 and found that the company had failed to take necessary steps to prevent accidental releases of hydrogen sulfide. Specifically, the company had not tested and inspected its equipment with the frequency consistent with manufacturers' recommendations, good engineering practices, and prior operating experience. The inspectors also found that with respect to PGV's storage, use and handling of pentane, a flammable substance used as a working fluid in the facility's electricity producing turbines, PGV failed to:
> • Conduct periodic compliance audits of its accident prevention program and document that identified deficiencies have been corrected.
> • Implement adequate written operating procedures that provide clear instructions for safely conducting activities.
> • Ensure that the frequency of inspections and tests of equipment is consistent with manufacturers' recommendations, good engineering practices, and prior operating experience.
> • Analyze and report on a worst-case release scenario and estimate the population that would be affected by an accidental release of pentane.

KHON 2 also reported:

> The U.S. Environmental Protection Agency announced Tuesday a settlement with PunaGeothermal Venture for Clean Air Act chemical safety violations at its geothermal energy plant. After an EPA inspection, the facility has now complied with the rules designed to minimize

> accidental chemical releases. The company has also agreed to pay a civil penalty of $76,500.

Note DOH did not do the inspection that resulted in the remedial actions and fine. The EPA had to step in and do the job that DOH should have done. Nonetheless, the $76,500 penalty is a mere slap on the wrist for a $7 billion dollar Ormat who makes millions from PGV revenues.

DOH and State of Hawaii regulatory capture

The State of Hawaii and DOH has acted in an arbitrary, capricious manner, characterized by abuse of discretion or clearly unwarranted exercise of discretion to keep PGV operating with minimal regulation.

This is exemplified by Governor Ige‘s response to concerns about the changed conditions around PGV after the lava flow. In a response to Senator Russell Ruderman, he states,

> DOH monitors the ambient air for the primary purpose of measuring ambient air concentrations of hydrogen sulfide (H2S) to ensure that the air quality standards are met. The DOH ambient air monitoring station previously located in the Leilani Estates subdivision was lost to the Kilauea East Rift Zone eruption in 2018. With Puna Geothermal Venture's plans to restart operations of its facility and the potential for the community to be impacted, the DOH re-established an air monitoring station at the Leilani Community Association. This station enables the DOH to provide the community, emergency personnel, and other interested parties with important air quality information for this area.

On the face of it, this sounds good. Yet an examination of the details show the cynical nature of these statements. In taking this action, DOH did not notify or consult with the community or ask for public comments on where to locate the new monitoring system. If they had, citizens would have told DOH that moving the replacement monitor 1.5 miles away from the site of the one covered by lava, and 1.5 miles further away from the PGV well field would not provide any useful data, only zeros regardless of plant conditions. Of course, that may well have been DOH's intention.

The new site, now 1.9 miles southwest of PGV, will not inform citizens of H2S conditions at PGV. My home on the other hand is one mile from PGV, with nothing but a lava field between us. The new monitoring site which the governor touts is almost twice as far from PGV as my ‘ohana's kitchen and bedrooms.

This action illustrates that DOH and the governor prefer no data to useful data.

If DOH had consulted with local citizens, we would have told them what should be obvious to DOH: H2S is heavier than air so it flows downslope. This happened during Tropical Storm Iselle when PGV gassed my family in our home and made a significant number of neighbors sick, including some who passed out.

The new DOH monitor is also 120 feet higher in elevation than PGV and all the PGV monitors are at a higher elevation and are north of the well field. Since H2S would flow downhill, this helps ensure H2S readings are minimized or non-existent.

The current “monitoring system” has no sensors makai and downslope of PGV. The closest monitors to the south and north of PGV leave a gap of 1 mile where a H2S plume would flow downhill, without registering on the monitors. It's as if DOH and PGV sited the monitors to avoid a H2S plume emanating from PGV and flowing makai. This alarms me and my neighbors who live downslope, directly makai of PGV.

DOH‘s capricious and arbitrary actions are putting my ‘ohana and neighbors at risk by intentionally putting sensors where they are least likely to register H2S.

Senator Ruderman voiced another concern in his letter:

> *Virtually all the trees, shrubbery and forests that were in the area are now gone. This results in noise and toxic fumes traveling much farther than before the eruption. Was this taken into consideration in awarding new Air Quality permits? In the noise monitoring? In what way was this considered?*

Governor Ige, advised by DOH, responds:

> It is not anticipated that the absence of trees, shrubbery, and forests would result in H2S emissions traveling a greater distance because PGV is a closed system whose normal operations result in minimal fugitive H2S emissions.

As the Adler report and numerous citizen‘s and formal government officials testimonies’ point out, 70 H2S incidents do not indicate the “closed loop” system is resulting in “minimal fugitive H2S emissions” during “normal operations”. When you have 70 incidents in 30 years of operation, “normal” is on average one H2S incident every 5 months that puts neighbors‘ health at risk. This does not account for the many incidents where citizens report a leak and the inadequate monitoring system does not record it.

By this specious argument, DOH and the governor brush off Senator Ruderman‘s legitimate concerns for the safety of local citizens in order to make the unwarranted claim that they do not have to address the lava flow and it‘s change in the terrain and complete absence of trees, shrubbery and forests. What should happen is an assessment of the new environmental conditions and a subsequent EIS. This action by DOH and the governor is an unwarranted abuse of discretion resulting in a violation of citizens’ right to a safe and healthy environment.

Poor Emergency Response due to inadequate monitoring The lack of adequate monitoring has interfered with Hawaii County Civil Defense responses to incidents and hampered fact-finding after incidents so that improvements could be made. Poor monitoring and alert systems put people’s lives at risk.

Here are three of the more than 70 incidents that help illustrate the problem of poor monitoring:

- March 13, 2013 PGV released 6 lbs of Hydrogen Sulfide. They filed a report saying trees had caused the plant to trip. Firemen, standing with neighbors at the perimeter of the plant measured H2S readings of 3 ppm and 1ppm.
- April 6 2013, a pipe leak released 13 lbs of H2S.
- During Tropical Storm Iselle, citizens estimated 300-600 lbs of H2S were released.

For all three of these incidents, the monitoring system approved by DOH did not register any releases. The first two plumes must have missed the monitors. The last one did not register any releases because all the monitors went offline when the power line to PGV went down, even though they had diesel generators to power the plant and were required to provide backup power to the monitors. PGV then proceeded to do maintenance on their wells for the following week while the monitoring system was shut down, which resulted in more releases that were reported by local citizens and conveniently not documented by the non-functioning monitors or PGV.

Local citizens, along with former state and county officials will testify to the impacts of deficiencies in monitoring of geothermal toxins on emergency response, as they have many times in the past. As Christopher A. Biltoft, testifies, “Hydrogen sulfide, when released in high concentrations, is a dangerous toxic gas. The potential for its release into public space must be properly addressed, along with adequate source monitoring, modeling, and communication with the affected public.”

The combined effects of these incidents, coupled with ongoing noise, vibration, and anxiety and stress about not knowing whether their lives were at risk and about future incidents has had a significant detrimental impact on the health and safety of local citizens.

Multi-hazards of PGV. The county’s multi hazard emergency response plan doesn’t mention the hazard of a hurricane or lava causing a release of h2s, heavy metals, and pentane at PGV. Or a pentane explosion. The state declared an emergency to get PGV to move the Pentane they had stored at the plant when the lava was flowing. By definition PGV is a multi-hazard emergency that has already happened but is ignored by PGV and the county plan, putting lives at risk.

Induced Seismicity In the region used by PGV, the dominant pattern of seismicity aligns parallel to the Kilauea Lower East Rift Zone. The majority of earthquakes occurs at 2-3 km depth, possibly associated with activity at the geothermal production plant. (Microseismicity and 3-D Mapping of an Active Geothermal Field, Kilauea Lower East Rift Zone, Puna, Hawaii, USA 2010)

We need more studies and data regarding induced seismicity at PGV before we can know whether increasing power production and injection wells will increase earthquakes. I live one mile from the plant. Since PGV restarted, I have had larger and more cracks in the foundation of my home. Risks to homes, people and structures are too great to proceed without more data.

- Other related issues that must be addressed are:
- Co-temporal dynamic triggering of disposal-induced earthquakes
- Delayed dynamic triggering of disposal-induced earthquakes

- Ground motions from induced earthquakes
- Effects of differential localized pressures and thermal gradients between upcoming well and injection well sites
- Increase in underground pore pressure and effect on fault geometries
- Relationship of injection fluid volume and pressure to induced seismicity
- Injectate slip triggering of nearby faults
- Effects of cumulative induced earthquakes on eruption dynamics of volcano

Lava events PGV has drilled into flowing lava before. In fact, they had some wells that produced lava just like fissures. It has been documented that dacite lava at ~1000 degrees Celcius was encountered and caused problems at least one well while drilling in 2005. This was not reported to the public until 5 years later when published by Bill Teplow, one of PGVs drilling consultants. How will PGV deal with that and protect nearby neighbors? Wells can be damaged even if the surface lava doesn't reach the plant, if an eruption shears off the wells underground. If the wells are damaged, they could blow out. They would release steam that could contain hydrogen sulfide and CO2, and whatever else is underground. That happened at a place called Krafla in Iceland in the 1970s. In fact, they had some wells that produced lava just like fissures. The PGV facility is located over extant fissures and given that Lava Zone 1 is by definition (by USGS) "***Includes the summits and rift zones of Kīlauea where vents have been repeatedly active in historic time." These areas are the most dangerous because all, or nearly all, erupted lava first emerges from the ground within Zone 1*.** Although there are portions of PGVs facility that were not directly impacted by the 2018 lava eruption, there is likelihood that a subsequent eruption could emerge from the land directly beneath any or all of the facility at any time in the future with direct risk to the safety of operating production or injection wells, piping, pentane storage, etc. This EIS should look at the fact that USGS has documented that East rift zone fissure eruptions have occurred every 12-15 years when averaged over the past 2000 years and the 30 years prior to the 2018 eruption when Pu‘u‘o‘o erupted continually for 30 years without other fissure activity during that time is actually an anomaly in the geologic history of the region. The 1987 EIS lists the historical activity in the region and explicitly says: `Potential volcanic hazards consist of lava eruptions. lava flows. ash falls. splatter falls. and their associated surface disruptions. The risk associated with these hazards has been greatly reduced by locating the plant site and new wellpads on high ground to avoid lava flows in the low areas. Quickly constructed berms or blankets of volcanic cinders will be utilized to protect the lower wellpads and key elements of pipelines from lava flow. Each wellhead in low ground will be protected from lava flow by timely full closure of the master valves and by burying the cellar and wellhead with insulating cinder piles.`

The actual events from 2018 clearly show that the treatment of this issue in that 1987 document was a severe underestimate. In addition to our justifiable concerns about our homes and farms in the local community regarding this lava event, we were subject to real and significant fear about the dangers from the plant, risks to the safety of the wells, risk of pentane explosions due to the poor management of the situation and the lack of accountability and transparency during the period between the start of the eruption in 2018 and when the State stepped in with expert help to mitigate the situation. By all accounts, PGV continued to pump water down the wells after the start of the eruption so that they would be able to more easily restart the wells at a later date. This should not have occurred and likely deteriorated the situation causing the subsequent much larger eruption of fissure 17 right by the wellfield itself which caused the majority of the damage of the 2018 eruption overall. This EIS should properly examine and evaluate the hazards associated with trying to operate an industrial facility in this region and given the extreme risks associated with the lava hazard, PGV should not be allowed to operate in this lava hazard area.

Social Justice In addition to the history of health impacts, poor to non-existent regulation, and gas- lighting by state and county officials, we experienced a lava flow in 2018 (a declared national disaster) which destroyed 700 homes and isolated many more homes and farms. We are a low-income ethnically-diverse community. This increase in geothermal power production puts our lives and drinking water at risk. We also have to live with the impacts of noise and light pollution. Puna already produces more power than any other district and uses a small fraction of that which is produced there. The power Puna doesn’t use is transported to Kona and Kohala for a power plant that will make electricity not for this area but for luxury hotels on the other side of the island. Helco is compensated for the line loss of shipping the power to the other side of the island by charging rate payers. This means that Puna residents live with the impacts of power generation and subsidize the cost of line loss for shipping the power to wealthy areas. Also, the most immediate neighbors to PGV do not have Helco power since Helco has not deemed it profitable to run electric lines there, even though they have two high power transmission lines to PGV. Again, no benefits, only negative impacts for neighbors. This is a clear social justice issue for the repowering of PGV.

Alternatives At page 1.6, the notice says “[n]either PGV nor Ormat have additional land positions for geothermal energy that would give them the ability to utilize other locations on Hawaiʻi Island or elsewhere in the state to commercially produce energy using geothermal resources.” The notice then says the only alternative that will be considered is the no action alternative. That approach is too narrow and restricted, as illustrated by the following facts.

In February of 2012 DLNR published an Environmental Impact Statement Preparation Notice for Ormat titled Ulupalakua Geothermal Mining Lease and Geothermal Resource Subzone Modification Application. Apparently a plan to develop geothermal energy production on Maui has not advanced, as far as further public notice is concerned, but it is possible.

Also in 2012, Hawaii Electric solicited proposals for an additional 25 MW of geothermal energy for Hawai'i Island. Ormat submitted the successful proposal, but eventually withdrew from negotiations of that contract.

In 2019, Ormat announced that it had commenced commercial operation of a geothermal and solar hybrid project, with 7MW of solar production, at its Tungsten Mountain geothermal project in Nevada. Hybrid solar generation and battery storage are plainly alternatives to be considered for PGV.

Act 205, signed on June 22, 2022, appropriated $500,000 dollars for the investigation, exploration, and identification of geothermal resources on Hawaiian home lands.

Public events in February of this year relating to local geothermal energy exploration and development, featured, among others, Mike Kaleikini identified as Director of Hawai`i Affairs for Ormat and a Commissioner of the Department of Hawaiian Home Lands.

Transparency Given these facts, it is misleading to suggest PGV and Ormat have no potential opportunities or interests in geothermal or related energy development beyond the present facility plans. The EIS should disclose and discuss all of these circumstances, as well as any additional alternatives.

Sustainability Another major factor that must be considered is the risk to the Islandʻs of Hawaiʻi by having a large fraction of the utility power dependent on this facility given the likelihood of this plant having to shut down or being destroyed by the very real and known lava hazards in the location of the plant. What mitigation must be done to protect the power supply of all the homes and businesses who depend on utility grid power when (not *if*) lava disaster strikes the production capability of PGV? It makes more sense to use other less risky power production using solar power plants and stored power to reach the States goals to reduce fossil fuel consumption.

Due process and lack of transparency Poor monitoring hampers emergency response, but it is useful to PGV and DOH in one very important way. It keeps the local community and the media from knowing what the actual releases are. This protects PGV and DOH from scrutiny by the public and the media. It also hampers local citizens' ability to document the link between releases and impacts on the community.

The only "closed loop" in this system that has had more than 70 incidents in 30 years, is the inadequate monitoring that keeps information from flowing to the local citizens, emergency response, and the media when there is an incident. This helps keep the veil of secrecy intact, protects PGV and DOH from accountability in the numerous lawsuits that have followed geothermal steam releases, and it violates citizens' right to know what is polluting their air (EPCRA) and their ability to seek redress for the impacts on their health.

Even this brief look at PGV history tells us what the future will look like unless there is a change in regulation. The final EIS, like the last one, will be a work of fiction. It will say all impacts are minimal or mitigated. Of course, they won't be. The noise, the H2S and heavy metal releases will impact neighbors, our water and the ‘aina. PGV will say they meet all regulations. If PGV can't meet the regulations, the state will change them. The state of Hawaii will continue to ignore the plight of neighbors, plants and animals that live near the plant. The county, the accepting agency for the EIS, will accept all this too. PGV will continue to lessen regulation, to expand industrial operations, and to gas and gaslight neighbors. This will continue until the next emergency. Then there will be silence, minimal media coverage and the cycle will continue.

I request that the County, as the accepting agency for this EIS, become less accepting of the noise, light pollution, potentially fatal hazards and impacts on neighbors–and actually regulate them. The first alert of an emergency shouldn't be neighbors getting sick or worse.

This EIS should properly examine and evaluate the hazards associated with trying to operate an industrial facility in this region and given the extreme risks associated with the lava hazard. **PGV should not be allowed to operate in this lava hazard area.**

There have been so many documented safety issues for the local community to deal with from the normal operation of PGV and the lack of willingness from the authorities to look clearly at the ways that the community has been both ignored and abused on an ongoing basis during the time of geothermal in Hawai‘i. It is clearly an issue for residents to deal with the potential for natural disasters, to have to move out from their homes and farms and perhaps lose them altogether. It is another magnitude scale issue altogether for the island‘s power supply to be so dependent on the safe operation of PGV. This time is long overdue to take a full and comprehensive look at all of the issues and take the appropriate action to prohibit further development in the East Rift Zone.

Sincerely,

Paul Kuykendall
Waihu O Puna Makai Watershed Coalition
bigislandpaul@gmail.com
PO Box 160
Pahoa, Hawaii 96778

Suzanne Wakelin, PhD
malamatree@gmail.com
PO Box 160
Pahoa, Hawaii 96778

Comment Letter 20

Mori, Ashley

From: Robert <nimo1767@gmail.com>
Sent: Sunday, August 21, 2022 11:30 PM
To: Planning Internet Mail; michele.lefebvre@stantec.com; Michael L. Kaleikini
Subject: PGV EIS comments 8/21/2022

8/21/2022

Aloha! Ms. Surprenant:

My name is Robert Petricci

Notice from 23 July 2022 states that the PGV Repower Project EIS Preparation includes a 30-day public review and comment period. I submit this written testimony and also adopt the position and statements submitted for this EIS by Puna Pono Alliance, Chriss Biltoff, Paul Keikandal, Sara Stiener, and Susan Wakeland as my own, so as not to be redundant.

Written comments for the draft Environmental Impact Statement review as follows are to supplement my oral comments submitted at the public meeting on 8/17/2022. I was cut off by the mediator before I could finish speaking on the record for the Proposed Puna Geothermal Venture Repower Project draft EIS. These comments are meant to empower and educate with no profit incentive on my part. I am not paid nor do I profit from providing the following information and comments. The county and state can not say the same, there is a profit motive for both who receive payments amounting to millions of dollars from geothermal royalties and taxes, PGV also has a profit motivation to make as much money as they can, including cutting corners, your company is also being paid. It is hard to deny large sums of money can influence decisions for projects like this, particularly when situated in one of the poorest communities in the state. Residents do not get paid or have paid staff to do this, why do we do it? There is no profit motive here for us. My motivation for spending so much of my time preparing this to the best of my ability with the scant resources I can muster is to do my best to make sure you have the best, most accurate information available to help you produce a well informed, EIS, that refelcts the reality on the ground for me and other area residents. I am not perfect and may make a mistake here or there, feel free to correct anything you consider inaccurate before the next public meeting. The state DOH, and sources ; like Don Thomas are natoriously tainted and biased, if ask I produce proof that what I am saying is true. They are not going to give you information that would expose some of the terrible possibly things they have done to me and the rest of the area residents over the last 42 years.

.At the end of the Pahoa meeting organized for public input and comments there was still some time left for speakers, I asked the mediator (after waiting to be sure no one else wanted to speak) to allow me to finish my comment because she had stopped me before I was done, she refused. That is not in the spirit of how to encourage or incorporate community input in this EIS, IMO. The venue selected for the 8/17/2022 was woefully insufficant from a community input stand point, and when there was time for more comment I was not allowed to provide information critical to the EIS in a public setting. I have a lot of experience and knowledge, you do not, did you want to hear it? I say that having run at least 50 public meetings about geothermal. You could have intervened and asked the moderator to let me finish, you chose not to, I believe that was a mistake. I am trying to convey that by not intervening in an easy way that would have allowed me to more fully participate and interact with you, you missed an opportunity.

You might be surprised by some of the things you still have to learn about this project judging by what was in the draft EIS. I think you will find if you read these written comments and the rest of the community comments with an open mind that there is much more to this than the draft EIS takes into account. Is this EIS as the draft suggests just going to be window dressing to try and meet HEPA law or are we going to do a comprehensive EIS that objectively looks at the impacts and risk as well as perceived benefits this power plant expansion will have on the area residents? That is a very real concern of mine after reading the draft EIS, and not being allowed to finish speaking at the public meeting when there was time left. Time will tell, however if history is an indicator it will not be comprehensive or look at things like what happens to one of the most fractured and unstable geologic locations on the planet when you re-inject cooled fluids into extremely heated rocks, voids, and or exsisting fractures. One of the elephants in the room that no one wants to talk about is the volume at which PGV does that, and what happens at the bottom of the pipe roughly 5,000 feet down.

What Mike Kalikini from PGV has told me several times at public meetings over the years is that at 38 megawatts PGV is reinjecting at the rate of approximately 4,000 GPM 24/7 365 days a year. That equates to over 2 billion gallons a year at 38 megawatts. I would like the EIS to tell us over the last 29 years barring the years the were knocked offline and unable to supply power what is the total amount of cold fluids PGV has put into that super heated rock over the life of plant operations. Do you know, does DLNR, DOH, the county, does PGV know?. This EIS must look at what impact that has on the rift zone and geologically around the plant and beyond to have any hope of being seen as legitimate by me and the community. What Mike Kalikini also told me is that when the cooled re-jectate comes in contact with super heated rock it explodes. His exact description was "what happens when you put cold water on a hot imu rock, it explodes". I will never forget that and need a lot more information about the pressure at the bottom of the pipe and what happens. The EIS should be the vehicle to look objectively at that, particularly as the lava from the 2018 eruption that occured around the PGV plant found it's easiest path to the surface right along the PGV boundary. Exactly where was PGV re-injecting, in relation to the boundary where the vents opened? What is the pressure at the bottom of the pipe where it contacts the hot rock and what happens when it does so under the weight of a 5,000 foot column of fluid? Does it cause any type of fracturing? I was told again by Mike Kalikini that PGV tries to re-inject far enough away from the resource not to cause cooling of the resource but close enough that the water can travel back through fractures and be reheated as it moves through the hot rock back to the resource to recharge it. Without that the resource would be used up recharging the resource would decline.

Was there a clear statement to the community about having more time to submit written testimony at the public meeting in Pahoa? If not, that was another missed opportunity for community input. If there was a clear announcement I missed it.

I live on Pohoiki road near enough to PGV that if there is an accident I may need to literally run for my health and safety, possibly even my life. I have lived in the area since buying property and building a home in Leilani Estates in 1981, I have extensive first hand personal knowledge and experience of geothermal development in Hawaii, including public hearings, litigation, accidents, community protest, community arrest for civil disobedience, legislation, and serving on the Addler health study group for mayor Kanoi. I had 2 Jerome H2S samplers purchased by the county for the residents in my care. I was the first responder to accidents for the community for decades. People would call me at all hours of the day or night when there were leaks, accidents, or noise problems at the PGV site and I would go to see what was going on. I responded to countless leaks and accidents at PGV. I still have the information from the jerome data loggers, in my possession, PGV has paid me damages as a result of injury from exposure to their toxic releases and for being evacuated during emergencies at the plant that made my home unsafe to be in as well.

Moving power great distances like is needed for PGV central generation model is inherently expensive and vulnerable to disruption, will the EIS please address that. Producing power where it is actually needed is far more reliable, sustainable, and affordable, will the EIS reflect those facts?. If the stated goal is to be safe, reduce cost, and be reliable, PGV is greatly handicapped, please explain how moving power great distances reduces cost or boost reliability and what makes PGV so safe with it's history that contradicts that claim. To prove that is true, can you name another power plant in the state of Hawaii that has caused numerous emergency evacuations and paid hundreds of people damages for health claims? I know of none, if that is the case, and I believe it is, it could be argued in fact PGV is and has been the most dangerous power plant in Hawaiian history and still is, yet the draft EIS calls the safe and reliable, please explain that..Also please explain how locating the power plant right where lava found its easiest path to the surface in 2018 makes PGV either safe or reliable when it is well known PGV will be subject to geological disruptions that could cause uncontrolled release of known toxins at deadly level and or be destroyed or incapacitated again.

The draft EIDS appears to be an exercise in trying to meet the requirements of HEPA laws while not really doing the work necessary to include information and comments from the residents, White washing or biased interpretations are prevalent in the PGV EIS draft document we are being asked to comment on. You will have to excuse me but after participating in the process of geothermal testing and development for the last 42 years, living less than a mile away from Geothermal development 1981, until forced from my home in 2004 because my health was deteriorating, I have learned a few things at least. I have been a plaintiff in many regulatory and civil litigation actions against both PGV and DOH. Why would I do that? I have tried to regulate PGV in the absence of state or county oversite for self preservation too many times to remember them all. PGV has paid me damages and the Hawaii supreme court has ordered PGV to do rulemaking as a result of some of that litigation I was a party to, because the state DOH simply refuses to follow the law. It is not a new problem with regulation, it is a historical one. With the extensive history of accidents and litigation making PGV the most contested power plant in state history. On top of the many accidents and evacuations making PGV arguably the most dangerous power plant in the state. Is it time yet to address these issues or is this EIS just going to kick the can down the road again. When does this become a crime? Intentionally trying to end run state laws and regulations for 42 years at some point becomes intentional, is that a crime? Can the EIS address that please? The EIS needs to consider and I look at why that is, the residents' actions and complaints have changed many times over the years, it is not the same people over and over although some of us have been here since day one.

This EIS draft so far looks like another example of how to do another end run around real monitoring, emergency response and evacuation for residents, or existing laws and requirements. That includes repeated examples of PGV being allowed to operate with expired permits, and in violation of permits and promises made to use best available technology (BACT) that were not enforced. This includes operating without an air monitoring system that provides reliable exposure levels to area residents from toxins released by PGV during operation and upset conditions. This is not a new problem, if PGV is not harming the residents with these constant releases why don't they want to collect the data to prove that? Simply put, after 25 years this has to be by design, if I wanted to prove I was not hurting people by releasing known dangerous levels of toxins I would want to have the data to prove it. They do not want that data, nor does the state DOH or DLNR, why not? With the long standing concerted effort to find ways around state and county permitting and laws for decades it begs the question: "do the of meetings or communication between PGV and regulators to figure out how to operate outside the norms of permitting and governing laws rise to the level of subverting the process or even conspiring to do so behind closed doors? I would like the EIS to explore the interaction between regulators and PGV, and the resulting decisions that have allowed PGV such latitude. How regulators actions and inactions to this day have resulted in no usable data to establish exposure levels to residents after 42 years of health complaints from the community. How is it possible that after all these accidents, protests, arrests, PGV settled damages for resident harm litigation, it is not like they do not understand the problem the lack of good data causes? At this point can the EIS determine if it is incompetence, collusion, or intentional means to prevent the collection of usable data through source monitoring and computer modeling. Can the EIS answer why PGV is allowed to use 1980 air sampling stations in the 21rst century if not to avoid collecting real data on what exposure levels in the community are?.Further at this point do the actions of regulators and PGV rise to the level of a conspiracy to do such, if not why not.. If that is truly the case does that rise to the level of a criminal offense? Please answer that question and how it is possible to operate for decades like this if it is not by design or collusion of regulators and PGV. Is it possible the state and county are influenced or motivated by the millions of dollars in royalties PGV pays (but only when operating) more so than the laws governing the process or are they simple incompetant to protect the public health, wellbeing, and good? While some might not take these comments seriously I can assure I and other residents do. Please do the work necessary to adequately address the issues I have raised. There was testimony about money PGV has given to community projects which is commendable, I have to wonder though if that money would have been better spent on a real system to collect exposure levels in the same community?

On another note, PGV's prominence at the Pahoa "public" meeting gave the appearance of them being in control of what was happening.

page 1-1 of the EIS......States....."although there was no statutory trigger, an Environmental Impact Statement (EIS) for the now operating power plant was voluntarily prepared by PGV".....

That statement is simply not true, as anyone reading the PUC record knows. Again calling into question the legitimacy and reliability of this draft EIS document we are commenting on here, IMO. HEPA laws require PGV to do an EIS as per the PUC record, this is not voluntary. The company that prepared the document was paid by who, That and the statement that PGV is safe and reliable come right out of PGV handouts, the facts say it is not the case. It is disturbing and disheartening to see that in a so-called unbiased draft EIS. Can you explain how that was put into the draft, where exactly did that information come from?

I disagree with the author's conclusion that this EIS is not required by law. State land use (the geothermal resource) clearly triggers HEPA requirements as pointed out publicly many times. This EIS is not voluntary, it is required. There are multiple false or misleading statements in this document that need to be corrected if this EIS hopes to have any legitimacy whatsoever. No new EIS was done or NCSP permit issued (the old permit had expired) even after the major changes since the 2018 eruption that closed the plant for years, not exactly reliable, then there was the blowout at KS-8 and Tropical Storm Issell. Including the state owned geothermal resources used by PGV that is now much hotter and includes changes both underground and in the ground elevations around the PGV plant and well field caused by the 2018 eruption.

The facts clearly show PGV has been largely self regulating since it began drilling operations. DOH's finding that no further environmental review was required for this expansion and new equipment is just another example of that regulatory bias and failure to perform its responsibility to protect the public health. Hawaii DOH, DLNR, and the county have long allowed PGV to operate in a manner that is dangerous to the surrounding community, and has caused harm. This goes back to the beginning when PGV first started drilling wells. The county GRP permit clearly stated in the 51 condition negotiated with the community that PGV was "required' to use best available control technology (BACT). The conditions "required" PGV to use BACT, there was no ambiguity there, BACT is required period. DOH, DLNR, and the county never enforced this or other conditions such as a viable emergency response plan for the community. Instead allowing PGV to open vent wells to the detriment of the health, safety, well being, and enjoyment and use of their property as documented in the county's Adler report. Without any way to document actual levels the community was exposed to that was over 20 years ago. They allowed this with no way to track the levels or impacts of the toxic gasses being released unabated into our community. I have a problem with that and this EIS needs to address it

The three PGV air samplers and the 1 DOH air samplers are another example of PGV not using BACT, it is not a "monitoring" system as there has never been any usable data generated to determine the level of exposure residents have been subjected to. Chris Biltoff, an expert on such systems has pointed this out to the state and county regulatory agencies as have others repeatedly to no avail. The county and state regulators refuse to update the wholly inadequate samplers that only register levels of gas that happen to hit them, and only if they do not fail as happened during Issell. PGV and DOH as well as the county had not installed a backup power source as we saw when the samplers were knocked offline during the disaster of Tropical Storm Issell. Issell trapped the community, there was no escape for residents as PGV was out of control and vented dangerous levels of H_2S. They almost lost the power plant that evening while people were trapped and could not escape. Over a hundred residents filed for damages which PGV paid, some people were knocked unconscious by the gasses. There is no reliable data to document the exposure levels in the community because for all intents and purposes there is no monitoring system

The samplers have been shown in court cases not to provide the data needed to establish exposure levels]in the surrounding community. Is that BACT? I would like a specific answer to why it is or is not BACT. Please explain in detail why there is no workable, tested emergency response plan for area residents from Civil Defense or DOH even as the roads are blocked by lava. PGV is being allowed to continue to put us at risk using expired permits (one expired 8 years ago) and no emergency response plan to get the community out when, not if the next major accident occurs? During litigation on several occasions after accidents and releases this was shown to be the case and has allowed PGV to dodge responsibility for hurting people because of a lack of data to show what the levels are during accidents and upsets. This has to be intentional after 25 years of this, it is not like PGV and the regulators do not know that, is it a criminal conspiracy? I think it needs to be investigated to see how this is even possible.

How could no viable data on exposure levels in the community possibly be BACT? PGV only started using BACT during well clean outs after I was arrested for simple trespass trying to stop the illegal, dangerous, and harmful release of unabated toxins and pollutants during well cleanouts. I was acquitted of the simple trespass at PGV under a lesser of evils defense. Circuit court judge Rikki May Amano found me not guilty of breaking the law because it was a lesser evil than to allow PGV to violate the permit and poison the community than it was to break the law to try and stop them. That was the last time PGV open vented a well clean out, not because of DOH, DLNR, or the county but because a resident was forced to be the regulatory agency for the permit conditions. That is not good regulatory oversight when a resident has to be arrested to enforce what the permit requires. After that PGV started using a cyclonic separator and abatement during well clean out that was actually BACT at the time, but much more costly. Was PGV even punished for that blatant permit violation that hurt so many residents, was regulation improved? Were the regulators incompatant ot in collusion to save PGV money at the expense of community health and well being? That is a fair question that needs to be answered, It is time to find out. These and other ongoing permit violations show there was and is no real oversite or enforcement of PGV permits, making PGV self regulating. Nothing has changed with DOH and DLNR continuing to allow PGV to operate for years on expired permits, dodge EIS laws and operate without real monitoring even after they were shown by experts that the sampling stations are not BACT monitoring and that without actual source monitoring and computer modeling there is no way to accurately collect the data needed to determine exposure levels to nearby residents. The list of examples of regulatory malfeasance and failure is long, documented, and irrefutable.

Further, PGV noted “repowering of the Facility will be the subject of further environmental review” but notes that “any change to the Facility
could arguably jeopardize PGV's permit shield, pursuant to which the terms and conditions of the 2009 NSP ... ‘shall remain in effect and
not expire until the application for renewal has been approved or denied’” – acknowledging that if PGV admits the facility is in need of
improvements in the pending permit renewal application, that could jeopardize its ability to continue to operate while agency matters are pending.
How is that not a conspiracy? How much more outrageous and for lack of another valid reason, corrupt can the regulators be in their failure to perform to protect the public good? When added to the totality of the history of allowing PGV to avoid the law and permit requirements? Has this risen to the level of a criminal conspiracy, to help PGV while throwing the community
under the bus by the state and county agencies charged with regulating them, if not how is this possible after decades of problems???

Further, allowing PGV to operate on an expired NCSP permits for 8 years even after major changes to the equipment, the resource, and the new typography is not pono., it seems corrupt.
PGV and DOH publicly saying after the new permit is granted based on the 2014 application (before the geologic and equipment changes) PGV submitted for renewal of the NCSP, they would then immediately revise or supplement the permit to show the changes, is not a fair process, how is that even legal? It is clear this is an end run around what the law requires or should require for a dangerous industrial project being built and operated in a pre-existing residential community. Why even have a public hearing if you just do what you want without regard to the reality of the project, then amend it? Isn't that a conspiracy to end run the permit process? It does not protect the health and safety of residents, it protects PGV at our expense, exposing the collusion of regulators and PGV, IMO. This shows again the failure of DOH, DLNR, and the county to perform reasonable regulatory oversight to protect the community. Instead the regulators are protecting PGV at the harm and detriment to me and the other residents hurt by their failure to perform their responsibility to protect the health, well being, and safety of area residents in a reasonable and professional unbiased way..

The contested case debacle underway now for the DOH NCSP has dragged on for 8 years while PGV has been allowed to continue to operate in a dangerous manner. Another example of how the whole process has been regulated since the beginning. Having participated for the full 8 years it is my observation that DOH and hearing officer Steven Jacobson appear for all intents and purposes intentionally using the process to allow PGV to operate on a permit that no longer is even relevant to the "new" PGV operating conditions and equipment, to protect PGV's permit shield. While at the same time putting the burden to keep going on the residents, even to the point of trying to cut people out or wear them down, how is that a reasonable, legal, regulatory process to protect the health and well being of area residents? If community members, PGV employees, or first responders are killed or injured as a result of these failures to perform reasonable regulatory responsibility, who is responsible? Who is liable, at this point they can not say they did not know what they were doing or what was happening? PGV has settled hundreds of lawsuits for damages, yet from a community standpoint nothing has changed. We do not even have a community evacuation plan, another permit requirement the county simply ignores even after a long list of emergencies and accidents including Tropical Storm Issell and the KS-8 31 hour blowout at PGV in 1991.

I am very familiar with the history of geothermal in Hawaii, having lived near the projects since before they began in 1981. As such I was ask to be a
member of the county Adler group that examined the history and impacts of geothermal on the community. We filed our reported findings on
September 9, 2013. Many of the things we found serve as the basis for and support my comments here.

Here is an excerpt from the county's Adler geothermal working group....."Events during the HGP-A era and during the 1991 blowout provided exposures associated with adverse health effects. This knowledge, along with other information contained in this report ... has led the Study Group to conclude there is evidence that there were health effects from the exposures during the development of
geothermal before 1993. (we do not have the data to show the effects because there isn't any real monitoring data, that is still the case today).The full extent and severity of those effects has not been documented. ...Risks from geothermal energy production in Lower Puna exist.The actual extent and impacts of those risks remains unresolved. What is known is that hazardous chemicals are brought up by PGV. PGV adds industrial chemicals to the mix in the process and then sends the composite fluid back down. However, fluids inevitably escape to air, water, or at surface level. Harmful effects can only be understood through better monitoring and reliable health data."

The 1987 EIS completely ignored the true horror of HGP-A and negative impacts to the community, or the impact of reinjection on the rift zone. To this day nothing has changed because of the ongoing regulatory failures to perform basic responsibilities to protect the public good, PGV was and is for all intents and purposes still self regulating. As my comments, the record, and history clearly show.

I would like to state for the record that the County of Hawaii is not an alternative accepting agency for this EIS because it admittedly has no HEPA jurisdiction. The county and state appear to be more worried about collecting their royalty checks from PGV than following the law or protecting my community. They have never enforced the conditions in PGV's GRP permit or reasonable regulatory oversight.

Robert Petricci

Comment Letter 21

Lefebvre, Michele

From: Melanie Stanley <MStanley@kaihawaii.com>
Sent: Monday, August 22, 2022 8:57 AM
To: Lefebvre, Michele
Cc: planning@hawaiicounty.gov
Subject: Testimony in Support of the Puna Geothermal Venture Repower Project
Attachments: Letter to Support Puna Geothermal Venture.pdf

Please accept this letter of testimony to support the Puna Geothermal Venture Repower Project.

Thank you,

Ken Hayashida, President

KAI HAWAII
STRUCTURAL & FORENSIC ENGINEERS
50 S. Beretania Street, #C-119C
Honolulu, HI 96813

KAI HAWAII
STRUCTURAL & FORENSIC ENGINEERS

Ken Hayashida, P.E. | *President*
Michael Hunnemann, P.E. | *Vice President*

August 12, 2022

Email: michele.lefebvre@stantec.com

Ms. Michele Lefebvre
Stantec Consulting Inc.

Subject: Puna Geothermal Venture Repower Project
Docket 2019-0333 Repowering Proposal Amended and Restated Power Purchase Agreement (PPA)

Dear Ms. Lefebvre:

As a member of the Hawaii Leeward Planning Conference, I am writing in support of the Puna Geothermal Venture Repower Project and the Draft Environmental Impact Statement they are in the process of completing.

With the new repowered facility, the amount of power added will increase the facility contract from 38 MW to 46 MW and will decrease the typical residential customer's bill over the course of the contract term. Once the additional 8 MW come online, Hawaii Island's renewable energy total will be close to 70 percent.

I support Puna Geothermal Venture's Repower Project as it will create a cleaner, more sustainable energy source for the future.

Sincerely,

Ken K. Hayashida

Ken Hayashida
President
KAI Hawaii, Inc.

CC: County of Hawaii Planning Department
Email: planning@hawaiicounty.gov

Comment Letter 22

From:	Nakamura, Darlene K
To:	Lefebvre, Michele
Subject:	Request for Comments - EISPN - Puna Geothermal Venture Repower Project
Date:	Monday, August 22, 2022 10:27:42 AM
Attachments:	Puna Geothermal Venture Repower Project.signed.pdf Puna Geothermal Venture Repower Project.DOFAW Comments.pdf Puna Geothermal Venture Repower Project.HDLO Comments.pdf

Attached are comments from the Hawaii Department of Land and Natural Resources to the above-entitled subject project.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

August 22, 2022

Stantec Consulting Services Inc.
Attn: Michele Lefebvre
P.O. Box 191
Hilo, Hawaii 96721

via email: michele.lefebvre@stantec.com

Dear Ms. Lefebvre:

SUBJECT: Environmental Impact Statement Preparation Notice for the Proposed **Puna Geothermal Venture Repower Project** located at Puna, Island of Hawaii; TMKs: (3) 1-4-001: 001, 002, and 019 on behalf of Puna Geothermal Venture

Thank you for the opportunity to review and comment on the subject matter. The Land Division of the Department of Land and Natural Resources (DLNR) distributed or made available a copy of your request pertaining to the subject matter to DLNR's Divisions for their review and comments.

At this time, enclosed are comments from the (a) Division of Forestry & Wildlife, and (b) Land Division - Hawaii District on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

Russell Tsuji

Russell Y. Tsuji
Land Administrator

Enclosures
cc: County of Hawaii Planning Department w/copies (via email: planning@hawaiicounty.gov)
Central Files

8/15/22

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Aug 10, 2022

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
_X_Engineering Division (DLNR.ENGR@hawaii.gov)
_X_Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
_X_Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
__Office of Conservation & Coastal Lands
_X_Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

FROM: Russell Y. Tsuji, Land Administrator *Russell Tsuji*
SUBJECT: Environmental Impact Statement Preparation Notice for the Proposed **Puna Geothermal Venture Repower Project**
LOCATION: Puna, Island of Hawaii; TMKs: (3) 1-4-001: 001, 002, and 019
APPLICANT: Stantec Consulting Inc. on behalf of Puna Geothermal Venture

Transmitted for your review and comment is information on the above-referenced subject matter. The EISPN was published on July 23, 2022, by the State Environmental Review Program (formerly the Office of Environmental Quality Control) at the Office of Planning and Sustainable Development in the periodic bulletin, The Environmental Notice, available at the following link:

https://files.hawaii.gov/dbedt/erp/The_Environmental_Notice/2022-07-23-TEN.pdf

Please submit any comments by **August 18, 2022**. If no response is received by this date, we will assume your agency has no comments. Should you have any questions, please contact Darlene Nakamura directly via email at darlene.k.nakamura@hawaii.gov. Thank you.

BRIEF COMMENTS:

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(✓) Comments are included/attached.

Signed: [signature]
Print Name: GORDON C. HEIT
Division: Land Division
Date: 8/12/22

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

75 Aupuni Street, Room 204
Hilo, Hawaii 96720
PHONE: (808) 961-9590
FAX: (808) 961-9599

August 12, 2022

MEMORANDUM

TO: Russell Y. Tsuji, Administrator

FROM: Gordon C. Heit, Hawaii District Land Agent

SUBJECT: Environmental Impact Statement Preparation Notice (EISPN) for the Proposed Puna Geothermal Venture Repower Project

LOCATION: Kapoho, Puna, Island of Hawaii,
TMK: (3) 1-4-001:001, 002, and 019

APPLICANT: Stantec Consulting Inc. on behalf of Puna Geothermal Venture

Pursuant to your request for comments on the above matter, we offer the following:

The Hawaii District Land Office has no objection to the proposed replacement of the current power generating units as outlined in the EISPN Project Summary. The Land Division will provide further comments when the Draft Environmental Impact Statement is available for review.

Please contact me should you have any questions.

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Aug 10, 2022

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
__Office of Conservation & Coastal Lands
X Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

FROM: Russell Y. Tsuji, Land Administrator Russell Tsuji
SUBJECT: Environmental Impact Statement Preparation Notice for the Proposed **Puna Geothermal Venture Repower Project**
LOCATION: Puna, Island of Hawaii; TMKs: (3) 1-4-001: 001, 002, and 019
APPLICANT: Stantec Consulting Inc. on behalf of Puna Geothermal Venture

Transmitted for your review and comment is information on the above-referenced subject matter. The EISPN was published on July 23, 2022, by the State Environmental Review Program (formerly the Office of Environmental Quality Control) at the Office of Planning and Sustainable Development in the periodic bulletin, The Environmental Notice, available at the following link:

https://files.hawaii.gov/dbedt/erp/The_Environmental_Notice/2022-07-23-TEN.pdf

Please submit any comments by **August 18, 2022**. If no response is received by this date, we will assume your agency has no comments. Should you have any questions, please contact Darlene Nakamura directly via email at darlene.k.nakamura@hawaii.gov. Thank you.

BRIEF COMMENTS:

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(✓) Comments are included/attached.

Signed: Lainie Berry
Print Name: LAINIE BERRY, Wildlife Program Mgr.
Division: Division of Forestry and Wildlife
Date: Aug 16, 2022

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

August 16, 2022

MEMORANDUM *Log no. 3778*

TO: RUSSELL Y. TSUJI, Land Administrator
Land Division

FROM: LAINIE BERRY, Wildlife Program Manager
Division of Forestry and Wildlife

SUBJECT: **Division of Forestry and Wildlife Comments for the Environmental Impact Statement Preparation Notice (EISPN) for the Proposed Puna Geothermal Venture (PGV) Repower Project on Hawaiʻi Island**

The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your request for comments for the EISPN regarding the proposed Puna Geothermal Venture Repower project located at 14-3860 Kapoho-Pāhoa Road, Pāhoa, on the island of Hawaiʻi; TMK: (3) 1-4-001: 001, 1-4-001: 002, and 1-4-001: 019. The proposed project consists of replacing the current 12 operating power-generating units with up to four upgraded power-generating units. The proposed project would be constructed within the current PGV facility site fence line. Other work includes installing new piping and reducing existing steel structures, piping, mechanical components, and associated flange connections (associated with the replacement of the currently operating equipment).

The State listed Hawaiian Hoary Bat or ʻŌpeʻapeʻa (*Lasiurus cinereus semotus*) could potentially occur at or in the vicinity of the project and may roost in nearby trees. Any required site clearing should be timed to avoid disturbance to bats during their birthing and pup rearing season (June 1 through September 15). During this period woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed. Barbed wire should also be avoided for any construction because bats can become ensnared and killed by such fencing material during flight.

Artificial lighting can adversely impact seabirds that may pass through the area at night by causing them to become disoriented. This disorientation can result in their collision with manmade structures or the grounding of birds. For nighttime work that might be required, DOFAW recommends that all lights used to be fully shielded to minimize the attraction of seabirds. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season, from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea. Permanent lighting also poses a risk of seabird attraction, and as such should be minimized or eliminated to protect seabird flyways and preserve the night sky. For illustrations and guidance related to seabird-friendly light styles that also protect seabirds and the dark starry skies of Hawaiʻi please visit https://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf.

State-listed waterbirds such as the Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica alai*), and Hawaiian Goose (*Branta sandvicensis*) could potentially occur at or in the vicinity of the proposed project site. It is against State law to harm or harass these species. If any of these species are present during construction, then all activities within 100 feet (30 meters) should cease, and the bird or birds should not be approached. Work may continue after the bird or birds leave the area of their own accord. If a nest is discovered at any point, please contact the Hawai'i Island Branch DOFAW Office at (808) 974-4221.

The State listed Hawaiian Hawk or 'Io (*Buteo solitarius*) may occur in the project vicinity. DOFAW recommends surveying the area to ensure no Hawaiian Hawk nests are present if trees are to be cut. 'Io nests may be present during the breeding season from March to September.

DOFAW recommends minimizing the movement of plant or soil material between worksites. Soil and plant material may contain invasive fungal pathogens (e.g., Rapid 'Ōhi'a Death), vertebrate and invertebrate pests (e.g., Little Fire Ants, Coconut Rhinoceros Beetles), or invasive plant parts that could harm our native species and ecosystems. We recommend consulting the Big Island Invasive Species Committee (BIISC) at (808) 933-3340 to help plan, design, and construct the project, learn of any high-risk invasive species in the area, and ways to mitigate their spread. All equipment, materials, and personnel should be cleaned of excess soil and debris to minimize the risk of spreading invasive species.

DOFAW recommends using native plant species for landscaping that are appropriate for the area (i.e., climate conditions are suitable for the plants to thrive, historically occurred there, etc.). Please do not plant invasive species. DOFAW also recommends consulting the Hawai'i-Pacific Weed Risk Assessment website to determine the potential invasiveness of plants proposed for use in the project (https://sites.google.com/site/weedriskassessment/home). Please refer to www.plantpono.org for guidance on the selection and evaluation of landscaping plants.

Due to the arid climate and risks of wildfire to listed species, we recommend coordinating with the Hawai'i Wildfire Management Organization at (808) 850-900 or admin@hawaiiwildfire.org, on how wildfire prevention can be addressed in the project area.

We appreciate your efforts to work with our office for the conservation of our native species. These comments are general guidelines and should not be considered comprehensive for this site or project. It is the responsibility of the applicant to do their own due diligence to avoid any negative environmental impacts. Should the scope of the project change significantly, or should it become apparent that threatened or endangered species may be impacted, please contact our staff as soon as possible. If you have any questions, please contact Paul Radley, Protected Species Habitat Conservation Planning Coordinator at (808) 295-1123 or paul.m.radley@hawaii.gov.

Sincerely,

Lainie Berry

LAINIE BERRY
Wildlife Program Manager

Comment Letter 23

From: Heather Irwin
To: Lefebvre, Michele; planning@hawaiicounty.gov
Subject: PGV
Date: Monday, August 22, 2022 10:56:04 AM

Aloha,

My name is Heather Irwin, a resident of Puna. I am writing to you on behalf of Keone Kalawe and Keikialoha Kekipi, both residents and active community members of Puna.

We wanted to address the topic of PGV and the Environmental Impact Study.

There are great concerns about the Opae Ula (shrimp) and possible toxicity impacting their viability as well as safety. Beyond the shrimp, there could be toxins being released under ground that is impacting both the land we grow food on, as well as leaching into the ocean and streams. All of which impacts the marine life, as well as everything and everyone else.

Safety, preservation, and protection is our greatest concern. Will there be monitoring wells to ensure everything is safe, preserved and protected? What additional measures will be taken to ensure the toxic release isn't hurting us all? Many things are already endangered. (Please see links below) With the new land created from the 2018 Lava Flow, there surely needs to be more measures in place to monitor all the new areas.

In Nevada they are finding that there are impacts to native species. That perhaps it is not as safe to all (plants/animals as well), as perhaps previously believed.

Additionally, having ohana all throughout Puna, one thing I hear the most griping about regarding PGV is noise pollution. When visiting ohana in Leilani Estates, you hear obnoxious grinding, churning, and sometimes screeching, all hours of the day and night. Understandably there was one trees and thick growth to muffle the noise pre-eruption, that is now no longer the case and people really seem to be suffering and their day-to-day peace they should find at their homes is being disrupted. *(Heathers Comment)*

Lastly, why is it that Hawaii County pays more per KWH than both Maui and Oahu? When we are generating power right here in our backyards? Not much incentive to have PGV in your backyard potentially harming the environment, when people locally see absolutely no benefit but perhaps a few specialized jobs. How does PGV help us on a local level here in Puna? *(Heathers Comment)*

https://biologicaldiversity.org/w/news/press-releases/legal-agreement-halts-construction-at-nevada-geothermal-project-to-weigh-harm-to-rare-toad-2022-08-01/

https://ecos.fws.gov/ecp/species/6944

https://www.gohawaii.com/trip-planning/travel-tips/responsible-travel/protected-species

https://www.ucsusa.org/resources/environmental-impacts-geothermal-energy

https://keolamagazine.com/malama-mokupuni/oopu-opae-tahitian-prawns/

Mahalo for your time,

Keikialoha Kekipi & Keone Kalawe

Heather Irwin

Comment Letter 24

From: Nick Heinrich
To: Lefebvre, Michele; planning@hawaiicounty.gov
Subject: PGV Expansion
Date: Monday, August 22, 2022 11:20:18 AM

I am in favor of PGV expansion. I believe Geothermal is the best source of electric power generation on the Big Island with its unlimited, very available, thermal energy resource. It is cost effective, possibly the least expensive. It has advantages over the other renewables:
-smaller footprint (vs photovoltaic, windmills, biomass, ocean, hydro)
-zero or minimal emissions
-available 24 hrs. requiring no batteries
-and worst of all, biomass combustion in low efficiency boiler power plants, polluting air and water.

However, concerns with safe operation, location and redundancy must be addressed.

Nick Heinrich
Mechanical Engineer
Puna Resident

Sent from my iPhone

Comment Letter 25

From: Garth Yamanaka
To: Lefebvre, Michele; planning@hawaiicounty.gov
Cc: JCCIH
Subject: PGV EIS Public Scoping
Date: Monday, August 22, 2022 12:39:43 PM
Attachments: JCCIH - PGV 08.22.22.pdf

Aloha,

Attached please find comments for the PGV EIS public scoping.

Please feel free to contact us with any questions.

Mahalo,

Garth Yamanaka
Co-Chair - Government Affairs Committee
JCCIH

--
Garth Yamanaka
Yamanaka Enterprises Inc.
1266 Kamehameha Avenue
Hilo, HI 96720
808-557-6379

Japanese Chamber of Commerce & Industry of Hawaii

Michele Lefebvre
Stantec Consulting Inc.
PO Box 191
Hilo, Hawaii 96721

Subject: Puna Geothermal Venture ("PGV") Repower Project EIS

Dear Ms. Lefebvre:

Thank you for the opportunity to provide comment on the PGV Repower Project Environmental Impact Statement.

The Japanese Chamber of Commerce and Industry of Hawaii (JCCIH) was established in 1951 and represents over 300 members of the business community on Hawai'i Island. The JCCIH continues to be a strong supporter of Puna Geothermal Venture (PGV), including the PGV Repower Project.

Puna Geothermal Venture has been in commercial operation since 1993, providing clean, renewable geothermal energy for Hawaii Island. From an environmental aspect, the amount of power PGV has produced from 1993 to present, has displaced the need to burn more than 141 million gallons of oil. The amount of greenhouse gases avoided would be in the millions of tons. Hawaii's goal is to be 100% renewable energy by the year 2045.

The Repower project would increase energy delivered to Hawaiian Electric from 38 MW to 46 MW. This increase would be accomplished by replacing 12 existing outdated generating units with 3 modern, more efficient generating equipment. There will be no need for increased geothermal resource to reach 46 MW. The reduction in generator units will result in lower noise emissions and reduced potential sources of geothermal fluid emission points. Once the additional 8 MW's comes online, Hawaii Island will be around 70% of renewable energy.

From an economic perspective, PGV will be providing energy that would be priced at more than 75% less of what residential consumers pay in 2022. Since 1991, PGV has provided living wage employment to over thirty full time employees and for hundreds of part time and contract workers. Taxes contributed to the State and County are in the millions of dollars annually.

714 Kanoelehua Avenue • Hilo, Hawaii 96720-4565
P.O. Box 7436 • Hilo, Hawaii 96720-8981
Phone: (808) 934-0177 • Fax: (808) 934-0178 • E-mail: jccih@jccih.org

Japanese Chamber of Commerce & Industry of Hawaii

For these stated reasons and many more, the JCCIH strongly supports the PGV Repower Project.

Sincerely,

Audrey Takamine
Chair - Government Affairs Committee
Japanese Chamber of Commerce & Industry of Hawaii

714 Kanoelehua Avenue • Hilo, Hawaii 96720-4565
P.O. Box 7436 • Hilo, Hawaii 96720-8981
Phone: (808) 934-0177 • Fax: (808) 934-0178 • E-mail: jccih@jccih.org

Comment Letter 26

Mori, Ashley

From: Robert <nimo1767@gmail.com>
Sent: Monday, August 22, 2022 1:44 PM
To: Planning Internet Mail; michele.lefebvre@stantec.com; Michael L. Kaleikini
Subject: Edited comments for the draft PGV EIS

In reviewing my comments I found a number of mistakes in grammar, I apologize as I was rushing to get it in before the deadline and did not have time to edit it. Please find edited for grammar and clarity my supplemental comments submitted here on 8/22/2022.

Aloha! Ms. Surprenant:

My name is Robert Petricci

Notice from 23 July 2022 states that the PGV Repower Project EIS Preparation includes a 30-day public review and comment period. I submit this written testimony and also adopt the position and statements submitted for this EIS by Puna Pono Alliance, Chriss Biltoff, Paul Keikandal, Sara Stiener, and Susan Wakeland as my own, so as not to be redundant.

Written comments for the draft Environmental Impact Statement review as follows are to supplement my oral comments submitted at the public meeting on 8/17/2022. I was cut off by the mediator before I could finish speaking on the record for the Proposed Puna Geothermal Venture Repower Project draft EIS. These comments are meant to empower and educate with no profit incentive on my part. I am not paid nor do I profit from providing the following information and comments. The county and state can not say the same, there is a profit motive for both who receive payments amounting to millions of dollars from geothermal royalties and taxes, PGV also has a profit motivation to make as much money as they can, including cutting corners to save money, your company is also being paid. It is hard to deny large sums of money can influence decisions for projects like this, particularly when situated in one of the poorest communities in the state. Residents do not get paid or have paid staff to do this, why do we do it? There is no profit motive here for us. My motivation for spending so much of my time preparing this to the best of my ability with the scant resources I can muster is to do my best to make sure you have the best, most accurate information available to help you produce a well informed, EIS, that reflects the reality on the ground for me and other area residents. I am not perfect and may make a mistake here or there, feel free to correct anything you consider inaccurate before the next public meeting. The state DOH, and sources ; like Don Thomas are notoriously tainted and biased, if asked I can produce proof that what I am saying is true. They are not going to give you information that would expose some of the terrible things they have done to me and the rest of the area residents over the last 42 years.

.At the end of the Pahoa meeting organized for public input and comments there was still some time left for speakers, I asked the mediator (after waiting to be sure no one else wanted to speak) to allow me to finish my comment because she had stopped me before I was done, she refused. That is not in the spirit of how to encourage or incorporate community input in this EIS, IMO. The venue selected for the 8/17/2022 draft EIS public meeting was woefully insufficient from a community input standpoint. When there was time for more comment, I was not allowed to provide information critical to the EIS in a public setting. I have a lot of experience and knowledge, you do not, did you want to hear it? I say that having run at least 50 public meetings about geothermal. You could have intervened and asked the moderator to let me finish, you chose not to, I believe that was a mistake. I am trying to convey that by not intervening in an easy way that would have allowed me to more fully participate and interact with you, you missed an opportunity.

You might be surprised by some of the things you still have to learn about this project judging by what was in the draft EIS. I think you will find if you read these written comments and the rest of the community comments with an open mind that there is much more to this than the draft EIS takes into account. Is this EIS as the draft suggests just going to be window dressing to try and meet HEPA law or are we going to do a comprehensive EIS that objectively looks at the impacts and risk as well as perceived benefits this power plant expansion will have on the area residents? That is a very real concern of mine after reading the draft EIS, and not being allowed to finish speaking at the public meeting when there was time left. Time will tell, however if history is an indicator it will not be comprehensive or look at things like what happens to one of the most fractured and unstable geologic locations on the planet when you re-inject cooled fluids into extremely heated rocks, voids, and or exsisting fractures. One of the elephants in the room that no one wants to talk about is the volume at which PGV does that, and what happens at the bottom of the pipe roughly 5,000 feet down.

What Mike Kalikini from PGV has told me several times at public meetings over the years is that at 38 megawatts PGV is reinjecting at the rate of approximately 4,000 GPM 24/7 365 days a year. That equates to over 2 billion gallons a year at 38 megawatts. I would like the EIS to tell us over the last 29 years barring the years they were knocked offline and unable to supply power what is the total amount of cold fluids PGV has put into that super heated rock over the life of plant operations. Do you know, does DLNR, DOH, the county, does PGV know?. This EIS must look at what impact that has on the rift zone and geologically around the plant and beyond to have any hope of being seen as legitimate by me and the community. What Mike Kalikini also told me is that when the cooled re-jectate comes in contact with super heated rock it explodes. His exact description was "what happens when you put cold water on a hot imu rock, it explodes". I will never forget that and need a lot more information about the pressure at the bottom of the pipe (not at the top or from the pumps, at the bottom where the weight of the fluids causes great pressure) and what happens when and where it comes in contact with the hot rock. The EIS should be the vehicle to look objectively at that, particularly as the lava from the 2018 eruption that occured around the PGV plant found it's easiest path to the surface right along the PGV boundary. Exactly where was PGV re-injecting, in relation to the boundary where the vents opened? What is the pressure at the bottom of the pipe where it contacts the hot rock and what happens when it does so under the weight of a 5,000 foot column of fluid? Does it cause any type of fracturing? I was told again by Mike Kalikini that PGV tries to re-inject far enough away from the resource not to cause cooling of the resource but close enough that the water can travel back through fractures and be reheated as it moves through the hot rock back to the resource to recharge it. Without that the resource would be used up, without recharging the resource would decline. over time.

Was there a clear statement to the community about having more time to submit written testimony at the public meeting in Pahoa? If not, that was another missed opportunity for community input. If there was a clear announcement I missed it.

I live on Pohoiki road near enough to PGV that if there is an accident I may need to literally run for my health and safety, possibly even my life. I have lived in the area since buying property and building a home in Leilani Estates in 1981, I have extensive first hand personal knowledge and experience of geothermal development in Hawaii having lived through it, including public hearings, litigation, accidents, community protest, community arrest for civil disobedience, legislation, and serving on the Addler health study group for mayor Kanoi. I had 2 Jerome H_2S samplers purchased by the county for the residents in my care. I was the first responder to accidents for the community for decades. People would call me at all hours of the day or night when there were leaks, accidents, or noise problems at the PGV site and I would go to see what was going on. I responded to countless leaks and accidents at PGV. I still have information from the jerome data loggers, in my possession, PGV has paid me damages as a result of injury from exposure to their toxic releases and for being evacuated during emergencies at the plant that made my home unsafe to be in as well.

Moving power great distances like is needed for PGV's centralized generation model is inherently expensive and vulnerable to disruption, will the EIS please address that. Producing power where it is actually needed is far more reliable, sustainable, and affordable, will the EIS reflect those facts?. If the stated goal is to be safe, reduce cost, and be reliable, PGV is greatly handicapped, please explain how moving power great distances reduces cost or boost reliability and what makes PGV so safe with its history that contradicts that claim. To prove that PGV is both safe and reliable as the draft EIS claims, can you name another power plant in the state of Hawaii that has caused numerous emergency evacuations and paid hundreds of people damages for health claims? I know of none, if that is the case, and I believe it is, it could be argued in fact PGV is and has been the most dangerous power plant in Hawaiian history and still is, yet the draft EIS calls the the plant safe and reliable, please explain that..Also please explain how locating the power plant right where lava found its easiest path to the surface in 2018 makes PGV either safe or reliable when it is well known PGV will be subject to geological disruptions that could cause uncontrolled release of known toxins at deadly level and or be destroyed or incapacitated again.

The draft EIS appears to be an exercise in trying to meet the requirements of HEPA laws while not really doing the work necessary to include information and comments from the residents, White washing or biased interpretations are prevalent in the PGV EIS draft document we are being asked to comment on. You will have to excuse me but after participating in the process of geothermal testing and development for the last 42 years, living less than a mile away from Geothermal development since 1981. I was forced from my home in 2004 because my health was deteriorating after years of repeated exposure to H2S and other toxins released by PGV into my home, with no data available to document the exposure levels. I have learned a few things at least from these experiences. I have been a plaintiff in many regulatory and civil litigation actions against both PGV and DOH. Why would I do that? I have tried to regulate PGV in the absence of state or county oversite for self preservation too many times to remember them all. PGV has paid me damages and the Hawaii supreme court has ordered DOH to do rulemaking as a result of some of that litigation I was a party to, because the state DOH simply refuses to follow the law. It is not a new problem with regulation at PGV, it is a historical one. With the extensive history of accidents and litigation making PGV the most contested power plant in state history. On top of the many accidents and evacuations making PGV arguably the most dangerous power plant in the state. Is it time yet to address these issues or is this EIS just going to kick the can down the road again. When does this become a crime? Intentionally trying to end run state laws and regulations for 42 years at some point becomes intentional, is that a crime? Can the EIS address that please? The EIS needs to consider and look at why that is, the residents' actions and complaints have changed many times over the years, it is not the same people over and over although some of us have been here since day one, why have so many different people fought PGV for so long a period? Bruce Anderson, director of the state DOH was quoted in the newspaper as saying we are all just rabidly anti geothermal, that is still the prevailing attitude at DOH. How could the director of the agency charged with protecting our community from PGV believe such nonsense and say that publicly. Are they simply trying to dehumanize us so they can continue to look the other way? Is he saying large segments of the community are simply doing this because we hate geothermal? Why would so many people do that for the past 25 years? We are not worth the same protection because he doesn't like us, and that we want real regulation that is inconvenient for them and PGV? Were we born that way or did PGV so harm us that it is self defense?

This EIS draft so far looks like another example of how to do an end run around real monitoring, emergency response and evacuation planning for residents, or and existing laws and requirements. That includes repeated examples of PGV being allowed to operate with expired permits, and in violation of permits and promises made to use best available control technology (BACT) that were never enforced. This includes operating without an air monitoring system that provides reliable exposure levels to area residents from toxins released by PGV during operation and upset conditions. This is not a new problem, if PGV is not harming the residents with these constant releases why don't they want to collect the data to prove that? Simply put, after 25 years that has to be by design, if I wanted to prove I was not hurting people by releasing known dangerous levels of toxins I would want to have the data to prove it. They do not want that data, nor does the state DOH or DLNR, why not? With the long standing concerted effort to find ways around state and county permitting and laws for decades it begs the question: "do the meetings or communication between PGV and regulators to figure out how to operate outside the norms of permitting and governing laws rise to the level of subverting the process or even conspiring to do so behind closed doors"? I would like the EIS to explore the interaction between regulators and PGV, and the resulting decisions that have allowed PGV such latitude. How regulators actions and inactions to this day have resulted in no usable data to establish exposure levels to residents after 42 years of health complaints from the community. How is it possible that after all these accidents, protests, arrests, PGV settled damages for resident harm litigation, it is not like they do not understand the problem the lack of good data causes? At this point can the EIS determine if it is incompetence, collusion, or intentional means to prevent the collection of usable data through source monitoring and computer modeling. Can the EIS answer why PGV is allowed to use 1980 air sampling stations in the 21rst century if not to avoid collecting real data on what exposure levels in the community are?.Further at this point do the actions of regulators and PGV rise to the level of a conspiracy to do such, if not why not.. If that is truly the case does that rise to the level of a criminal offense? Please answer that question and how it is possible to operate for decades like this if it is not by design or collusion of regulators and PGV. Is it possible the state and county are influenced or motivated by the millions of dollars in royalties PGV pays (but only when operating) more so than the laws governing the process or are they simple incompetant to protect the public health, wellbeing, and good? While some might not take these comments seriously I can assure I and other residents do. Please do the work necessary to adequately address the issues I have raised. There was testimony about money PGV has given to community projects which is commendable and appreciated, however I have to wonder if that money would have been better spent on a real system to collect exposure levels in the same community?

On another note, PGV's prominence at the Pahoa "public" meeting gave the appearance of them being in control of what was happening.

page 1-1 of the EIS......States....."although there was no statutory trigger, an Environmental Impact Statement (EIS) for the now operating power plant was voluntarily prepared by PGV".....

That statement is simply not true, as anyone reading the PUC record knows. Again calling into question the legitimacy and reliability of this draft EIS document we are commenting on here, IMO. HEPA laws require PGV to do an EIS as per the PUC record, this is not voluntary. The company that prepared the document was paid by who? That and the statement that PGV is safe and reliable come right out of PGV handouts, but the facts say it is not the true. It is disturbing and disheartening to see that in a so-called unbiased draft EIS. Can you explain how that was put into the draft, where exactly did that information come from?

I disagree with the author's conclusion that this EIS is not required by law. State land use (the geothermal resource) clearly triggers HEPA requirements as pointed out publicly many times. This EIS is not voluntary, it is required. There are multiple false or misleading statements in this document that need to be corrected if this EIS hopes to have any legitimacy whatsoever. No new EIS was done or NCSP permit issued (the old permit had expired) even after the major changes since the 2018 eruption that closed the plant for years, not exactly reliable. The state owned geothermal resources used by PGV is now much hotter and includes changes both underground and in the ground elevations around the PGV plant and well field caused by the 2018 eruption, that triggers the HEPA requirement.

The facts clearly show PGV has been largely self regulating since it began drilling operations. DOH's finding that no further environmental review was required for this expansion and new equipment is just another example of that regulatory bias and failure to perform its responsibility to protect the public health. Instead of calling us names like "rabidly anti geothermal" to somehow justify their bias, DOH needs to be shaken up and start doing their jobs for once. Hawaii DOH, DLNR, and the county have long allowed PGV to operate in a manner that is dangerous to the surrounding community, and has caused harm, that is why people here object to PGV. This goes back to the beginning when PGV first started drilling wells. The county GRP permit issued over massive testimony by the community against granting the permit.51 conditions were then negotiated with the community. Those conditions were supposed to address the concerns raised by the community. PGV was "required' by the permit to use best available control technology (BACT). The conditions "required" PGV to use BACT, there was no ambiguity there, BACT is required period. DOH, DLNR, and the county never enforced this or other conditions such as a viable emergency response plan for the community. Instead allowing PGV to open vent wells to the detriment of the health, safety, well being, and enjoyment and use of their property by the residents as documented in the county's Adler report. Without any way to document actual levels the community was exposed to, that was over 20 years ago. DOH, DLNR, and the county allowed this with no way to track the levels or impacts of the toxic gasses being released unabated into our community. I have a problem with that and this EIS needs to address the lack of oversight and permit compliance.

The three PGV air samplers and the 1 DOH air samplers are another example of PGV not using BACT, it is old and useless technology not a "monitoring" system. Tere has never been any usable data generated by these air samplers to determine the level of exposure residents have been subjected to. Chris Biltoff, an expert on such systems has pointed this out to the state and county regulatory agencies as have others repeatedly to no avail. They do not want to know because then they would have to address it. The county and state regulators refuse to update the wholly inadequate samplers that only register levels of gas that happen to hit them, and only if they do not fail as happened during Issell. PGV and DOH as well as the county had not installed a backup power source as we saw when the samplers were knocked offline during the disaster of Tropical Storm Issell. Issell trapped the community, there was no escape for residents as PGV was out of control and vented dangerous levels of H2S that were not recorded even by the inadequate samplers. PGV almost lost control of the power plant that evening when their back up generator for the plant failed while people were trapped and could not escape. Over a hundred residents filed for damages which PGV paid, some people were knocked unconscious by the gasses. There is no reliable data to document the exposure levels in the community because for all intents and purposes there is no monitoring system, how will the EIS fix that?

The samplers have been shown in court cases not to provide the data needed to establish exposure levels]in the surrounding community. Is that BACT?I would like a specific answer to why it is or is not BACT. Please explain in detail why there is no workable, tested emergency response plan for area residents from Civil Defense or DOH even as the roads are blocked by lava. PGV is being allowed to continue to put us at risk using expired permits (one expired 8 years ago) and no emergency response plan to get the community out when, not if the next major accident occurs. During litigation on several occasions after accidents and releases this was shown to be the case and has allowed PGV to dodge responsibility for hurting people because of a lack of data to show what the levels are during accidents and upsets. This has to be intentional after 25 years of this, it is not like PGV and the regulators do not know that, is it a criminal conspiracy? I think it needs to be investigated to see how this is even possible.

How could no viable data on exposure levels in the community possibly be BACT? PGV only started using BACT during well clean outs after I was arrested for simple trespass trying to stop the illegal, dangerous, and harmful release of unabated toxins and pollutants during well cleanouts. I was acquitted of the simple trespass at PGV under a lesser of evils defense. Circuit court judge Rikki May Amano found me not guilty of breaking the law because it was a lesser evil than to allow PGV to violate the permit and poison the community than it was to break the law to try and stop them. That was the last time PGV open vented a well clean out, not because of DOH, DLNR, or the county but because a resident was forced to be the regulatory agency for the permit conditions. That is not good regulatory oversight when a resident has to be arrested to enforce what the permit requires. After that PGV started using a cyclonic separator and abatement during well clean out that was actually BACT at the time, but much more costly. Was PGV even punished for that blatant permit violation that hurt so many residents, was regulation improved? Were the regulators incompatant or in collusion to save PGV money at the expense of community health and well being? That is a fair question that needs to be answered, It is time to find out. These and other ongoing permit violations show there was and is no real oversite or enforcement of PGV permits, making PGV self regulating. Nothing has changed with DOH and DLNR continuing to allow PGV to operate for years on expired permits, dodge EIS laws and operate without real monitoring even after they were shown by experts that the sampling stations are not BACT monitoring and that without actual source monitoring and computer modeling there is no way to accurately collect the data needed to determine exposure levels to nearby residents. The list of examples of regulatory malfeasance and failure is long, documented, and irrefutable.

Further, PGV noted "repowering of the Facility will be the subject of further environmental review" but notes that "any change to the Facility
could arguably jeopardize PGV's permit shield, pursuant to which the terms and conditions of the 2009 NSP ... 'shall remain in effect and
not expire until the application for renewal has been approved or denied'" – acknowledging that if PGV admits the facility is in need of
improvements in the pending permit renewal application, that could jeopardize its ability to continue to operate while agency matters are pending.
How is that not a conspiracy? How much more outrageous and for lack of another valid reason, corrupt can the regulators be in their failure to perform to protect the public good? When added to the totality of the history of allowing PGV to avoid the law and permit requirements? Has this risen to the level of a criminal conspiracy, to help PGV while throwing the community
under the bus by the state and county agencies charged with regulating them, if not how is this possible after decades of problems???

Further, allowing PGV to operate on an expired NCSP permits for 8 years even after major changes to the equipment, the resource, and the new typography is not pono., it seems corrupt.

PGV and DOH publicly saying after the new permit is granted based on the 2014 application (before the geologic and equipment changes) PGV submitted for renewal of the NCSP, they would then immediately revise or supplement the permit to show the changes, is not a fair process, how is that even legal? It is clear this is an end run around what the law requires or should require for a dangerous industrial project being built and operated in a pre-existing residential community. Why even have a public hearing if you just do what you want without regard to the reality of the project, then amend it? Isn't that a conspiracy to end run the permit process? It does not protect the health and safety of residents, it protects PGV at our expense, exposing the collusion of regulators and PGV, IMO. This shows again the failure of DOH, DLNR, and the county to perform reasonable regulatory oversight to protect the community. Instead the regulators are protecting PGV at the harm and detriment to me and the other residents hurt by their failure to perform their responsibility to protect the health, well being, and safety of area residents in a reasonable and professional unbiased way..

The contested case debacle underway now for the DOH NCSP has dragged on for 8 years while PGV has been allowed to continue to operate in a dangerous manner. Another example of how the whole process has been regulated since the beginning. Having participated for the full 8 years it is my observation that DOH and hearing officer Steven Jacobson appear for all intents and purposes intentionally using the process to allow PGV to operate on a permit that no longer is even relevant to the "new" PGV operating conditions and equipment, to protect PGV's permit shield. While at the same time putting the burden to keep going on the residents, even to the point of trying to cut people out or wear them down, how is that a reasonable, legal, regulatory process to protect the health and well being of area residents? If community members, PGV employees, or first responders are killed or injured as a result of these failures to perform reasonable regulatory responsibility, who is responsible? Who is liable, at this point they can not say they did not know what they were doing or what was happening? PGV has settled hundreds of lawsuits for damages, yet from a community standpoint nothing has changed. We do not even have a community evacuation plan, another permit requirement the county simply ignores even after a long list of emergencies and accidents including Tropical Storm Issell and the KS-8 31 hour blowout at PGV in 1991.

I am very familiar with the history of geothermal in Hawaii, having lived near the projects since before they began in 1981. As such I was asked to be a
member of the county Adler group that examined the history and impacts of geothermal on the community. We filed our reported findings on
September 9, 2013. Many of the things we found serve as the basis for and support my comments here.

Here is an excerpt from the county's Adler geothermal working group....."Events during the HGP-A era and during the 1991 blowout provided exposures associated with adverse health effects. This knowledge, along with other information contained in this report ... has led the Study Group to conclude there is evidence that there were health effects from the exposures during the development of
geothermal before 1993. (we do not have the data to show the effects because there isn't any real monitoring data, that is still the case today).The full extent and severity of those effects has not been documented. ...Risks from geothermal energy production in Lower Puna exist.The actual extent and impacts of those risks remains unresolved. What is known is that hazardous chemicals are brought up by PGV. PGV adds industrial chemicals to the mix in the process and then sends the composite fluid back down. However, fluids inevitably escape to air, water, or at surface level. Harmful effects can only be understood through better monitoring and reliable health data."

The 1987 EIS completely ignored the true horror of HGP-A and negative impacts to the community, or the impact of reinjection on the rift zone. To this day nothing has changed because of the ongoing regulatory failures to perform basic responsibilities to protect the public good, PGV was and is for all intents and purposes still self regulating. As my comments, the record, and history clearly show.

I would like to state for the record that the County of Hawaii is not an alternative accepting agency for this EIS because it admittedly has no HEPA jurisdiction. The county and state appear to be more worried about collecting their royalty checks from PGV than following the law or protecting my community. They have never enforced the conditions in PGV's GRP permit or reasonable regulatory oversight.

Robert Petricci

Comment Letter 27

From:	Donald Thomas
To:	Lefebvre, Michele; planning@hawaiicounty.gov
Subject:	Comment Letter regarding Puna Geothermal Venture EIS preparation notice
Date:	Monday, August 22, 2022 3:17:30 PM
Attachments:	EIS Letter.pdf

To whom it may concern:

please find attached a letter in support of the PGV Repower Project.

Best regards

Donald Thomas

--
Hawaii Institute of Geophysics and Planetology
Center for the Study of Active Volcanoes
Office: 808 932 7554
Cell: 808 895 6547

Donald M. Thomas
19-4741 Ama'uma'u Rd.
PO Box 865
Volcano, HI 96785

August 22, 2022

To Whom It May Concern:

I am submitting this letter in support of the Puna Geothermal Venture Repower Project.

I am a several-decade resident of Hawaii Island; I am a member of the University of Hawaii faculty as a researcher and currently hold the title of Director for the Center for the Study of Active Volcanoes. Beginning in 1973, my research focus has been on Hawaii's volcanic, geothermal, and groundwater processes. I did extensive research on the Kilauea East Rift Zone hydrology and geochemistry and led research on the geothermal fluid chemistry of the Lower Puna geothermal system and assisted in the management of the process chemistry of the State-managed HGP-A Geothermal Generator. My research expanded to a more general investigation of groundwater hydrogeology of Hawaii and I am currently conducting an investigation of the hydrogeology of the Red Hill region of Oahu in collaboration with staff of the Hawaii Department of Health in response to the recent fuel releases occurring there. I am also assisting the staff of the Hawaii Commission on Water Resources Management in assessing groundwater resources and flow in the Keauhou, Kiholo, Anaehoomalu, and Waimea aquifer sectors and have provided support to the Hawaii County Department of Water Supply in their efforts to develop new groundwater resources in the Keauhou aquifer. Due to my frequent (pro bono) interactions with State and County agencies, I do not perform private sector consulting and have not done so for the last ~30 years; hence, I have no current or future financial interest in Puna Geothermal Venture's proposed Repower Project.

My support for the Repower Project, and for further development of geothermal power in Hawaii, is based on my belief that geothermal power production is an established and proven technology that has been successfully implemented world-wide. It has generally proven itself as a more cost-effective, and environmentally benign, technology than power generation from fossil fuels. As implemented at Puna, it has negligible emissions of carbon dioxide, no emission of nitrogen oxides, or sulfur dioxide – all products of fossil fuel power generation – of which our major sources are located in the island's major population centers of Hilo and Kona. Although there are some emissions of hydrogen sulfide, the release rate of that gas is also trivial when compared to the nitrogen and sulfur oxides of our current oil-fired generation.

In my opinion geothermal is superior to solar and wind power – the former is available 24/7 and is dispatchable, whereas solar and wind power, as currently implemented, are intermittent, have very limited reserve capacity, and are both subject to catastrophic losses due to severe weather events which, with only a casual review of current media, appear to becoming much more frequent than in the past. Without a significant, reliable, generation capacity available, a severe weather event that destroys a substantial fraction of solar and wind capacity will cripple both our economy as well as delay and substantially prolong recovery efforts by months to years.

With respect to the many claims of adverse effects that have been made against Puna Geothermal Venture's operations, similar claims about geothermal operations have been made for decades but, on investigation, the most serious claims have been found to be groundless. Claims that the operation was adversely affection groundwater chemistry of Lower Puna were investigated by the USGS who found that there was no evidence of geothermal fluids in either existing test well or in coastal springs. I can further confirm that finding since I collected groundwater samples in Lower Puna in 1975, before the first geothermal well was drilled in Hawaii. The water chemistry reported by the USGS for the same wells that I sampled nearly fifty years ago were not materially different from that found in the 1975 samples collected. At that time (1975) several wells had been drilled in the region and all the wells located within the geologic trace of the rift showed both chemical and thermal evidence of natural discharge of geothermal fluids into the shallow groundwater system. Those early test wells were drilled in an effort to develop both irrigation and drinking water sources – due to their chemical compositions (in 1975) none were deemed acceptable as irrigation or drinking water sources.

The claims of health effects from the geothermal emissions are, I believe, equally groundless. I reference two important epidemiological studies conducted on the effects of exposure to hydrogen sulfide in the ambient air:
Investigation of Hydrogen Sulfide Exposure and Lung Function, Asthma and Chronic Obstructive Pulmonary Disease in a Geothermal Area of New Zealand, by Michael N. Bates[1]*, Julian Crane[2], John R. Balmes[1], Nick Garrett[3] ([1] School of Public Health, University of California, Berkeley, California, United States of America, [2] School of Medicine and Health Sciences, University of Otago, Wellington, New Zealand, [3] Faculty of Health, Auckland University of Technology, Auckland, New Zealand), PLoS ONE 10(3): e0122062. doi:10.1371/journal.pone.0122062.
Chronic Ambient Hydrogen Sulfide Exposure and Cognitive Function, by Bruce R. Reed[a,b], Julian Crane[c], Nick Garrett[d], David L. Woods[a,e], and Michael N. Bates[f,*] ([a]Department of Neurology, University of California, Davis, USA, [b]Alzheimer's Disease Center, Veterans' Administration Northern California Health Care System, Martinez, CA, USA, [c]School of Medicine and Health Sciences, University of Otago, Wellington, New Zealand, [d]Faculty of Health, Auckland University of Technology, New Zealand, [e]Human Cognitive Neurophysiology Laboratory, Veterans' Administration Northern California Health Care System, Martinez, CA, U.S.A, [f]School of Public Health, University of California, Berkeley, CA, U.S.A., Neurotoxicol Teratol. 2014 ; 42: 68–76. doi:10.1016/j.ntt.2014.02.002.

Both studies investigated the potential adverse health effects arising from exposure to ambient air Hydrogen Sulfide for residents in the city of Rotorua, New Zealand. These were large studies, with more than 1500 participants, who experienced exposure to varying levels of H_2S for durations of, for some participants, decades, and tested for potential pulmonary as well as neurological impacts associated with that exposure. Very briefly, the results of those studies showed that there were no detectable impacts – neither neurological nor pulmonary – on the residents at the highest average aggregate exposures when compared to a control group having near-zero exposure to hydrogen sulfide. (In fact, the studies found evidence of better pulmonary health status of those in the higher exposure group that the authors speculated may have been associated with the therapeutic effects of hydrogen sulfide on those individuals who have reactive airway syndrome). To further investigate the relevance of the findings of these studies to Puna, I made a request to Puna Geothermal Venture to provide me with their fence-line H_2S monitoring data; they provided me with hourly H_2S averages that spanned approximately ten years of monitoring. In order to assess the average H_2S readings in Puna in an equivalent way to those used in the New Zealand studies, I re-computed the average exposures that would have occurred at the power plan fence-line monitoring stations using the same averaging times that were used in the New Zealand studies. When I compared the fence-line averages to those in the highest exposure areas of Rotorua, I found that the <u>maximum</u> average fence-line values reported (e.g. during periods of steam venting) were approximately 1% of the averages in the high-exposure areas that were routinely documented in the Rotorua study; at all other times, the average fence-line values were substantially below the Rotorua high-exposure values. Given that: residents of the Puna district live thousands of feet to several miles from the PGV fence-lines; and that the PGV data showed fenceline H_2S levels were highly dependent on wind direction which was quite variable, any individual in the surrounding communities would experience an actual long-term exposure to ambient air H_2S far below those occurring for the Rotorua residents who experienced no epidemiologically detectable adverse health impacts. (I would note that a similar study was proposed by Dr. Bates, the lead author on one of the above papers, and funding was initially made available to conduct the study; however, at that time, newly-elected Mayor Kim, who had opposed geothermal development from the outset, elected to cancel the contract before it was finalized and, hence, no formal investigation of alleged health impacts on the residents of Lower Puna has been performed).

Recently, more creative allegations of harm have been made that claim that actions by Puna Geothermal Venture before and during the onset of the lower Puna eruption, in some way, affected the course of the eruption and the locations of some of the more productive vents. Those claims were investigated by the scientific staff of the Hawaiian Volcano Observatory and were found to be without geologic merit. I would further offer that these claims are based on an extremely naïve understanding of the basic physics (and chemistry) of rock fracture and a complete absence of understanding of the pressure-temperature-volume relationships of water at elevated temperatures and pressures. Whereas the volume change of water to steam at 100°C and atmospheric pressure is an increase by >1600 times in volume, the same change in a deep borehole at a hydrostatic pressure of ~3000 psi, brings a volume change of only ~2.5; hardly the explosive reaction alleged by some in the community.

In summary, many allegations have been made that further expansion of current geothermal power production will bring great harm to Lower Puna and Hawaii in general. When critically examined, these claims can be shown to have little basis in reality or merit. Further, those making these claims ignore: the many economic benefits that can be derived from locally produced power; the greater security that baseload dispatchable power offers over intermittent and extreme-weather-vulnerable renewable alternatives; the immediate impacts on air quality that are imposed on Hawaii Island's communities that arise from combustion of fossil fuels for current power generation; and the long term impacts on our global climate that continued increases in atmospheric carbon dioxide that use of fossil fuels for power generation will produce. Hence, the benefits of expansion of geothermal power production to the local and global community greatly exceed the few minor adverse impacts of that increase.

Thank you for this opportunity to comment on the EIS preparation by Puna Geothermal Venture.

With best regards,

Donald Thomas

Donald Thomas

Comment Letter 28

From:	Malama O Puna
To:	Lefebvre, Michele; Planning@hawaiicounty.gov
Subject:	Re: Public Comment on the PGV EIS
Date:	Monday, August 22, 2022 4:24:55 PM
Attachments:	PGV EIS public comment".pdf

Aloha,
Please find attached the comments from Malama O Puna regarding the PGV EIS.
Mahalo,
Eileen O'Hara, Executive Director

MALAMA O PUNA
P.O Box 1467
Pahoa, Hawaiʻi 96778
(808) 965-2000
www.malamaopuna.org * malamaopuna@yahoo.com

Protecting Hawaiʻi's precious natural heritage

August 22, 2022

TO: Michele Lefebvre
Stantec Consulting Inc.
michele.lefebvre@stantec.com

County of Hawaii Planning Department
planning@hawaiicounty.gov

RE: Public Comment Regarding PGV's EIS

Aloha,

In Malama O Punaʻs opinion the lava flow was a perfect time to shut down PGV permanently. Other much less polluting and truly renewable energy systems currently exist at Natural Energy Laboratory of Hawaiiʻs Ocean Thermal Energy Conversion (OTEC) and through island wide wind turbines and solar. These are currently putting out, and have the potential to put out much more power than PGV, with no risk to communities.

PGV has often not been a good neighbor. Blowouts of H_2S, not shutting down during the 2014 approach of Hurricane Iselle causing a huge blowout and harming many nearby residents some of whom found themselves knocked unconscious, and by having an insufficient monitoring and public notification system which is soley administered by PGV and has not resulted in timely, clearly worded warning to people living with the 3-mile radius of the plant.

We have always been of the opinion that placing a geothermal plant so close to neighboring communities was a bad idea to begin with and for the people living around PGV this has proven to be the case. Now, after the lava flow, the situation has worsened. There is nothing between the plant and the neighboring communities allowing gasses to travel faster and noise pollution to be much greater. The communities around PGV have a much larger population than they did when PGV was first built so the risk of harm has increased.

At the very least, we request that an independently operated (third-party) notification system be implemented with the ability to provide real time and immediate information to the public in the event of any action by PGV that could cause potential harm to residents. Further, there needs to be an expansion of water and air monitoring sites, not just within the PGV leased property, but within a 1-mile radius of the plant. Reporting of those monitors should be provided to the public in a weekly announcement emailed to residents within the 3-mile radius of the plant and available through daily updates to their website.

We thank you for the opportunity to provide public comments on this draft EIS.

Mahalo,

Eileen O'Hara

Eileen O’Hara, Ph.D.
Executive Director

Comment Letter 29

From: Sara Steiner
To: Lefebvre, Michele
Subject: Fwd: Steiner-Wood Comments on PGV EISPN
Date: Monday, August 22, 2022 7:46:58 PM
Attachments: COMMENTS ON PUNA GEOTHERMAL VENTURE EIS-3.pdf

---------- Forwarded message ---------
From: **Sara Steiner** <pahoatoday@gmail.com>
Date: Mon, Aug 22, 2022 at 6:54 PM
Subject: Steiner-Wood Comments on PGV EISPN
To: Planning Internet Mail <planning@hawaiicounty.gov>, Michael Kaleikini <Mkaleikini@ormat.com>, <michele.lefebvre@santec.com>

Dear Ms. Lefebvre, Ms. Suprenant and Mr. Kaleikini:

Please find attached our comments and exhibits. The Exhibits will be sent separately because they are too big to send together in one email.

Sara Steiner
Larry Wood

Sara Steiner pahoatoday@gmail.com
Larry Wood leoredwood222@gmail.com

August 22, 2022

County of Hawai`i Planning Department
Attn April Surprenant
101 Pauahi Street, Suite 3
Hilo, HI 96720
via email planning@hawaiicounty.gov

Puna Geothermal Venture
c/o Mike Kaleikini
P.O. Box 30
Pahoa, HI 96778
via email mkaleikini@ormat.com

Stantec Consulting Services Inc.
c/o Michele Lefebvre
P.O. Box 191
Hilo, HI 96721
via email michele.lefebvre@santec.com

Re: Puna Geothermal Venture Repower Project
Environmental Impact Statement Preparation Notice

COMMENTS ON PGV EISPN

Pg. 2 "Discretionary Consent Required" *I OBJECT* THAT THE COUNTY OF HAWAII IS THE APPROVING AUTHORITY FOR THE EIS WHEN THE "DISCRETIONARY CONSENT REQUIRED" IS FROM THE STATE OF HAWAII DEPARTMENTS OF CLEAN AIR AND CLEAN WATER BRANCHES - MEANING GOVERNOR IGE and/or THE STATE OF HAWAII IS ACTUALLY THE APPROVING AUTHORITY PURSUANT TO HAR 11-200.1-7(d) (1-5) which indicates the State is the Approving Authority because the State has the most discretionary authority due to PGV's outstanding Air Pollution permit (NSP N0. 08-002-N expired in 2014) and (UH-1529) Underground Injection Wells permits (expired 2020), the State of Hawaii has the most agencies involved and spends the most money on PGV's

Pg 3 - states PGV is currently authorized for and operating a geothermal plant in the Puna District... PGV Is Only Authorized To Have 14 Wells According To Their Expired Air Pollution And Underground Injection Well Permits. They Have Already Drilled And Are Operating Since 2020 and wells KS-16, 17, 18, 19 And 20 without either Department Of Health Permits.

Pg 9 - a) Is it BLNR or DLNR? - Hawaii has a Department of Land and Natural Resources that issues discretionary environmental impact permits to PGV.

b) Is "CDA" Hawaii County Civil Defense Agency or the State of Hawaii Civil Dense Agency?

c) <u>WHAT IS THE HAWAII EMERGENCY RESPONSE COMMISSION?</u> I don't see the "**ERC"** listed on the page 42 list of government agencies notified of this EISPN, and *I reviewed the last 4 years of annual reports of the ERC to the Hawaii Legislature with no mention of Puna Geothermal Venture Emergency Response Plan except for in 2019: a 1 paragraph statement and a photo about fissures opening and PGV removing 55,000 gallons of pentane during the 2018 eruption and a mention of lava covering homes.*

d) According to a July 2022 UIPA request, the Hawaii County Civil Defense Agency (responsible for notifying and evacuating residents surrounding PGV in case of emergency) is operating off of their old <u>2016 Emergency Response Plan</u> for evacuating residents in case of lava flow or hydrogen sulfide emergency, and the 2016 ERP shows the evacuation routes as the same before the 2018 eruption. Hawaii County Civil Defense also stated it is not aware of the location of the 3 Department of Health perimeter hydrogen sulfide monitors are located in July 2022, and they have no knowledge of when PGV's ERP was presented to the public for inspection or approval, *and* the Civil Defense and/or Hawaii Fire Department Hazmat team that is supposed to respond and protect the residents is located an hour away, in downtown Hilo. *The State and County of Hawaii do not have an effective ERP to timely respond to a H2S leak, much less verify the amount of the leak, so this new EIS needs to have an effective immediate emergency response plan to notify the surrounding residents, and not just in their imaginary 3500' radius–1.* The UIPA answer can be found at: https://uipa.org/request/puna-geothermal-venture-emergency-response-plan/#-

*<u>**e) Hydrogen Sulfide Kills In Seconds Or Minutes,** It Doesn't Recognize **Imaginary 3500'** Borders Or Hang Around For Hours Waiting For Government Officals To Show Up With Fancy Suits And Air Monitors.</u>*

PG 11 - a) <u>I want this EIS to clarify on pg 9 when you talk about the 2012 "expansion" of PGV.</u> You need to disclose it was paid for with a grant fraudulently obtained from the US Federal Government for an upgrade to Ormat's Nevada Brawley geothermal plant and Puna Geothermal Venture. The grant was made via the American Recovery and Reinvestment act of 2009**.** The suit was brought by two Ormat employees in Nevada in charge of the grant application who complained about falsified application information including dates and descriptions of the plant operations and wells. Approximately 10% of the $136.8 million awarded was allotted to PGV ($13,821,143.00 cash grant). This grant was earmarked to help pay for the cost of drilling KS-14 and the plant expansion when none of it was eligible for a grant. Ormat made an out-of-court settlement in 2016, but only 4% of the taxpayers money pilfered was returned. They fraudulently received $136,800,000 from the American taxpayers (supposed to be used for new electric plants not for both of Ormat's old already existing plants) but only paid back $5.5 million. *See* <u>US v Ormat Industries;</u> April 2016 attached to Exhibits.

Pg 11 - a) Paragraph 1 says PGV is currently "authorized for and operating" a geothermal plant on Hawaii Island. <u>SANTEC CONSULTING SERVICE IS HEREBY NOTIFIED THAT PGV IS OPERATING IN 2022 *WITHOUT* ACTIVE DEPARTMENT OF HEALTH AIR POLLUTION PERMIT OR CLEAN WATER BRANCH UNDERGROUND INJECTION WELL PERMIT.</u> THIS EIS NEEDS TO

CLEARLY STATE THAT PGV IS OPERATING WITH EXPIRED AIR POLLUTION PERMIT (2014) and EXPIRED UNDERGROUND INJECTION CONTROL PERMIT (2020). We, the people, have been waiting 7 years already (since 2015) for a contested case on the Air Pollution permit and I just found out 2 weeks ago that PGV's Underground Injection Permit expired in March of 2020 . **THERE SHOULD BE A PART IN THE EIS WHICH TALKS ABOUT ALL THE MISSING PERMITS, FINES, VIOLATIONS AND LAWSUITS PGV HAS HAD OVER THE YEARS. PGV IS NOT A GOOD NEIGHBOR AND THE RESIDENTS HAVE SUFFERED FOR YEARS.**

b) 1.0 Why this EIS is Being Prepared. This EIS is also being prepared because the old EIS expires in 2022... and that EIS's are supposed to follow HRS 343. PGV's first version of their ARPPA submitted to the PUC claimed 2 new OEC's would replace the 12 old ones as the resource had changed to mostly steam, then the ARPPA was amended in 2020 or 21 to need 3 OECs and were are told the resource has changed again back to liquids and now the total number of new OEC's is 4.

c) PGV's stale 1987 EIS spent plenty of money telling us which way the wind blows the toxic Hydrogen Sulfide through the community, the noise flows (make sure this EIS discloses the fact that PGV got the 40db noise limit upped to their benefit to 70dbs) and the viewing impacts - but not one penny was spent on making any graphs, maps or charts which show how 60k+ gallons of pentane would blow up and how 35 years of geothermal wells injecting 6-10.8 million gallons a day of acidic effluent with added chemicals to prevent scale and silica buildup fracture the ground and how those fractures propagate and also how PGV is going to mitigate (prevent) this **(HINT - IMPOSSIBLE!).**

This EIS will need to show the cumulative effects of the underground fracturing of PGV's wells on the enviornment 4000-8000 or more feet underground, wells drilled sideways (and all kinds of crazy ways - see attached as an exhibit, Damage and Repair of KS-14 (2020) with multiple re-drills and spuds and perforated pipes and they don't even know which way they are drilling, and also attached as an exhibit is 5 Pages from PGV's 2020 EPA application which show the fractures PGV creates and a side view of their enhanced engineered geothermal plant ...

c) FYI - I sued the DOH Clean Air Branch and PGV when they determined (without consulting any outside authorities) that didn't require PGV to perform an EIS. The case got to the Intermediate Court and was dismissed BECAUSE AFTER 7 YEARS THE STATE OF HAWAII NEVER GOT THEIR ACT TOGETHER TO HOLD THE CONTESTED CASE AND THE COURT WAS GIVING PREFERENCE TO THE BAD FAITH GOVERNMENT AND PGV. **This EIS should disclose all lawsuits filed against the State /County and PGV and should also disclose how long normal DOH contested cases should take to be held, for example, the DOH just held a contested case in 2022 *against the US Military* over the Red Hill water polluting *within 2 months of stating their intention*.** *THIS EIS NEEDS TO DISCLOSE THAT AFTER 7 YEARS THE HAWAII DEPARTMENT OF HEALTH'S CLEAR INTENTION AND ACTION IS TO NEVER HOLD A CONTESTED CASE HEARING WHERE THE PEOPLE GET TO HAVE THEIR SAY HEARD BY GOVERNMENT OFFICIALS.*
b) Paragraph 3, PGV's "voluntarily provided" 1987 EIS did not discuss the cumulative impacts of multiple injection wells thousands of feet underground on an unstable active volcanic rift

zone, including the effects of the added chemicals to prevent silica and corrosion and biofouling. PGV's 1987 EIS said injection wells can cause M4.0 earthquakes and that was depth of discussion. I am providing to Santec Consulting copies of the 2018 United States Bureau of Land Management's protocol where to locate injection wells (**OR IN PLAIN ENGLISH - HOW TO SAY "NO" WHEN IT ISN'T SAFE TO PUT GEOTHERMAL WELLS IN THE MIDDLE OF AN ACTIVE VOLCANIC RIFT ZONE)** . I have also included the Induced Seismicity Monitoring Plan for the Newberry Geothermal Plant in California so that Santec can see the true depth of discussion on geothermal induced seismicity that needs to be included in the EIS, including PGV's plans for seismic monitoring and how the public will access that information REALTIME since we do not and cannot trust PGV to provide accurate information on anything. WHERE IS THE BACKGROUND SEISMIC STUDY AND WHERE IS THE SEISMIC MONITORING AND "MITIGATION" PROGRAM FOR PGV? **The EISPN document does not contain the words "cumulative" or "induced seismicity" or "seismic monitoring" ONE (1) TIME - just the same as the 1987 EIS. WE NEED TO MOVE INTO THE NEW CENTURY USING NEW TECHNOLOGY - THIS EIS NEEDS TO SHOW THE FRACTURES PGV MAKES WHILE OPERATING AND HOW WE ARE GOING TO MONITOR THE UNDERGROUND CONDITONS AND HOW PGV IS GOING TO MITIGATE THEM!** Enhanced Geothermal is illegal in the County of Hawaii. PGV looks and acts like an enhanced geothermal plant AND THAT IS ILLEGAL.

c) 1.2 Proposed Action - states that PGV will use the same amount of resource. That is not true, the new OEC's will pump up to 10.8 million gallons of fluid a day, versus 6 million gallons a day in 2018. THAT IS AN 80% INCREASE OF RESOURCE AND A 80% INCREASE OF MICRO-EARTHQUAKES ON OUR UNSTABLE VOLCANO!

Pg. 12 - a) The State of Hawaii needs to be the accepting authority according to HAR 11-23-7. PGV has 2 outstanding permit applications at the State of Hawaii Department of Health that need to be accepted by the State of Hawaii, AIR POLLUTION AND UNDERGROUND INJECTION. The County can be the accepting authority but the State/ Governor SUPPOSEDLY has the "expertise and authority" to **approve** those permits. The county merely is issuing grubbing and grading permits. **Our lives are at stake here and the State of Hawaii is foisting the approval of this EIS on the County which goes in opposition to HAR 11-23.** The EIS needs to clarify that it should be the State as the Approving Authority. THE State "Office of Environmental Control or Planning (or whoever is now in charge of EISs) is operating in Bad Faith and is trying to make the County liable for approving our safety when THE STATE HAS TAKEN ALL REGULATORY AUTHORITY AWAY FROM THE COUNTIES RELATING TO GEOTHERMAL YEARS AGO SO THEY CAN SHOVE IT DOWN OUR THROATS FROM THE SAFETY OF OAHU.

b) This EISPN claims there is no County or State money involved in running PGV. I tell you that is grossly incorrect. THE STATE AND COUNTY HAVE HAD TO RESPOND TO ANY AND ALL EMERGENCIES AT PGV SINCE THEIR INCEPTION AND THE STATE HAD TO DECLARE A STATE OF EMERGENCY AND PAY FOR ALL OF PGV'S EMERGENCY EQUIPMENT IN 2018: WATERPUMPS, METAL PLUGS AND CLAY TO CEMENT THEIR WELLS. The EIS needs to clarify that PGV has cost the State and County plenty of money since they started operations in the early 90's.

Pg 14/15- Power Generation on Hawaii Island. a) **In Table 1-1**, the column on the right is headed "amount generated" (megawatts). The table actually lists nameplate capacity for the power plants listed, and not the amount generated. Since the "amount generated" is the most relevant quantity if one wants to seriously evaluate the power generation on the Big Island, I have included below a table with total amounts generated during the years 2010-2020 as the megawatt equivalent for each plant during this period. The rightmost column on Figure 1 below is capacity usage (production/capacity) and can be seen to vary from 16% to 58% for the power plants on the Big Island, rendering the capacity figures listed in Table 1-1 almost meaningless.

There are 4 plants which have consistently, for the past 20 years, generated about 75% of the Big Island's total electricity. They are, in order of 2010-2020 production, Keahole (Kona Airport) 30.2 MWe, Hamakua (Honokaa) 23.6 MWe, PGV (Lower Puna) 22.3 MWe, and WH Hill (Hilo Airport) 20.8 MWe. Increasing contributions from wind, biodiesel, solar and others will diminish this percentage as time passes.

The two oil burning plants near the Kona and Hilo airports are the primary plants which need to be replaced in order to achieve 100% renewable electricity on the Big Island, corresponding to 50.9 MWe out of a total Big Island generation from oil of 57.3 MWe (2010-2020). The other two large plants can both be classified as at least partially renewable. Increasing their output to demonstrated (Honoka'a 45 MWe) and proposed (PGV 60 MW) capacity would provide enough generation to allow the closure of all oil plants on the island. And this is without including the two 30 MW (~15 MWe total) grid scale solar projects about to come online near Waikoloa, or other emerging alternatives.

The Honoka'a plant deserves further mention. The plant opened in 2000 and was designed as a peaking power plant, able to respond quickly to demand fluctuations. With this in mind, it was sited about halfway between the two main demand centers on the island, Hilo and Kona. By the time the plant was built there was already a recognition that the island should move toward renewable energy as quickly as possible. So an ability to respond to the fluctuations inherent in solar and wind energy was also incorporated in the design.

In a further move toward sustainability the plant was designed to burn naphtha, a byproduct of the distillation of crude oil, which has traditionally been used primarily as a solvent. Another improvement occurred in late 2019 when a contract was signed with Pacific Biodiesel to provide enough fuel for about 5 MWe of the plant's output. Pacific Biodiesel has a plant in Kea'au, about 50 miles from Honoka'a, which produces "certified sustainable" biodiesel from recycled cooking oil and agricultural waste. A similar amount (~5 MWe) comes from naphtha produced at Hawaii's only refinery on Oahu. So the production of electricity from Honoka'a is all waste, about 20% local, and about 10% sustainable at a production of 50 MW. At its typical production rate with all other plants operating normally (~ 10 MWe), the Honoka'a plant is 50% sustainable and 100% local.

PLANT	TYPE	CAPACITY	PRODUCTION	USAGE %
			2010-2020	(PROD/CAP)
		(MW)	(MWe)	
KEAHOLE	OIL	77.6	30.2	38.9
PUNA	OIL	36.7	5.9	16.1
KANOELEHUA	OIL	5.5	0.1	1.7
WAIMEA	OIL	7.5	0.2	2.8
HILL	OIL	35.5	20.7	58.4
DISPERSED		5.0		0.0
HAMAKUA	NAPHTHA/ BIODIESEL	66.0	23.6	35.8
PGV	GEOTHERMAL	38.0	22.3	58.6
PUUEO	HYDRO	3.4	1.5	44.7
WAIAU	HYDRO	1.1	0.5	43.9
WAILUKU	HYDRO	10.0	2.9	29.3
PAKINI NUI	WIND	21.0	12.2	58.1
HAWI	WIND	10.6	3.8	36.3

CUSTOMER SOLAR SITES		**22.0**		
TOTALS		**339.9**	**124.1**	

Figure 1 - Comparing Net Capacity with Actual Generated Power

The plants listed in Table 1-1 total 406.7MW (nameplate capacity). The amount of electricity generated on the Big Island in 2020 was **1042 Gigawatt hours, corresponding to a total generation of 118.6 MWe (Megawatt equivalent).** This makes it clear that Table 1-1 has little to do with actual electricity generated, only nameplate capacity. Actual electricity generated was about one third of the listed capacity.

Pg 15 continued: c) Re Santec Graph 1: PAGE 14 SAYS HAWAII ISLAND WAS GENERATING 60% (under State Renewable Energy Production), while the State of Hawaii was generating 38% renewables. Yet, we are told in Graph 1 that the total percentage of renewable energy generated on the Big Island is not 60% as listed above, but only 38%.

On Page 14 the EIS states that Hawaii Island had the highest percentage of energy generated by renewable resources, which was listed at 60%. On Page 15 of the EIS it is stated that Hawaii Island was able to increase the amount of renewable energy to approximately 38% in 2021. Maybe I'm naive but I find these statements confusing. A nice graph of the 38% number is included in the EIS. We have attached as Figure 2 below a very similar graph displaying the source of the 60% quote. Is anyone home? Is there a proof reader or editor? There should at least be an explanation of why the two renewable energy numbers are so different.

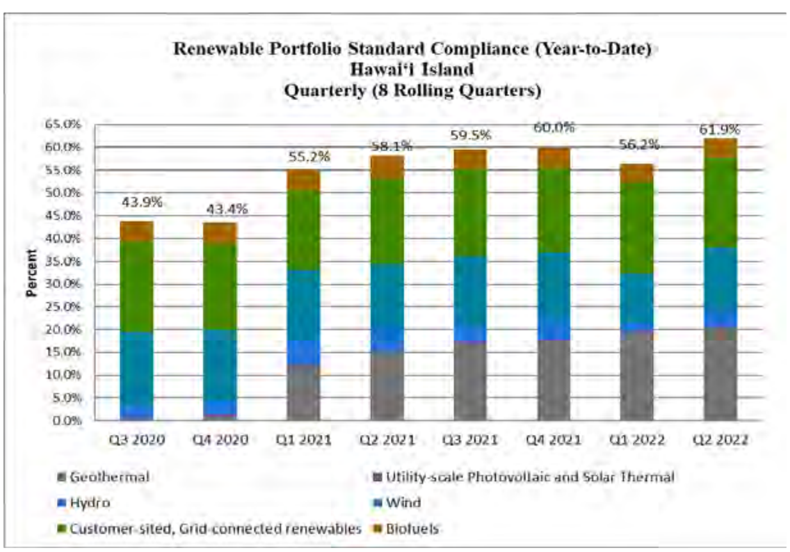


Figure 2 - "Renewable Portfolio Standard Compliance" DBEDT

c) also puzzling in Graph 1(pg 15) is the almost 16% jump in renewables created by PGV's return online. Numbers for the entire year of 2021 indicate a total Big Island production of 130.0 MWe. Based on that total, PGV's average generation during 2021 was 19.5MWe. So while the claim that PGV is already generating 25.7 MW may be technically correct in mid 2022, it was less than 20 MWe for all of 2021. When we attempted to open the link to the citation listed as the source of this graph, we received "the page you requested is no longer available". The data information leading to these conclusions just became available on DBEDT.

Pg 16 a) Begins with the sentence "Hawaiian electric also identifies additional solar, biomass, and energy projects in development on Hawaii Island, which would add approximately 184.5MW if they come online (Hawaii Electric 2021b). <u>THE ENTIRE POWER CONSUMPTION OF THE BIG ISLAND HAS STEADILY GONE DOWN SINCE 2007. WE DON'T NEED air polluting and ground destabilizing geothermal power any longer.</u>

b) Project Purpose - Puna Geothermal Venture is not a firm source of power generation and should be listed in the Variable (As-Available) Generation. See Figure 3 below. All electricity graphs were made using State of Hawaii DBEDT data and/or EIA (Energy Information Administration) data**. THERE IS NOTHING FIRM ABOUT PGV EXCEPT THAT IT FLUCTUATES REGULARLY.**

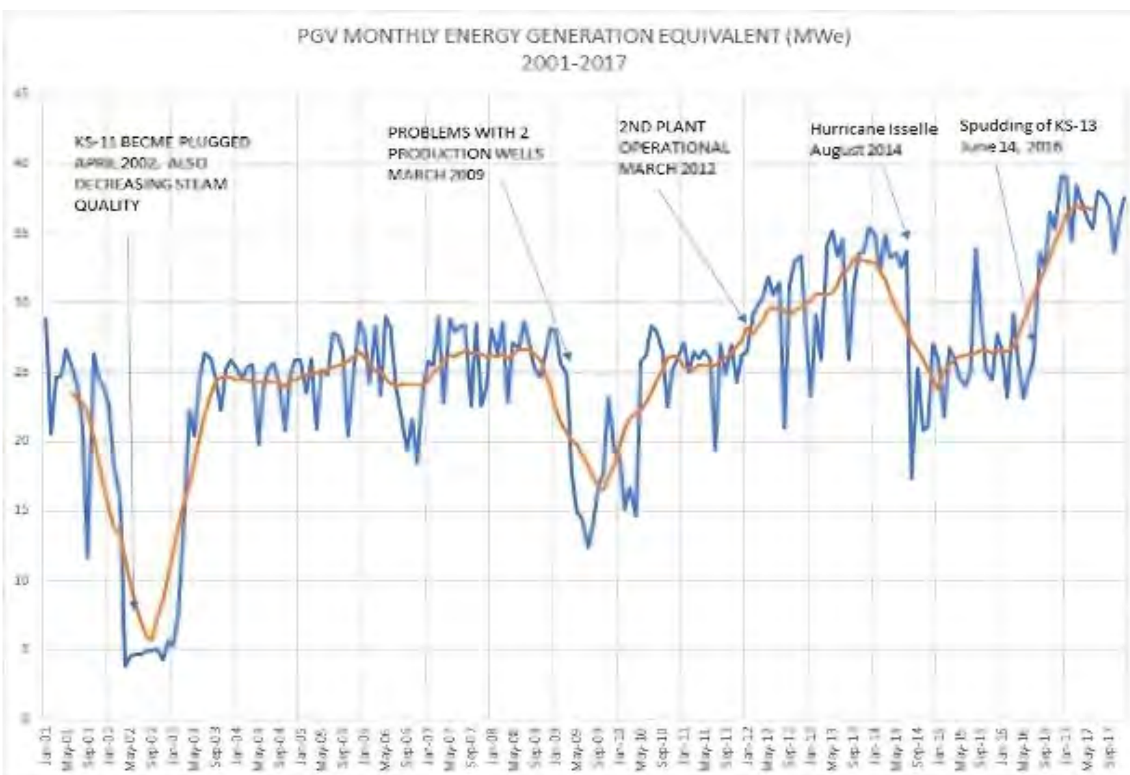


Figure 3 - PGV Monthly Energy Generation Equivalent

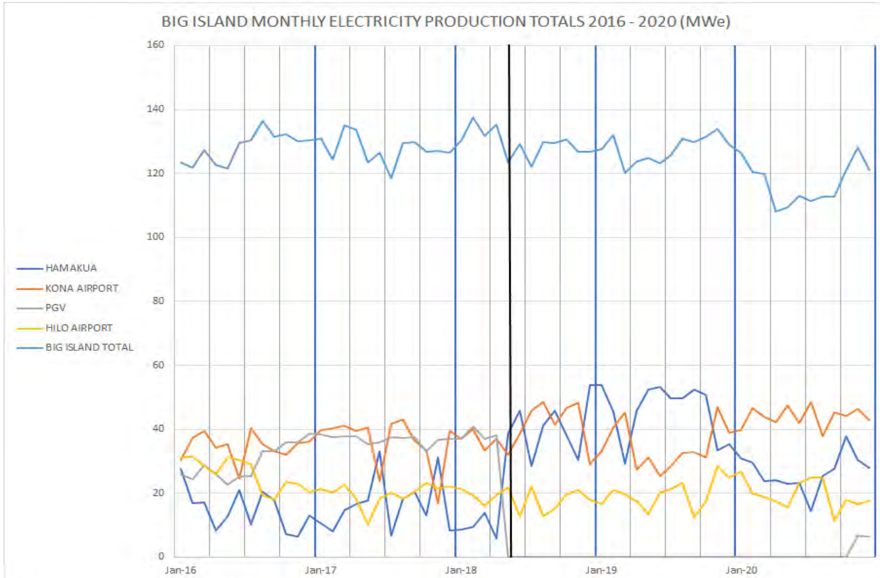


Figure 4 - Monthly Individual Plant Generating Totals 2016 - 2020 (MWe)

Figure 4 above is designed to show how HELCO managed output from their individual plants before and after the 2018 eruption. In May 2018 PGV's production decreased immediately from about 38MW to zero. Meanwhile, the Honokaa plant output jumped from 6.0 MWe in April to 38.6 in May and 45.3 MWe in June, fully covering the 38 MW loss created by the eruption. The Honokaa plant continued to provide an average of 45 MWe of generation until October 2019. Most of the other plants had only minor changes in their activity. Once again, this demonstrates the ability of the Honokaa plant to preserve system stability by increasing output in response to disruptions at other plants. It actually does what PGV promised but has failed to deliver throughout its 30 year history.

<u>Pg 16 - 1.4 Alternatives:</u> a)The 1987 EIS said the life of the PGV plant was 35 years. A great alternative is <u>PGV decommissions their the plant as envisioned in the 1987 EIS.</u> 35 years from 1987 is 2022! It is time for PGV to pack up and go and stop harming the environment and residents. PGV was shut down for over 2 years after the 2018 eruption and we didn't experience one brownout or electrical shortage. The State has mandated we use less power and so we don't even need PGV to meet our projected power usage as it keeps declining. PGV can decommission as anticipated in the 1987 EIS and pack it up and restore the land to its former beauty. The community would benefit from the property being acquired by the County of Hawaii Open Space Fund and returned as a park to the people who lost so much in 2018.

b) Shut down the PGV plant and move toward more biodiesel and solar, improve battery storage, and also implement the virtual power plant concept now being experimented with on Maui, Big Island and Oahu. It is called VPP, Virtual Power Project, Swell Energy (6000 batteries and 25MW on 3 islands) and you can find more about it at: https://www.swellenergy.com

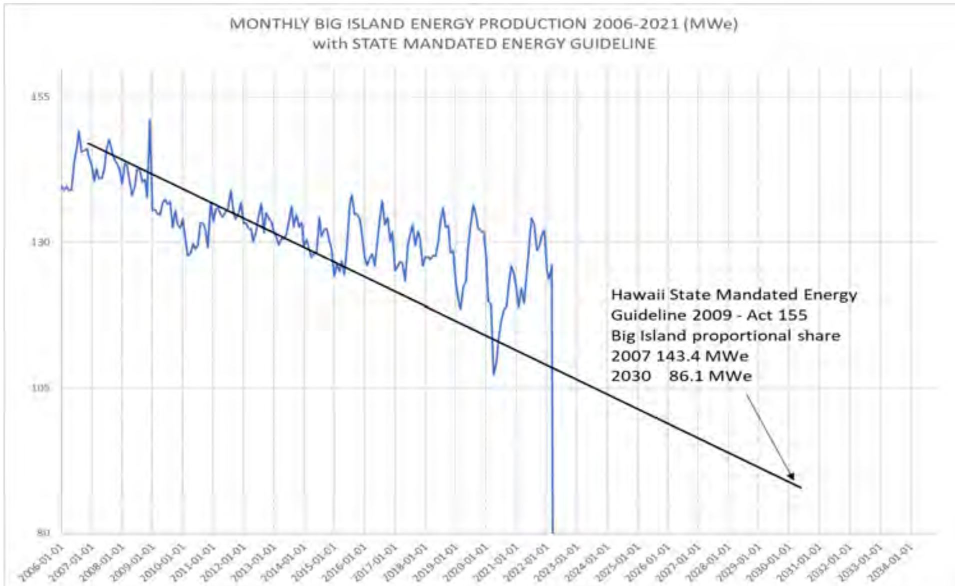


Figure 5 - Big Island Energy Consumption is Mandated to Go Down

Pg 16 cont. c) As part of its goal to become self-sufficient, the State of Hawaii initiated a program to reduce State electric utility sales by 40% from 2007 levels by 2030. According to this scenario shown in Figure 5 above , total Big Island electric utility sales would fall off to 85MWe by 2030. That is, the State has mandated a steady shrinkage of electric utility sales in Hawaii. Even with no additional projects, the island would achieve 100% renewable energy by 2030 under this scenario, assuming a full 38MW contribution from PGV. Continuation of the roughly 2MW per year downward trend mandated by the 2008 Act would entirely remove the need for any energy from PGV before the expiration of any new RPPA (lasting until at least 2052) that would result from the approval of PGV's EIS, and this is without any addition of new renewable energy projects on the island.

d) 1.5 Geothermal Resource Subzones. Greedy speculators and government officials enacted the geothermal resource subzones in the 1980's WITHOUT PERFORMING ANY ENVIRONMENTAL REVIEW WHICH WOULD DISCLOSE THE CUMULATIVE EFFECTS OF INJECTION WELLS WITH ADDED CHEMICALS DESIGNED TO PREVENT SILICA BUILDUP AND HOW THOSE INJECTION WELL FRACTURES PROPAGATE AND/OR DISSOLVE ROCK IN ACTIVE VOLCANOES UNDER EXTREME PRESSURE. Our illustrious legislators in Oahu condemned Puna residents to the last 35 years of hell from PGV and then on top of it PGV injects cold water and salt water underground while lava is erupting less than 200 yards away from their property line during the 2018 flow trying to save their wells. The entire world knows about phreatomagmatic explosions at Halema'uma'u when the lava hits the water and the entire world knows that lava explodes on contact with the ocean - so why PGV didn't think pumping cold water and salt water into an erupting volcano wouldn't explode. WE SAW EXACTLY HOW IT EXPLODED OUT FISSURE 17. Then PGV didn't stop pumping water for 2 weeks while they waited for the State of Hawaii to organize and pay for emergency equipment to cement wells. PGV SHOULD HAVE JUST CALLED FOR THE CEMENT TRUCKS ON MAY 4 AFTER THE 6.9 EARTHQUAKE AND NOT

BLOWN THE RIFT ZONE OPEN FOR 2 WEEKS. I made a UIPA request to the State of Hawaii Emergency Management Agency about the details of the "Governor's Expert Task Force" and what actually transpired during those several weeks in May 2018. Who was pushing for cement to fill the wells and who was pushing to inject water and salt water to try and save the wells. I will provide the information upon receipt.

Pg 17 - Project Location. As you can see by the maps attached to the end of the EISPN, PGV is trying to downplay that they are located in the middle of several subdivisions, including lava covered areas WHERE PEOPLE STILL OWN LAND AND PLAN TO REBUILD. NOT EVERYONE IS TAKING THE BUYOUTS! SANTEC NEEDS TO DISCLOSE THAT INSTEAD OF PUSHING THE BUYOUTS. Why did Santec or PGV cut off most of the right-hand sides of their maps in Figures 2-6? TO HIDE THE FACT THERE ARE HOMES AND PEOPLE AND ANIMALS LIVING THERE!

Pg 18 - Existing Operations: Geothermal Wells and Wellfield Facilities. a) PGV IS NOT A RENEWABLE RESOURCE. PGV IS NOT FIRM. PGV HAS TO CONSTANTLY RE-DRILL WELLS AND GET NEW EQUIPMENT IN AN ATTEMPT TO MEET THEIR CONTRACT. Drilling new wells involves massive drill rigs, diesel engines and miles of special strength steel pipes, drilling muds and oils and chemicals, all brought in overseas.

b) PGV uses many hundreds of thousands of gallons of petroleum products (diesel, pentane) plus tens of thousands of gallons of liquid nitrogen and who knows how many gallons of highly corrosive acids to keep the silica and corrosion from fouling their systems.

c) THE INFORMATION IN TABLE 2-1 CONTRADICTS THE INFORMATION IN PGV'S POO (PLAN OF OPERATION) APPROVED BY HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES AND SUBMITTED TO THE HAWAII PUC AS BEING CURRENT IN 2020 as shown in Figure 6 below, which clearly shows well pads I, G, J and even K. What is going on at PGV? Why are their diagrams of operations and wellpads different for DLNR than what is provided elsewhere?

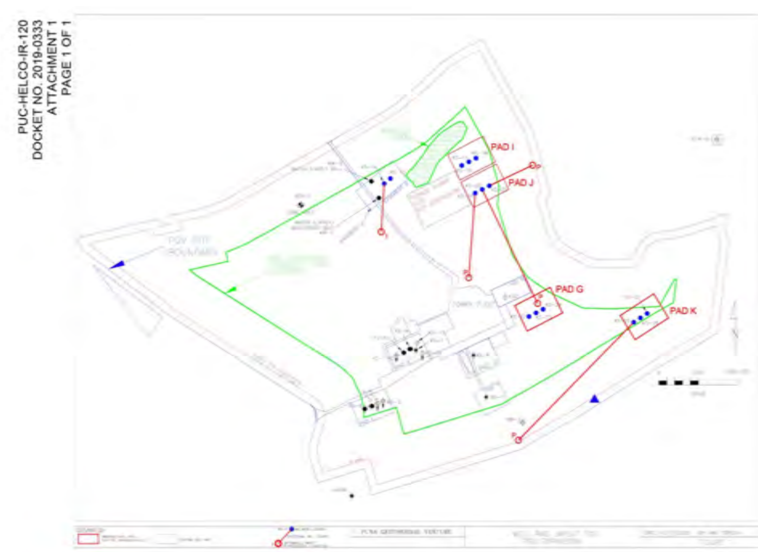


Figure 6 - PGV's POO provided to the PUC in 2020

Pg 18 - c) THIS EIS NEEDS TO DISCLOSE THE ACTUAL WELLS PGV HAS CREATED - ALL OF THEM - WITH TOP AND BOTTOM GPS COORDINATES, AS WELL AS THE REDRILLS AND SPUDS FOR EACH. Also answer the burning questions why PGV needs so many wells, why they need rock catchers and why wells fail. The people need to realize PGV is drilling down and then sideways into an active volcano. We also need to know the status of all the production wells listed in 2-1 which do not say plugged or covered but say "out of service" anyway, and if that counts as a proper plug and abandonment.

Pg 20 - 2.1.6 Existing Operations. a) PGV got in trouble in 2016 with the EPA for using and losing an inordinate amount of the petrochemical pentane. The 2015 USGS Water report clearly states PGV injects Pentane into their wells. THIS EIS NEEDS TO CLARIFY WHY PGV INJECTS PENTANE UNDERGROUND.

Pg 23- I reviewed the reports to the Legislature from the Hawaii Emergency Response Commission from 2019-present and I can find no mention of working on PGV's Emergency Response Plan or Hawaii County Civil Defense's ERP. I made a UIPA request to Hawaii County Civil Defense, they know nothing about how the public was informed of PGV's Emergency Response Plan or how the public was notified and given a chance to comment. According to the UIPA answers, Hawaii County Civil Defense does not even know the location of PGV's H2S perimeter monitors since they were moved after the lava and they only have a 2016 Emergency Response Plan which shows all the roads to be used in an emergency THAT HAVEN'T EXISTED SINCE 2018. The HAZMAT response team that is supposed to protect the people from PGV is an hour away. WE COULD ALL BE DEAD BY THE TIME THE HAZMAT TEAM IS DRESSED AND GETTING ON THE ROAD - IT ONLY TAKES A FEW SECONDS OF A HIGH CONCENTRATION TO KILL. H2S gas follows the lowest topography and does not flow upwind and uphill to where PGV moved the monitors after 2018. We had a prime example of the lack of emergency response during the 2014 Hurricane Iselle, where PGV did not shut down ahead of the advancing storm and instead stayed operating until winds knocked trees out all over the community, bringing down electrical poles, and the plant tripped off and gassed the neighbors trapped in their homes by fallen trees.

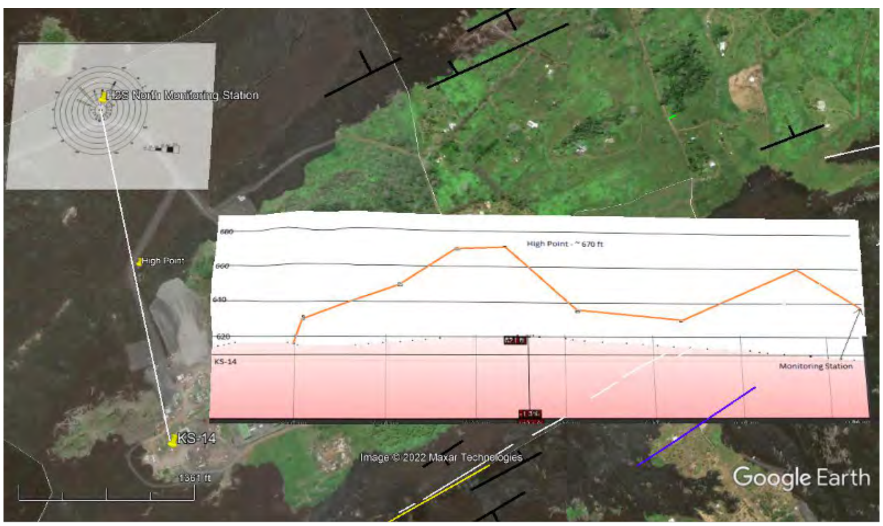
Pg 24 - a) Proposed Power Operations - In 2018 PGV was pumping about 6 million gallons-a-day. According to the specifications listed in the EISPN, PGV would be pumping about 10.8 million gallons per day in order to generate the full capacity of 60 MW (678+226=904 kph, 904*24=21,696 kpd, 21,696*1000=21,696,000 pd, 21,696,000/8=2,712,000 gpd per unit, 2,712,000*4=10,848,000 total gpd). ***This corresponds to an increase of 80% over 2018 pumping rates into the fractured rift zone.***

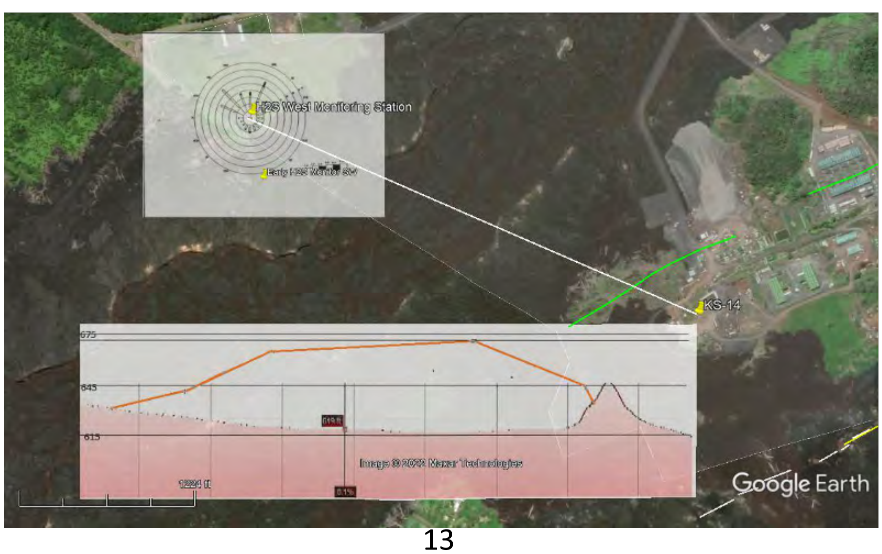
b) What type of propants does PGV use to keep the fractures open? How do the chemicals PGV injects into their wells to keep silica, mold and scale from forming react with the rock formation fractures? If you are injecting and producing from "the same resource" "in a closed loop system" then we need to know why you have to keep adding more chemicals.

Pg 25 - a) Proposed Monitoring and Maintenance - WHERE IS THE SEISMIC MONITORING? Geothermal plants in the US mainland have to perform seismicity studies and have seismic arrays around them and hook up to the local USGS monitoring site SO WE CAN SEE WHAT THE HECK IS GOING ON UNDERGROUND. Mike Keleikini clearly stated that PGV has their own seismic monitoring program at his public meeting in July 2022. LET'S SEE THE SEISMIC RESULTS NOW! Perhaps that is how Ormat was able to warn their stockholders 17 times in 2017 that lava flows were imminent, because they knew they had turned the ground to rubble in their injection zones… (see Blindsided with Advance Warning 6/14/2018 attached as an exhibit below).

b) How often do the 3 Department of Health Hydrogen Sulfide Monitors have wind blowing their direction? Maybe 10% of the time, if at all. **Does Hydrogen Sulfide travel uphil?** NO, SO THEN WHY ARE THOSE DOH MONITORS LOCATED UPWIND AND UPHILL? *See Figure 7 below which shows the wind direction roses and elevations for the 3 DOH monitors as they are in August 2022.*

c) How does averaging out the leaking hydrogen sulfide into rolling minutes or hour or day averages protect the residents? Why can't we have monitoring at the Source = The Production Wells?





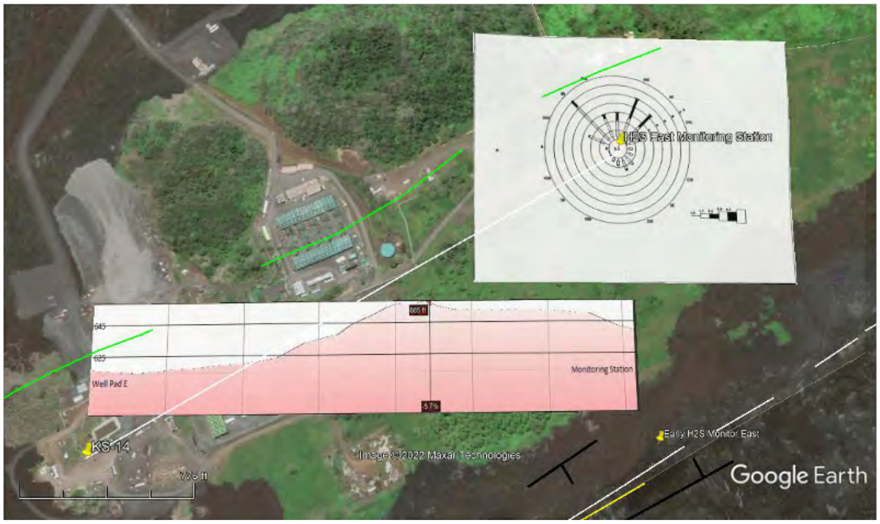


Figure 7 - Views of 3 Department of Health Hydrogen Sulfide Monitors with Wind Roses and Elevations 2022

Pg 27 - Geology. a) I find it incredible that the EIS draft discussion of geology is only a little over one page long. The geology of the area is what enables the existence of the plant and the geology also creates the greatest dangers. Not only is the discussion very brief, it is also highly generalized and largely deals with the Big Island as a whole and not with the specific area of the plant. I believe this is a conscious effort to broad brush the events of 2018, because a detailed examination of the area and events during the eruption will lead to completely different conclusions regarding PGV's influence upon it.

b) There is not a single map or diagram in the geology discussion, so I provide a map in Figure 8 below showing the events which transformed the 2018 eruption from an event "within the range of normal behavior of Kilauea Volcano" (EISPN, p 3-2) into the by far the largest eruption of Kilauea since the arrival of the haole.

c) One of the most amazing "coincidences" of the 2018 eruption was the close correspondence between the fissure line and the PGV boundary for a distance of about 1 km on the southeast boundary of the lease area. Part of the reason for this is that the former Pu'u Pilau was used as a survey marker for PGV's boundary. This point became Fissure 22 in 2018. Preexisting faults continued in this direction all the way to the end of Fissure 18, an additional kilometer. Fissure 22 became the major eruptive center for a period of about 4 days beginning on May 18. It is directly connected via another unmapped fault to the bottom of well KS-14. The existence of this fault was shown in the initial advance of lava from Pu'u O'o on May 3 which passes directly along a line containing KS-14 and Fissure 22, the former Pu'u Pilau.

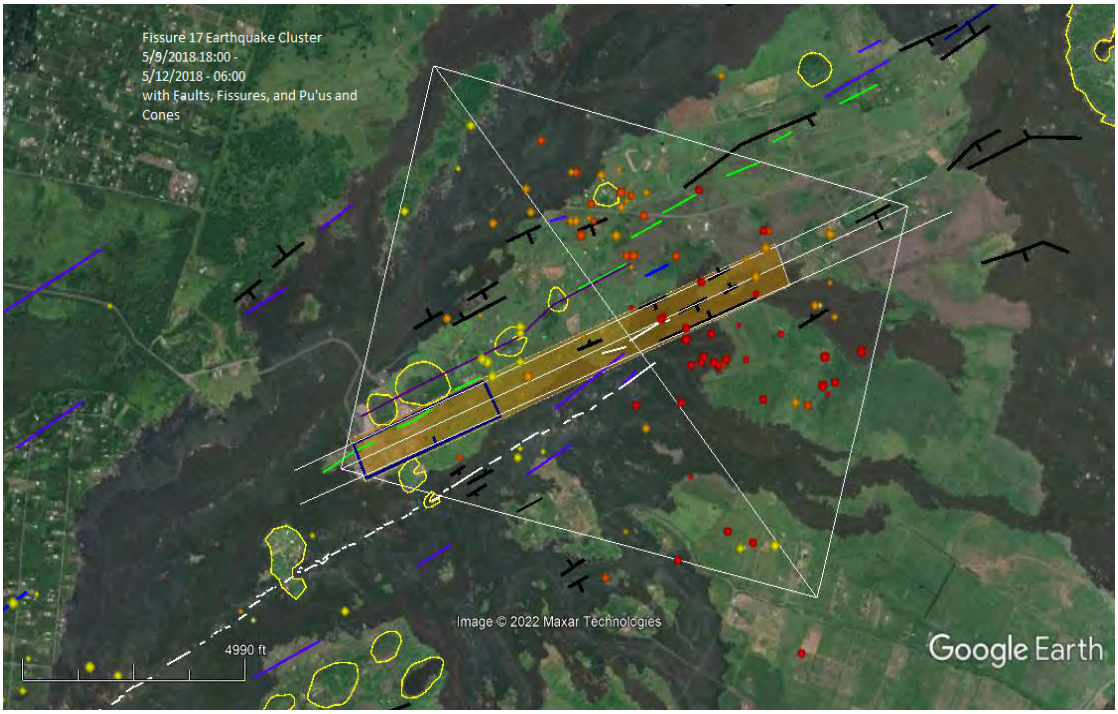


Figure 8 - DETAIL OF GEOLOGY NEAR PGV'S LOCATION WITH EARTHQUAKES FROM MAY 9 18:00 TO MAY 13 04:00, 2018

c) On May 13, 2018 the most explosive fissure (Fissure 17) of the eruption opened around 4 am. The small circles (primarily red, orange, and yellow) show earthquake epicenters for an 82 hour interval which ended just before the opening of Fissure 17. 2018 fissures are shown in heavy white lines. There is a rectangle outlined in faint white lines which contains the earthquakes of the cluster. Fissure 17 lies almost exactly in its center, as shown by the diagonals.

Also shown on the map are faults with throw (heavy black lines), 1955 fissures (heavy lime green), and previous known fissures (heavy blue lines). The rectangle outlined in dark blue shows the fault mapped by Kennedi et al. The rectangular area shaded with orange shows a structural graben defined by the known faults shown on the map. Grabens are known to be frequent locations of volcanic eruptions. Kennedi described her mapped fault as the main fault exploited by PGV. Explosions produced by water injection would have been directed by this structure directly downrift to Fissure 17.

There had been no earthquakes in the rectangle during the 2018 eruption until this time - 6:20 pm, May 9. There had only been 93 earthquakes within the rectangle during the previous 50 years, one less than the number which occurred in less than 4 days during 2018.

The southwest corner of the rectangle is the focal point of the cluster and lies near the southwest corner of the PGV well field. What a coincidence.

Not only was Fissure 17 the most explosive fissure of the eruption, it also erupted lava which was unique for the 2018 eruption and rarely seen in Hawaii before. Large pieces of pre-existing rock were thrown hundreds of feet into the air. When this rock was analyzed, it was found to be dacite with a silica content of ~67%. With the exception of a small deposit on Oahu, the only other sample of this type of rock found in the Hawaiian Islands occurred when PGV encountered lava while re-drilling KS-13. Another amazing coincidence.

After the opening of Fissure 17, lava eruption moved systematically uprift, with major outpourings from Fissures 22, 13, and 7 before activity became centered at Fissure 8 on May 28. *PGV was injecting water into their production wells throughout this period.*

d) NO MENTION OF THE HILINA SLUMP. The EIS needs to disclose the entire southeast flank of Kilauea Volcano is breaking apart along the rift zones and is sliding into the ocean, including the area where PGV wants to withdraw up to 10.8 million gallons a day which is then cooled and then injected deeper into the hot ground with added chemicals to prevent silica buildup and corrosion. ***The Hilina Slump is sliding at an accelerated pace since 2018.*** The Draft EISPN talks all about earthquakes on the surface and how PGV is built to withstand them but fails to mention the worldwide problem of induced seismicity impacts ***underground*** and what that is and how it is safe to locate multiple wells in the middle of antithetic faults and grabens which are producing and injecting into a rift zone experiencing "active tectonic dilation" *See attached pages from PGV's application to the EPA. Look how PGV names the fractures they create after the well numbers. Look at the side views of PGV's multiple wells criss-crossing faults and TELL US HOW PGV IS NOT AN ENHANCED ENGINEERED GEOTHERMAL PLANT*.

e) PER THE EISPN "The location of the Proposed Action is somewhat topographically protected from potential flows; however, several wells were damaged in the 2018 Lower Puna eruption." **PGV IS NOT SOMEWHAT PROTECTED NOW, THEY ARE SURROUNDED ON 3 SIDES BY LAVA NOW AND NOT ON A HILL ANYMORE EXCEPT FOR ON ONE SIDE BY CINDER CONES FROM PAST ERUPTIONS.** We need a current map with current elevations.

f) The ground at PGV has uplifted several feet at PGV wellpad E as discussed in Damage and Repair of KS-14 (1034260.pdf) attached as an exhibit below. That report doesn't conform with the frenzied media reports from May 2018 about how 10 of 11 wells were quenched and plugged by May 21. Where are the other well repair reports? What wells were plugged and what wells were not? PGV's "Quench Log" (*see* attached as exhibit) doesn't list 10 or 11 wells.

l) How intelligent is that to locate a plant in a Lava Zone 1? HAWAII VOLCANO OBSERVATORY HAS NO SEISMOMETERS BELOW PGV SINCE 2018, even before that (Cooper & Dustman 1995 available at https://evols.library.manoa.hawaii.edu/handle/10524/62941), Catherine Kenedi (2010 available at: https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/3111/D_Kenedi_Catherine_a_2010.pdf?sequence=1) and 2011 available at: PDF Microseismicity and 3-D Mapping of an Active Geothermal Field, Kilauea ...) WE NEED A THOROUGH SEISMIC STUDY OF THE PGV AREA, INCLUDING THE MICRO-EARTHQUAKES GENERATED BY PGV. I just received the "Geothermal Induced Seismicity National Environmental Policy Act Review at: 1423753-

geothermal-induced-seismicity-national-environmental-policy-act-review. This Induced Seismicity Report discloses results of 4 geothermal plant monitoring schemes and concludes that more research needs to be done on induced seismicity. I will attach it as an exhibit for your ease of viewing.

m) PGV was questioned by the PUC last year about Protocol for locating geothermal injection wells. Of course back then I was mistaken and thought it was USGS protocol, but it actually was EPA and USBLM protocols. Of course PGV said "they wern't aware of any protocols and I should ask USGS". **Interestingly, in the Reference section of the above document, there is a citation to an Ormat Brady Geothermal Plant Protocol - WHICH MEANS PGV HAS KNOWN SINCE AT LEAST 2013 OF PROTOCOL WHERE NOT TO LOCATE INJECTION WELLS.** *See Ormat. 2013. Brady's EGS Project PROTOCOL FOR INDUCED SEISMICITY ASSOCIATED WITH ENHANCED GEOTHERMAL SYSTEMS DOE Award: DE-FG36-08GO18200. Ormat Nevada Inc. pg. 1 – 38. (no link provided).* ***PGV knows exactly that their wells create fractures - fractures in the same place for 30 years make the ground weak. Weak ground lets the lava out from an active volcano. This EIS gets to discuss that problem.***

n) The draft EISPN states "In the event of a volcanic hazard with the potential to threaten the facility or block a well, all production and injection wells would be shut-in (i.e., pumps stopped and injection ceased) and PGV would implement the ERP. Your Precious PGV DID NOTHING AFTER MAY 3 AS THE LAVA APPROACHED. PGV did not follow that relic 1992 Emergency Response Plan, did not remove 60K+ gallons of explosive pentane, they did not disassemble or remove any sensitive equipment, did not cement their wells shut to prevent explosions or blowouts of Hydrogen Sulfide, like common sense would dictate. UNTIL THE GOVERNOR ORDERED A STATE OF EMERGENCY AND THREATENED TO TAKE OVER THE PLANT.

o) The State of Hawaii had to find a team of "experts" during the 2018 lava flows to manage PGV's operations because nobody at PGV had a clue. Instead of putting cement in their wells immediately they caused phreatomagmatic explosions underground for weeks pumping cold water and salt water into their wells while they waited for the State to ship in their emergency supplies (*See* Damage and Repair well KS-14). **PGV'S 1992 EMERGENCY RESPONSE PLAN IN EFFECT DURING 2018 SAID NOTHING ABOUT "COOLING THE RESOURCE" OR "QUENCHING ANY WELLS"** The explosivity of Fissure 17 is easy to understand - water and lava and hot rocks don't mix...

p) PGV's 2021 ERP states that PGV will start circulating water in the wells in the event of a lava flow. I DEMAND THIS EIS DISCLOSE WHAT PHREATOMAGMATIC EXPLOSIONS AND ERUPTIONS ARE AND THAT THEY OCCUR WHEN LAVA AND WATER MEET UNDERGROUND. This EIS needs to tell the permitting authorities how lava and water explode up at Halema'uma'u and how lava explodes when it touches the ocean - this EIS needs to explain how PGV think this does not happen when decided to inject water into hot dry 2000 degree wells with lava erupting less than 200 yards away. 1 GALLON OF WATER EXPLODES TO STEAM WITH THE FORCE OF 8 STICKS OF DYNAMITE - THIS NEEDS TO BE EXPLAINED IN THE ENVIORNMENTAL IMPACT STATMENT BECAUSE PGV INJECTED WELL OVER 1,342,194 GALLONS OF COLD WATER

AND SALT WATER INTO AN ERUPTING VOLCANO DURING THE 2018 ERUPTION. *What PGV did during the eruption (injecting cold water into 2000 degree that caused the underground explosions is clearly stated in "Lava Eruption Disrupts Puna Geothermal Venture - The Background" available at: https://www.higp.hawaii.edu/hggrc/lava-eruption-disrupts-the-puna-geothermal-venture/*
NOTE: the links to the actual document have recently been removed from the internet, I suspect to hide the evidence, but don't worry, I will attach a copy to the August 22, 2022 filing of this comment paper so all government agencies involved can see the extent of the intentional negligence in 2018. Here is a brief comment to support our position:

> "Usually a geothermal well can be quenched by pumping cold water; however, the intrusion of the 2000+°F magma nearby and on the surface changed the wells' behavior and [the water] didn't work well at first on some of the wells." According to Wardlow, the operators of PGV were able to collect downhole temperature and pressure measurements before the lava had entered the facility. One of the wells had measured temperatures of 100°F greater than normal, even at 2500 ft depth. In addition to salt water, this well had to be quenched with a mud-barite mixture, which is intended to generate a ceramic seal upon exposure to high temperature conditions. The team also encountered problems due to delays in equipment delivery (especially bridge plugs) to the islands. Overnight mail doesn't exist [on Hawaii] noted Wardlow.

q)The 2022 Emergency Response Plan released by PGV has so many deficiencies that it is difficult to know where to begin criticizing it.

It is largely unchanged from earlier versions of the plan dating back to 1992 before the opening of the plant. While aspects of the plan dealing with hydrogen sulfide have received a great deal of attention, problems related to safely shutting wells have been scarcely addressed. The few sentences dealing with this subject are scattered and contradictory as well.

Chapter 8 deals with shut down procedures in the event of eight kinds of emergencies. The first two relate to lava and magma intrusion. Both cases reference "layup/recirculation per PGV procedures" of all production wells.

Layup/recirculation is not defined anywhere in the document. The term layup as used with reference to boilers and other furnace related equipment means filling with water before a time of disuse. Evidently this is a new term to describe what was described as "quenching" during the 2018 eruption. Recirculation is an added term, perhaps to acknowledge that water would surely boil/explode if not changed frequently. Certainly, a clear definition of the procedure referred to as layup/recirculation should be required.

r) Another glaring deficiency in PGV's Emergency Response Plan is its failure to address the possibility of lava erupting directly beneath the plant, not in the sense of lava seeping up one of the well bores, but massively exploding through the ground as a new fissure. There are

frequent examples of lava erupting from the same fissure many times. That is how pu'us, craters, and the great maunas form.

Evidently, this possibility did not occur to the builders of the PGV plant. Figure 9 below shows the location of one of the original 1955 fissures (in lime) superimposed over an image of the main plant. The 10 original OEC units are shown as well as the turbines. There are literally dozens of pipes filled with pentane suspended directly over the former fissure while the plant is operating. This is another way in which PGV shows that it always has the safety of their employees and nearby residents as top priority.

Figure 9 - PGV located directly over 1955 fissure line

s) PGV paints a very simplistic picture of the procedure described in 2018 as "quenching".
Quenching is a common procedure in any kind of well. It is used to stabilize a well which has a problem until it can be repaired. The well is filled with water the weight of which is sufficient to prevent any gas leakage or other instabilities. The idea is that the well is filled with water and remains full until repairs can be completed. While this process works very well in most situations, doing it in the presence of nearby lava changes the situation drastically. Figure 10 below is based on documents provided by PGV regardings its Underground Injection Permit with the EPA and shows the daily volume of water (gallons) injected into its production wells from May 15-27, 2018.

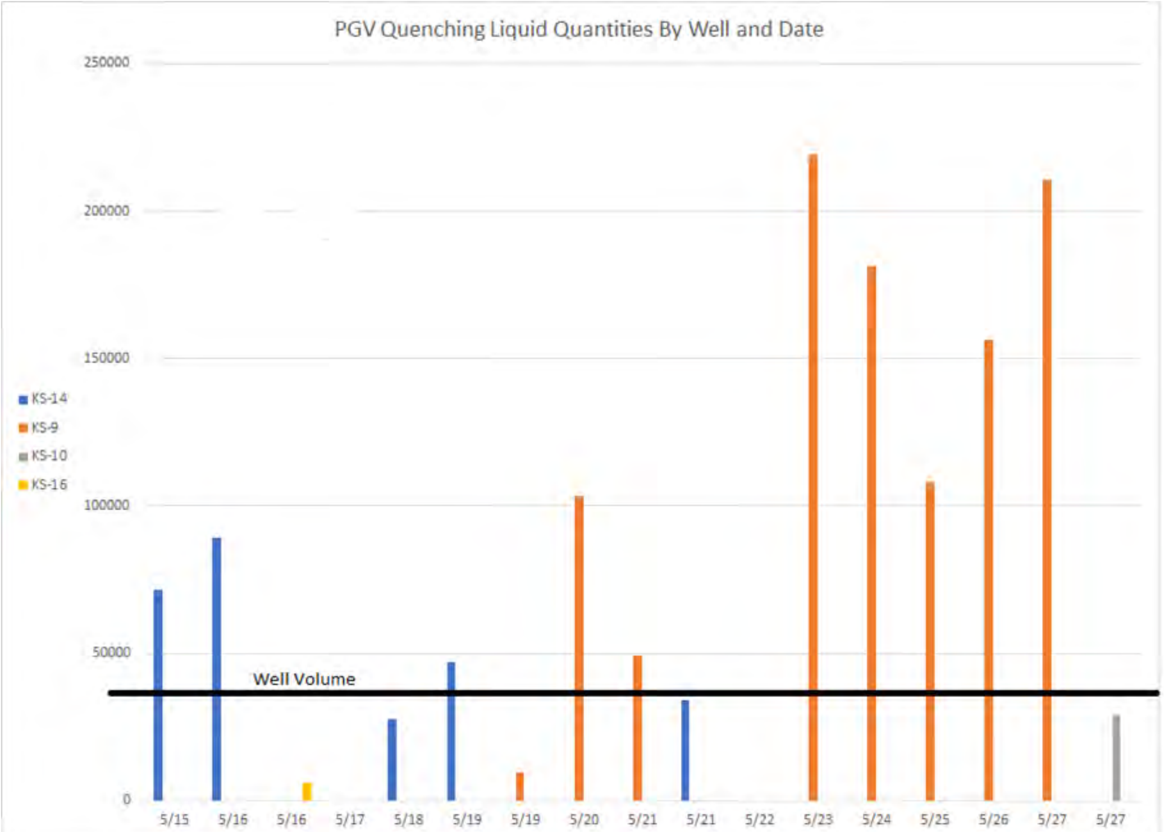


Figure 10 - Graph of PGV's "quenching" amounts

PGV injected a total of over 1.3 million gallons of water into 4 wells over a period of 12 days. The heavy black line shows the maximum volume of a typical PGV well. The total injected would have been enough to fill the 4 wells 8 times each. Between May 23 and May 27, enough water was pumped to fill KS-9 25 times, including 7 times on May 23. What happened to all that water?

Well KS-14 was heavily damaged during the eruption but has since been repaired. Enough water to fill it 7 times was pumped into KS-14 from May 15 to May 21. Well head pressure and temperature increased abruptly at KS-14 from 323 psi, 428^{o} F on May 1, 2018 to 1295 psi, 577^{o} F on May 3. A narrative of the repair (Spielman et al, 2020) states that pressures rose as high as 2000 psi during the injections during 2018. A fault crossing the well bore is believed to have moved a meter and the well casing was damaged severely. Thus it is hard not to imagine major leakage from the well as it was pumped full of water. Given the temperature and pressure conditions, explosions would seem inevitable.

This massive excess pumping renders the very idea of "recirculation" absurd. So much for the lessons learned from the 2018 eruption. It also shows that pumping any water into any well with lava nearby is criminal.

t) A much more sensible emergency plan would be to require **immediate cementing of all production wells** at the first appearance of any fissures within a mile. Ideally, this would have occurred on May 3, 2018, but nothing had been done with the wells until Governor Ige intervened on May 9.

Pg 28 - a) PGV is using the 2020 USGS/Hawaii Volcano Observatory report "Have humans influenced volcanic activity on the Lower East Rift Zone of Kilauea Volcano" as *authoritative proof that PGV did nothing to influence the 2018 eruption.* That "scientific" report did not: discuss the world-wide known impacts of geothermal injection wells, b) did not discuss the "cumulative impacts of 30 years of multiple injection wells 6000-8000+ feet below the surface of the ocean" and did not mention world-wide known fact that PGV was "cooling and quenching" its "resource" with cold water and salt water for 2 weeks while PGV waited for the State of Hawaii have their emergency pumps, well plugs and bentonite clay flown in on the taxpayer dime. PGV was unprepared and did nothing until the Governor ordered them to and brought in a group of 'experts'. The head of the Hawaii Volcano Observatory was on the Governor's Task Force of "experts". I guess he didn't know that putting cold water into hot rock while a volcano was erupting a few feet away was going to create underground explosions!

b) Hydrology - reservoir is separated from the groundwater aquifer in the LERZ by a semi-permeable confining layer (or "cap rock") that is located at depth of between approximately 2,750 and 4,000 feet below the ground surface (EPA 2021). The EIS needs to detail how PGV will prove the "semi-permeable" cap rock is not fractured since the lava from the 2018 eruption came from magma chambers below 2,700-4000 feet in a Fissure Line which broke all along PGV's property line. "Semi-permeable" means is not a sealed formation, it leaks, so NO, it does not protect the groundwater from PGV's injections of chemicals, including pentane and isopropanol What is Royal Purple? The PGV injects that and we want to know what it is!

c) "the EPA's UIC permit includes injection pressure limits which are based on formation testing to reduce the potential for the creation of fractures". *RIGHT THERE YOU ARE ADMITTING PGV INJECTIONS HAVE THE PROPENSITY TO CREATE FRACTURES, including test injection into new wells until the fracture point is established.* <u>It is safe to assume that 30 years of microfractures will turn the injection zone into a mass of rubble unable to support an earthquake and also unable to keep back the pressurized lava in the Kilauea magma system.</u> This EIS can use the data from both Cooper & Dustman (1995) and Catherine Kenedi (2010, 2011) to show their is seismicity associated with Puna Geothermal Venture operations and how the microfractures were occupying the rift zone in the same area as the 2018 fissure line broke out of. WHY ISN'T PGV BE REQUIRED TO HAVE A SEISMIC ARRAY AND A SEISMIC MONITORING PROGRAM AVAILABLE TO THE PUBLIC REALTIME?

d) Here are links to other geothermal plant EIS's with comments. The best comment came from the EPA in relation to Ormat's new Casa Diablo IV geothermal plant: *Appx C of the Diablo EIS contains the EPA comments and also a recommendation that induced seismicity be disclosed and the cumulative effects of seismicity and how induced seismicity is monitored and mitigated:*

https://gbuapcd.org/Docs/PermittingAndRules/CD4/cd4_final_eir_volume_2_appendices_a-f.pdf

e) The Casa Diablo EIS available at
https://gbuapcd.org/Docs/PermittingAndRules/CD4/cd4_final_eir_volume_1.pdf The word "seismic" only shows up 3 times in this EIS, no mention of cumulative effects of geothermal-well induced seismicity. It is the same as the 1987 PGV EIS, says the area already seismically active and "does not expect induced seismicity to be a problem". How is covering up induced seismicity in an EIS protecting the environment?

f) The technology exists to monitor PGV's microfractures and project the cumulative effects of multiple wells removing and injecting 6-10 million gallons a day. ***When are we going to move into the new century and admit geothernal operations induce seismicity and that it is not intelligent to locate fracturing technologies in unstable areas where the island is falling into the ocean naturally and we have potential hidden faults that are unknown because PGV and HVO and USGS refuse to study it, in direct opposition to the rest of the world?***
https://today.tamu.edu/2021/03/30/underground-noise-reveals-fracture-pathways-needed-for-energy-production/

g) BOTTLE ROCK EIS available at https://www.osti.gov/servlets/purl/6887368

The Bottle Rock geothermal plant EIS I found from 1978 clearly states at page 21:

> Recent seismologic studies (Hamilton and Muffler, 1972, Bufe, *et al.,* 1978) show that a large number of "micro-earthquakes" (an earthquake having a magnitude of 2 or less on teh Richter scale) occur continously in the Geysers steam field. This type of activity is common in both developed and undeveloped geotheral areas throughout the world. While some of these events appear to be realted to regional geologic forces, others may be related to natural changes in the geothermal system**. Preliminary results presented by Marks, et al., (1978) indicate the micro seismic activity is increasing as a result of development of the steam resource.**

h) **THIS EIS MUST DISCLOSE THE CUMULATIVE EFFECT OF UP TO 30 GEOTHERMAL WELLS (with all the added redrills and spuds listed for each well) withdrawing and injecting 6-10.8 million gallons of acidic effluent with added chemicals *per day* as indicated by PGV's intention to increase to a 60 mw plant.** the EIS must disclose the **cumulative amount of chemicals which will be dumped into the ground** over the next 35 years in plain English and also the impact of the chemicals that prevent silica buildup in pipes and how they react underground with the rock formation they are injected into.

i) This EIS will disclose how the "impermeable cap rock" that is supposed to protect the water table isn't really impermeable because, besides PGV's constant drilling into it, the island is actively experiencing tectonic dilation, lava dike intrusions and slumping into the ocean exactly at the spot where PGV is located, and the cap rock was fractured in the 2018 eruption all along the fissure line, that is how the lava got to the surface.

Pg 29 - Air Quality and Climate Change. Since reopening in 2020, PGV has moved their 3 DOH Air Pollution Monitors to areas that the wind does not blow and uphill where the heavy Hydrogen Sulfide gas does not flow. The EISPN states PGV has prepared new air dispersion modeling report. The EIS needs to disclose which way the winds actually blow and how and where PGV will place DOH monitors to actually pick up Hydrogen Sulfide, downwind and low to the ground. It seems like the H2S will pool around PGV during the normal trades and then flow downhill at night, the heavier-than-air gas flowing down through the areas that were not covered by lava.

b) the imaginary 3500' circle around PGV does not prevent toxic gasses from travelling into the neighborhood. During the 2014 Huricane Iselle the toxic gasses passed 3500' and knocked out people all around PGV. PGV paid money to make the lawsuits go away. Explain how an arbitrary circle drawn on a map protects the residents.

Pg 30 - a) Noise - The noise in upper Leilani Estates is unbearable since the foliage is gone. Make sure you go up there and survey the residents. PGV IS CONTROLLING FOR "COQUIS" in their noise studies so we need to know all about that and also realize that is being done to show PGV is operating below permitted noise levels.

b) Biological Resources - make sure you talk about the endangered Newell Shearwaters which have been documented nesting in Pu'ulena Crater next to PGV. In the past, PGV was ordered to dim their lights because of the birds. Obviously, they arn't dimming their lights anymore since the eruption. Has anyone checked to see if there are still Newell Shearwaters at Pu'ulena?

Pg 34/35 a) RELATING TO CENSUS There are a bunch of 10 acre lots that are located in that acreage above and to the left where the word "Pohoiki" is superimposed on the map on Page 48 of th EISPN. They all have Bureau of Conveyance activity in 2022, it appears to be a subdivision "Onipa'a II" but without obvious infrastructure. This EIS should disclose the fact that Hawaii is a hot real estate market and address how many more substandard lots and vacant land surrounding PGV could potentially be on the market and open to development within several miles from PGV where there are no roads and no escape routes are being provided, and how those people will be protected from gasses travelling downhill from PGV.

b) Community Development - Geothermal Relocation Fund We need to be assured the lava-covered land bought with government funds is not re-sold like the County of Hawaii resold the homes purchased by the Geothermal Relocation to PGV employees for a very low price over the years, including my ex-home on Mohala Street in Leilani Estates, where Fissure 1 broke out.

c) Explain what "Environmental Justice" is and explain how PGV giving money for pet projects for County and State governments protects the environment in the area surrounding PGV from negative and irreversible effects of PGV's cumulative operations. THE RESIDENTS ARE SICK AND TIRED OF BEING GUINEA PIGS FOR PGV'S EXPERIMENTS IN LAVA ZONE 1 while PGV pays royalties to the government for the privilege to harm us.

d) Many people arn't selling out to FEMA and want to keep their lava lots. This EIS should detail a map showing the lots people have applied to be bought out of versus the lots that still remain in the areas surrounding PGV that are still owned by people.

e) Cultural Practices - This EIS needs to take notice of the local customs and beliefs. We have seen that come front and center with the TMT (Thirty Meter Telescope). There is a long history of opposition to geothermal in Puna. We are in Hawaii and should give deference to the Hawaiian culture of living in harmony with the land. *See*

Pg 36 - a) Hazardous Materials and Solid Waste. How many gallons of Pentane TOTAL does PGV use and have onsite at all times? How much liquid Nitrogen? How much of that is used in the Operating Systems versus how much being stored in tanks. Make sure we have the total amounts of petrochemicals onsite and the blast radius' diagrams for all hazardous chemicals and petroleum products stored at PGV.

b) Hydrogen Sulfide "...H2S which is emitted as a gas from volcanic activity"... Clarify that H2S is produced and located very deep underground and as it rises it mixes with groundwater and turns into Sulfer Dioxide. H2S is not a normal product of volcano emissions. This EIS should detail the strength of the concentration of H2S in Puna versus the rest of the world's geothermal

Pg 37 - a) Transportation and Access. When evaluating transportation of dangerous chemicals, we need to be advised of how many trucks of and quantities of each kind of chemical (pentane, nitrogen, etc) that will be driving each month right next to and past public schools during school time and neighborhoods for the next 35 years.

b) Evaluate how Civil Defense will get to Pohoiki Road in the case of emergency, including the time and miles.

c) Detail how the 1000+ residents living to the south and east will escape PGV blowout and gassing if Highway 130 is blocked between Leilani Estates and Pahoa.

Pg 42 - a) We need to notify both the State of Hawaii Civil Defense Agency *and* the Hawaii County Civil Defense Agency of this EISPN and all further drafts, neither of those agencies are on your list. I just received a UIPA request from the County of Hawaii Civil Defense Agency and they don't even know where PGV's Department of Health Perimeter Hydrogen Sulfide meters are located in July 2022. Hawaii County Civil Defense plans on evacuating residents in 2022 look like they will follow their HCDA 2016 Emergency Response Plan which is outdated and shows images of public roads that don't exist since 2018. See notes on Page 48 below.

b) The United States Bureau of Land Management has protocol where not to locate injection wells - located at:
https://www.blm.gov/sites/blm.gov/files/policies/Attachment%203%20Induced%20Seismicity%20Screening%20Worksheet%20Guidance%20Document.pdf

This decision tree should have been included in the decision-making of on how intelligent it would be to locate a geothermal plant on an active volcano within 5 miles of schools, within 1000' of residental homes and with no seismic background or even a sesimic monitoring program.

Pg 43 - Neighbors and Concerned Citizens. This is a request to add Sara Steiner/Larry Wood as persons to be notified and consulted on this EIS. Our emails are listed above. Puna Geothermal Venture and the State and County of Hawaii are aware of us and know we have been trying to protect Puna from PGV since the eruption.

Pg. 48 to 53 - There is no title or any identifying mark on each page (49-53) so how do we know what image we are looking at? Additionally, *each image on Pages 48-53 is only a partial image of the surrounding area and cut off on the right-hand side of the document's legend. <u>We need to see the entire document in the EISPN Figures 1-6,</u> including the Author and Title of document and* ***we want to see the surrounding area east of PGV where people live right in close proximity downwind from PGV.***

Pg. 48 - a) What is the Blue Outline Parcel TMK 140010010000? That is not part of PGV's known Lease Area unless they are expanding on it and then we need to know now as PGV claims to have no interest in expanding beyond their 815 acres..

b) <u>WE HAVE NO ROADS ON THE LAVA LIKE the Figure on page 48 shows.</u> This EIS needs to show the general public and (government agencies tasked with our safety) exactly what roads the surrounding residents are going to use to escape PGV's constant gassings (70 times in 30 years). Pg 48 is FALSE INFORMATION AND MAKES IT LOOK LIKE THE RESIDENTS HAVE ESCAPE ROUTES FROM PGV! *This EIS needs to take off the lava covered roads and only show the roads if they are open and usable by the public.*

<u>Pg 49. a) Where are wellpads "G" "I" and "J" detailed in PGV's POO at Figure 6 above?</u> (PGV's "POO" is their Plan Of Operation approved by the State of Hawaii Department of Land and Natural Resources**. The POO (*<u>updated in 2020 to the PUC</u>*) shows KS-13 and KS-14 located somewhere up in the area covered with lava, and shows future wells KS -15, 16, 17, 18, 19 and 20 on some nonexistent well pads named "G", "I" and "J" and "K"(see below graph).** ***HOW CAN WE BELIEVE ANYTHING PGV SAYS???*** **<u>What documents are true, the documents approved by the State of Hawaii Department of Land and Natural Resources and submitted by HELCO to PUC or some documents submitted to the EPA and the Health Department?</u> HOW MANY WELLS ARE ALLOWED ON A WELLPAD? HOW CLOSE ARE PGV'S WELLS? HOW MANY REDRILLS AND SPUDS ON EACH WELL? The cumulative effectsl of the wells that PGV is anticipating using for their 60MW expansion need to be disclosed now!**

<u>////////ADDITIONAL COMMENT REGARDING EIS PREPARATION///////</u>

NOTE: PURSUANT TO <u>HAR 11-200.1-13</u> THIS EIS MUST CONSIDER AND EVALUATE THE SUM OF EFFECTS OF THE PROPOSED ACTION ON THE QUALITY OF THE ENVIRONMENT, including:

<u>HAR 11-200.1-13(b)(4)</u> PGV has a substantial adverse effect on the social, welfare and cultural practices of the Community and State -Hawaiians don't want you drilling into Pele, the residents of the State & County do not want you to spend innumerable funds responding to constant emergencies at PGV, including having the Governor declare a state of emergency specifically because PGV refused to do anything to follow their Emergency Response Plan during the 2018 eruption. The State had to threaten to take over the plant so finally PGV evacuated the 67,000 gallons of pentane and then because there was nobody at all who could take charge of the emergency, the State had to fly in an "expert" from California (who conveniently used to be an Ormat Vice President) who only cared to save PGV's wells. In order to do that, the State of Hawaii paid to ship in quench pumps, metal plugs and clay to plug wells <u>BECAUSE PGV DID NOT HAVE ANY EMERGENCY EQUIPMENT ON SITE.</u> Besides the above, the County of Hawaii Hazmat team has had to suit up in Hilo and drive 40 miles from Downtown Hilo to respond to minimum of 70 toxic gassings in 30 years. The State and County also have to have public shelter available to escape PGV blow-outs, etc… The State and County have paid for studies for Hydrogen Sulfide harm to residents - let this EIS discuss those studies and what happened to the results.

<u>HAR 11-200.1-13(b)(5)</u> PGV has a substantial adverse effect on public health, no reliable monitoring of toxic substances (monitors located upwind and uphill), 24/7/365 Noise, drilling, banging, clanging, vibrations, lights. PGV's Geothermal resource is a toxic deadly chemical soup which PGV adds more chemicals to every day and the quantitiy totals for the next 35 years need to be stated. **What about psychological harm to people who are exposed to constant danger** from a known polluter and the government does nothing for 35 years but make excuses and give permit shields instead of permits and call for emergency declarations to bypass regulatory environmental rules?

<u>HAR 11-200.1-13(b)(6)</u> PGV involves adverse secondary impacts, besides fear and loathing from being gassed 70 times in the last 30 years and Ormat Nevada criminals lying and stealing money from the federal government to pay for upgrades to Ormat Puna, **we have no underground monitoring of expanding fracture zone caused my multiple production and injection wells thousands of feet underground. <u>USGS/HVO monitors ERZ3, ERZ4, PO7, 2816 are broken or don't exist or don't work since 2018,</u>** actually it has been "fruitless" to rely on any UGSG/HVO monitoring of PGV since 1991 (*see* 1995 Cooper & Dustman) <u>*NOTHING HAS CHANGED SINCE 1995 EXCEPT WE HAVE **LESS** USGS SEISMIC MONITORS IN PUNA.*</u>

<u>HAR 11-200.1-13(b)(7)</u> DISCLOSE THE DEGRADATION OF THE ENVIRONMENT BY PRODUCING AND INJECTING 6 MILLION GALLONS OF ACIDIC EFFLUENT AND CHEMICALS INTO THE ROCK FORMATION - PGV CREATES INDUCED SEISMICITY AND IT FRACTURES THE GROUND INTO RUBBLE AFTER 35 YEARS. PGV's 1987 EIS failed to even mention degradation of the underground environment.

<u>HAR 11-200.1-13(b)(8)</u> We need the cumulative effects of fracturing the unstable rift zone with 20 or 30 or more wells (<u>however many wells PGV needs to reach 60 MW</u>), <u>including</u>

multiple re-drills and spuds off of wells and how the chemicals to remove silica and corrosion and biofouling agents don't dissolve the rock formation they are injected into and why geothermal wells fail - they fill with rock from all the fracturing.

HAR 11-200.1-13(b)(10) PGV has substantial NEGATIVE effects on AIR and WATER and AMBIENT NOISE LEVELS, also the 2015 USGS water survey stated PGV injects Pentane and Isopropanol into their wells and it has showed up in the monitoring wells. HELLO, it is just a matter of time before it leaches down to the ocean. PGV creates 24/7/365 noise, drilling, banging, clanging, vibrations, lights and now there is no foliage to buffer the neighbors, only new lava which enhances the noise and smells and vibrations also come out of all the open fissures in Leilani Estates. The County enacted a night-time drilling ban demanded by the residents surrounding PGV way back in 2015 or so - but PGV never obeyed and the people had to sue.

HAR 11-200.1-13(b)(11) have a substantial adverse effect on or be likely to suffer damage by being located in an environmentally sensitive LERZ. PGV fits both of these problems. First off they are located in the middle of an active volcanic rift zone which is experiencing tectonic dilation, which means it is pulling apart at the LERZ and south flank of Kilauea is falling into the ocean naturally *without help from PGV!* During the 2018 Kilauea eruption, lava flowed from out of their property line WHILE PGV MADE SUBSTANTIAL ADVERSE EFFECT ON PUNA BY INJECTING COLD WATER AND SALT WATER INTO AN ERUPTING VOLCANO.

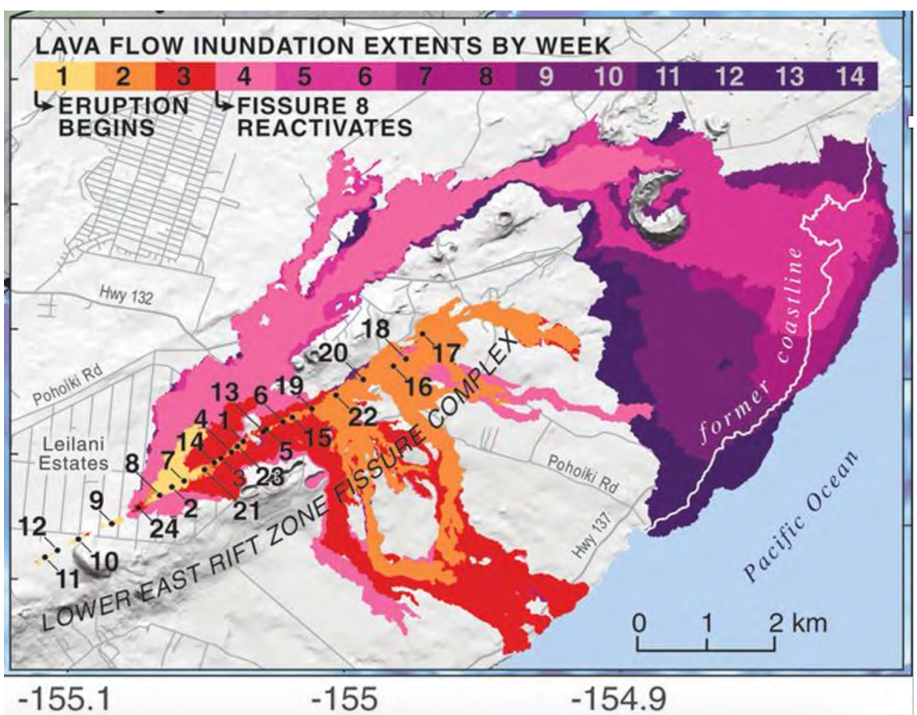


Figure 11 - USGS map of Lava Flow Inundation Extents by Week

HAR 11-200.1-13(b)(12) Since 2018 PGV is viewable now from all sides except the cinder-cone side (at the north) , sticks out like a sore thumb. All the foliage is gone and the lava surrounds the plant and it is louder and more bright since the eruption. Fissures on their property line are still smoking and noise from the plants emits from the fissures..

<u>HAR 11-200.1-13(b)(13)</u> Require Substantial Energy Consumption and emit substantial greenhouse gas. *AND ANOTHER POWER PLANT HAS TO BE KEPT MAINTAINED FOR EVERY TIME PGV GOES OFFLINE*, including 2 21/2 years while PGV tried to get it together after the eruption. PGV IS NOT FIRM RELIABLE POWER. PGV IS NOT RENEWABLE - THEY USE AND LOSE AN INORDINATE AMOUNT OF PENTANE, HAS TO CONTINUALLY DRILL NEW WELLS AS THE OLD ONES FAIL (JUST LIKE OIL AND GAS)

EXHIBITS

Pages from PGV's 2019 Application to EPA 1

Bureau Of Land Management Induced Seismicity Worksheet 6

Preliminary Induced Seismic Mitigation Plan Newberry Volcano 23

Damage and Repair of Puna well KS-14 . . . . 70.

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From:	Sara Steiner
To:	Lefebvre, Michele
Subject:	Fwd: Steiner-Wood Comments on PGV EISPN
Date:	Monday, August 22, 2022 7:49:04 PM
Attachments:	Exhibits for Steiner-Wood Commentary EISPN.pdf

---------- Forwarded message ---------
From: **Sara Steiner** <pahoatoday@gmail.com>
Date: Mon, Aug 22, 2022 at 6:55 PM
Subject: Re: Steiner-Wood Comments on PGV EISPN
To: Planning Internet Mail <planning@hawaiicounty.gov>, Michael Kaleikini <Mkaleikini@ormat.com>, <michele.lefebvre@santec.com>

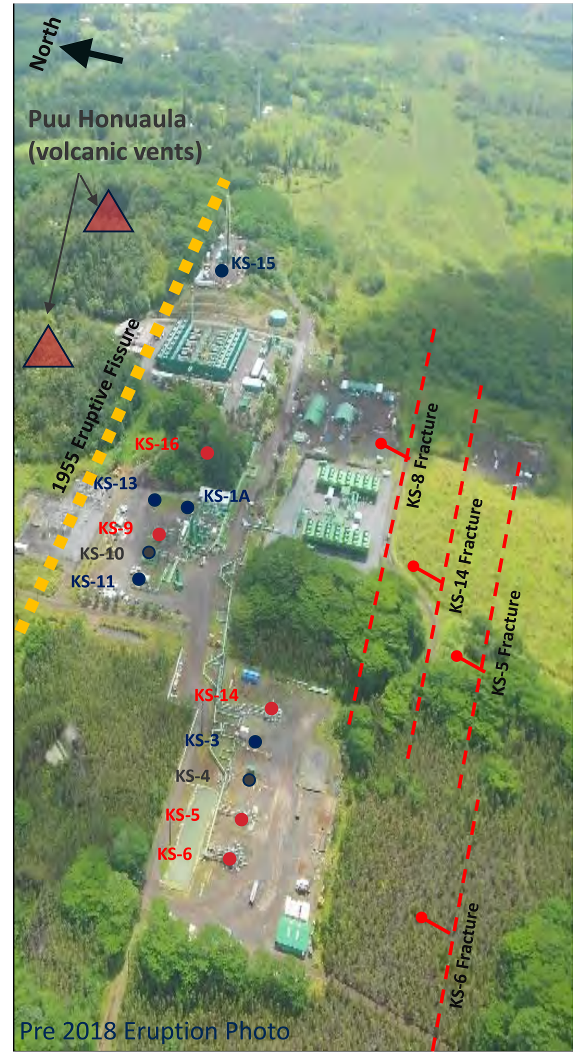
Exhibits for Steiner-Wood Comments EISPN

On Mon, Aug 22, 2022 at 6:54 PM Sara Steiner <pahoatoday@gmail.com> wrote:

> Dear Ms. Lefebvre, Ms. Suprenant and Mr. Kaleikini:
>
> Please find attached our comments and exhibits. The Exhibits will be sent separately because they are too big to send together in one email.
>
> Sara Steiner
> Larry Wood

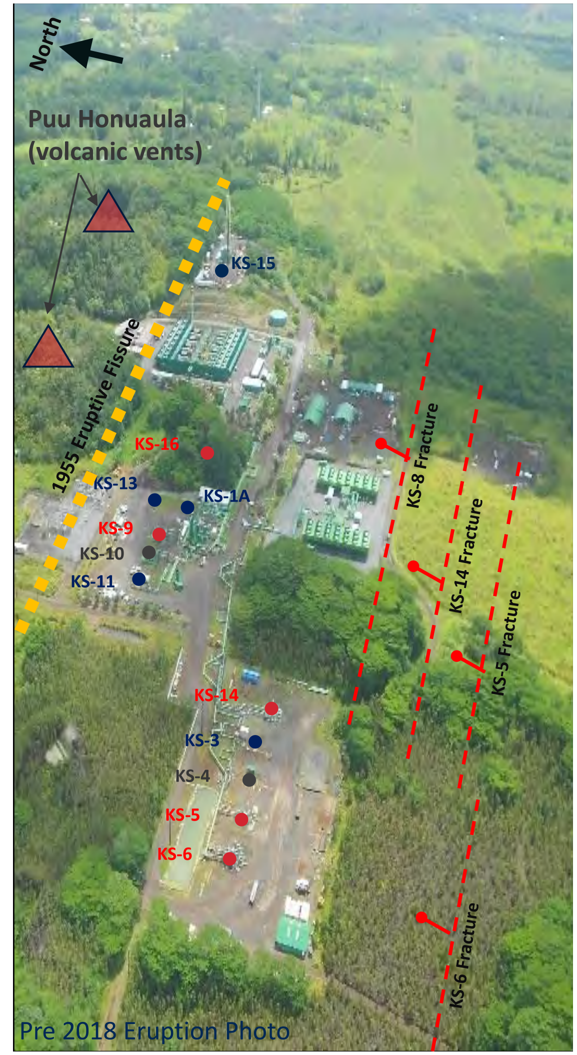
PGV RESOURCE OVERVIEW-PRODUCTION

- Associated with large-aperture, steeply dipping fractures.
- Location and attitude of these fractures are well constrained by drilling to be orientated at **N63°E** and dipping at **85°** to the NW.
- Fractures are aligned en-echelon and form a major left-step along the rift axis which results in a localized zone of enhanced dilation.
- Diabasic dikes commonly associated with large aperture fractures (wall rock).
- The main fractures exploited are the **KS-6, KS-5, KS-14 & KS-8.**
- Production depths 4500-6500 ft.
- Wells are two phase steam and brine at temperatures of 600°F (315°C) at a high pressure of 1,430 psi (100 bar). Yield high initial productivity (10-25 MWe).



PGV RESOURCE OVERVIEW-INJECTION

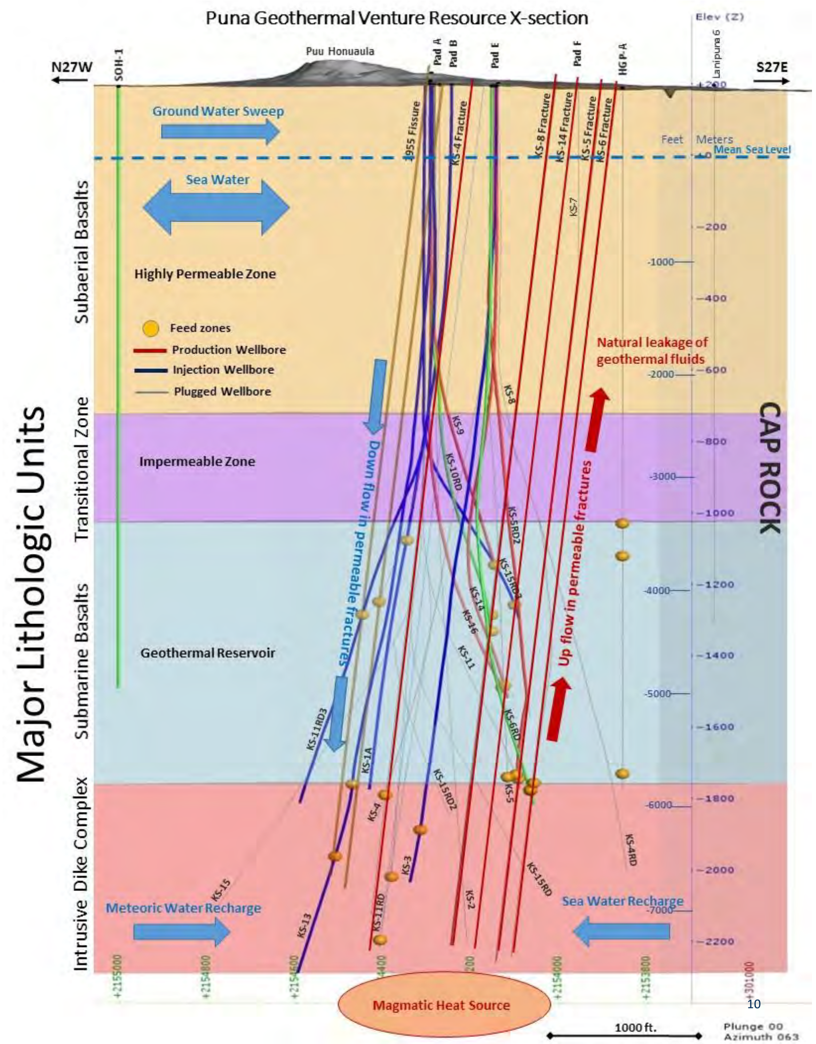
- Associated with large-aperture, steeply dipping fractures/fissures and the Puu Honuaula volcanic vents.
- Permeability is also associated with stratigraphic units in submarine basalts consisting primarily of hyaloclastites (glassy basaltic sediments) and pillow basalts. These stratigraphic zones have not proven suitable for production due to their low productivity (2-3 MWe) and higher acidity, but are suitable for injection.
- The main permeable structure exploited is the **1955 Eruptive Fissure**.
- Injection depths 4200-8000 ft. (Majority below 6500 ft.)



SIMPLIFIED GEOLOGIC MODEL

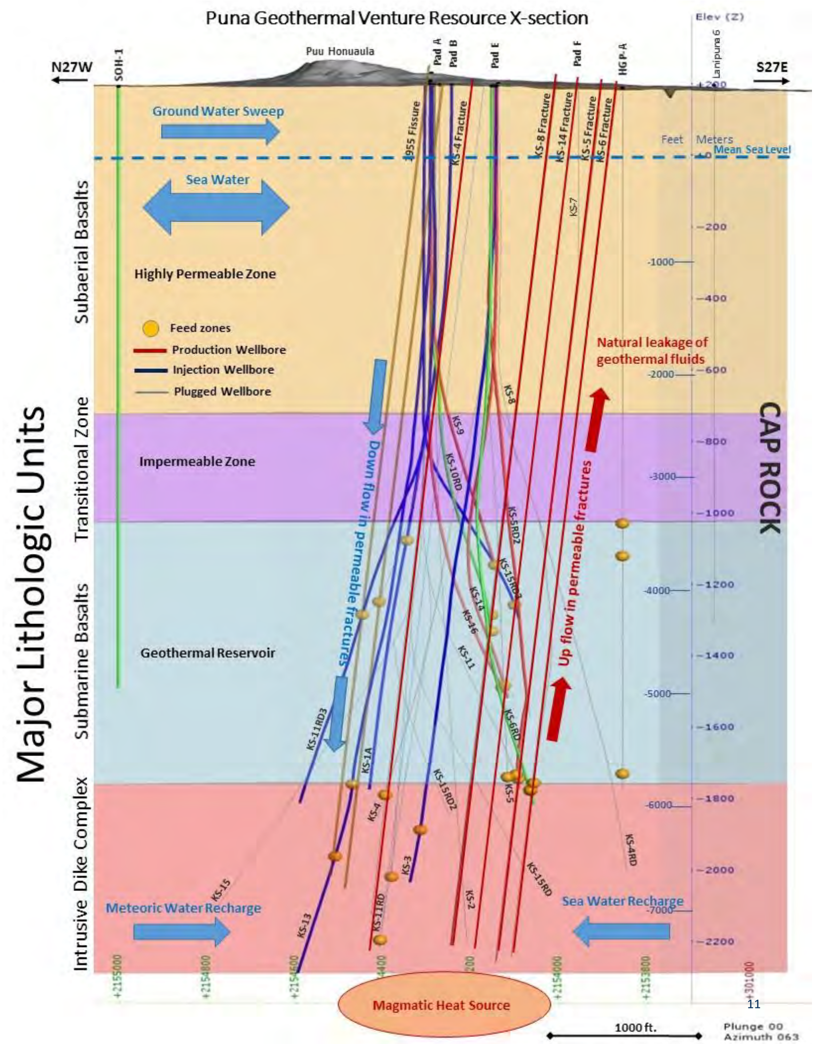
Major Lithologic Units

- Subaerial Basalts: Intercalated lava flows, scoria zones and weathered interfaces. Two types of basalts occur as (non) vesicular. Olivine-Tholeiitic & Diff-Tholeiitic
- Transitional Zone: Hyaloclastites intercalated with differentiated basalts (aerial & subaerial flows (pillows) and dikes).
- Submarine Basalts: Pillow basalts, minor hyaloclastites
- Intrusive Dike Complex: (Micro) Porphyritic differentiated basalt.

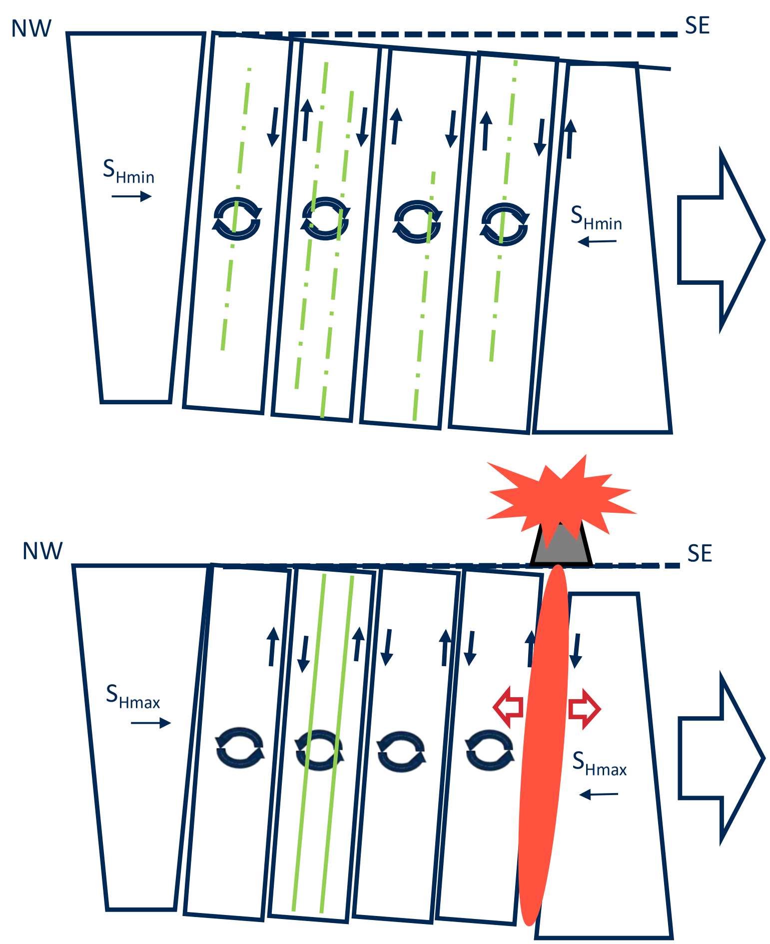


SIMPLIFIED HYDROLOGIC MODEL

- Produced geothermal fluids are reinjected into the reservoir at depths below ~4000 ft., beneath a semi-impermeable caprock which separates the geothermal reservoir from an upper groundwater zone.
- Groundwater zone extends from the top of the caprock to the water table ~600 ft. below the surface.
- The groundwater in this upper aquifer in the vicinity of PGV is thermally and chemically influenced by natural leakage of geothermal fluids through the caprock.

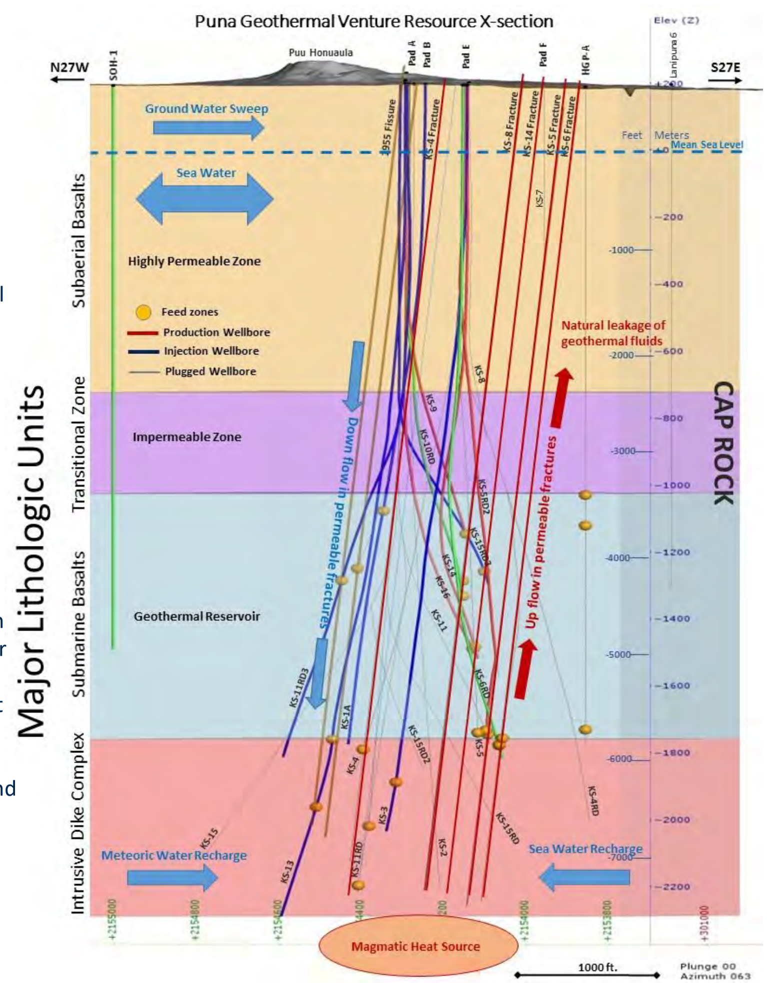


SIMPLIFIED STRUCTURAL MODEL



South flank of Kilauea displaced seaward due to lithostatic over loading. Rift zone dilates via normal displacement along high angle structures.

Episodic injection of magma further drives flank displacement but temporarily compresses rift zone (internal) and may reactivate older structures along preexisting planes of weakness.



Appendix B:
BLM Induced Seismicity Screening Worksheet Guidance Document

Prepared by:

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National Renewable Energy Laboratory

Dan Munger, BLM CA State Geothermal Lead; Alex Jensen, BLM NV State Geothermal Lead

In collaboration with the Induced Seismicity Expert Team

For:

Lorenzo Trimble
Geothermal Program Lead
Bureau of Land Management

Disclaimer:

The induced seismicity screening worksheet ("ISS Worksheet") presented in this document is for informational and guidance purposes for the Bureau of Land Management (BLM) only, for the limited purpose of identifying certain low-risk projects that may be approvable without the need for a formal probabilistic seismic hazard analysis conducted by a seismologist. The worksheet is not intended to provide an analysis of the seismic risk or seismic hazard of a geothermal hydraulic stimulation or Enhanced Geothermal System (EGS) project; nor does successful completion of the screening factors guarantee approval of a permit. It takes good judgment on when and how to implement an induced seismicity protocol. To try to boil it down to a few pages of guidance may be unrealistic. The IS expert team highly recommends that the BLM hire internal expertise (a seismologist or structural geologist) and involve that person as early in the process as possible.

The Alliance for Sustainable Energy LLC, the operator of the National Renewable Energy Laboratory (NREL), and the Induced Seismicity Expert Team specifically disclaim any warranties, whether written or oral, or express or implied, including any warranty of quality, merchantability, or fitness for a particular use or purpose and are not liable for any direct, indirect, special or other consequential damages, costs, liabilities, expenses and legal actions including without limitation by third parties that may result from, arise from or relate to any use of the information contained in this document. The views and opinions expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Golden, Colorado
August 22, 2018

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Executive Summary

An Induced Seismicity Screening Worksheet (ISS Worksheet) and accompanying guidance document have been prepared by the National Renewable Energy Laboratory (NREL) for the BLM in collaboration with an induced seismicity expert team (IS Expert Team). The ISS Worksheet and guidance document assist BLM field office staff with conducting a preliminary screening on seismic risk of a geothermal hydraulic stimulation or Enhanced Geothermal System (EGS) project. The ISS worksheet guides the user through eleven questions related to the operator performance, geothermal project technical details, historical local seismicity, and proximity to faults and population centers. Successful completion of the screening worksheet does not provide or indicate permit approval, but is intended only to inform the BLM of whether it has sufficient information related to the potential for induced seismicity, and resource specialists with an appropriate level of expertise on staff, to proceed in considering the permit. Based on the answers to these questions, the worksheet has four possible outcomes:

1. Resolve issues with operator: Unsatisfactory communication or mitigation plan or unresolved past negligence or non-compliance issues should be resolved before screening can continue
2. Low level concern: Initial screening passed; proceed with next steps in processing the application
3. Medium level concern: The BLM field office can proceed with evaluation of the application after involving the State Office Geothermal Program Lead. He / she may recommend consulting with industry or academic seismic experts and potentially apply the DOE Induced Seismicity Protocol.
4. High level concern: The BLM field office should not proceed further with processing the application without first contacting the State Office Geothermal Program Lead. The Geothermal Program Lead will perform in-depth review (likely in consultation with industry or academic seismic experts) and require the applicant to implement the full Induced Seismicity Protocol.

The ISS Worksheet is included in Appendix A. This guidance document (Appendix B) explains the reasoning for each question and where to find relevant data to answer these questions. Four examples are included in Appendix C to illustrate how to apply the ISS Worksheet.

Acknowledgments

NREL would like to thank the IS Expert Team for providing technical guidance and review in preparation of this ISS Worksheet and guidance document:

- Lorenzo Trimble, National Geothermal Lead, BLM Washington D.C. Central Office
- Dan Munger, State Geothermal Lead, BLM California State Office
- Alex Jensen, State Geothermal Lead, BLM Nevada State Office
- Kermit Witherbee, former BLM National Geothermal Lead
- Dr. Ernie Majer, former Director LBL Earth Sciences Division, Lawrence Berkeley National Laboratory
- Dr. Ole Kaven, Research Geophysicist at Earthquake Science Center, USGS
- Dr. Art McGarr, Research Geophysicist at Earthquake Science Center, USGS.

1 Introduction

In 2012, DOE released a Protocol for Addressing Induced Seismicity with Enhanced Geothermal Systems (EGS). The Protocol identified 7 steps (as shown in Figure 1) for addressing induced seismicity issues as they relate to the whole project. This induced seismicity screening worksheet is to be used by BLM staff as a preliminary screening evaluation as suggested by Step 1 of the Protocol. See the Protocol (Majer et al., 2012) and best practices document (Majer et al., 2016) for detailed information on Steps 2 through 7.

Step 1 Perform a preliminary screening evaluation.

Step 2 Implement an outreach and communication program.

Step 3 Review and select criteria for ground vibration and noise.

Step 4 Establish seismic monitoring.

Step 5 Quantify the hazard from natural and induced seismic events.

Step 6 Characterize the risk of induced seismic events.

Step 7 Develop risk-based mitigation plan.

Figure 1. **Screenshot of the steps in addressing induced seismicity as taken from Majer et al. (2012).** The BLM induced seismicity screening worksheet is to be used by BLM staff as a preliminary screening evaluation as suggested by Step 1 (red oval) of the Protocol. See the Protocol (Majer et al., 2012) and best practices document (Majer et al., 2016) for detailed information on Steps 2 through 7.

1.1 Data necessary for applying Induced Seismicity Screening Worksheet

When an operator submits a project with the potential for induced seismicity, make sure to gather the following information necessary to apply the ISS Worksheet:

❑	Operator's communication and mitigation plan	from Applicant
❑	Operator's compliance track record	from PET/GET at State Office
❑	Fluid injection plan (injection pressure, flow rate, total volume of injected fluid)	from Applicant
❑	Location of wellbore	from Applicant
❑	Regional historical seismicity (M2.0+ seismic events within 20 km radius)	from Applicant and/or USGS (See Section 2.2)
❑	Closest population center, and sensitive/critical infrastructure	from Applicant and/or Google Earth/Maps (see Sections 2.3.3a through 2.3.3d)
❑	Fault map of the area	from Applicant and/or USGS (see Section 2.3.3e)

1.2 Scope of BLM's Induced Seismicity Screening Worksheet

With guidance from a multi-agency Induced Seismicity (IS) Expert Team, the National Renewable Energy Laboratory (NREL) has prepared an Induced Seismicity Screening Worksheet (ISS Worksheet, Appendix A) and this accompanying guidance document for the BLM. The ISS Worksheet was designed to assist BLM field staff with evaluating the risk of induced seismicity caused by fluid injection for hydraulic stimulation to create an Enhanced Geothermal Systems (EGS) reservoir.[1] EGS reservoirs are man-made reservoirs in rock formations where temperatures are high but permeability is poor and often little to no water is present.

The potential for induced seismicity at an EGS site is different for each site, and the assessment of the impact of induced seismicity must be done on a case-by-case basis. Each site will have uncertainties in its properties and the unknowns will be different for each site. Therefore, the overall assessment of induced seismicity must be done as a sum of all the impacts, rather than each different potential parameter on the impact of induced seismicity.

The experts have suggested that the most reliable means for successfully dealing with induced seismicity is to follow the process in the Induced Seismicity Protocol, which starts with screening community outreach and ends with mitigation (i.e., a mix of sociology, engineering, hypothesis-driven science, risk analysis, and, if all else fails, politics, and insurance). Hence, one size does not fit all. Skipping one of the steps, or not using the right amount of each element at the right time, may lead to high costs or even failure.

Section 2 provides step-by-step guidelines for providing input data to the ISS Worksheet, as well as technical background information for each question. Section 3 discusses how to interpret and respond to the ISS Worksheet output. Appendix C provides four examples of EGS project sites and their concern of induced seismicity assessed with the ISS Worksheet. Appendix A includes the ISS Worksheet.

1.3 Hydraulic Stimulation and Induced Seismicity

In EGS, geothermal reservoirs are hydraulically stimulated to increase the reservoir rock permeability and connectivity and thereby enhance the overall performance of the reservoir. Hydraulic stimulation—or hydro-shearing—is one technique among others (e.g., acid and thermal stimulation) applied to treat hydrologically poorly performing wells. Hydraulic stimulation is performed by injecting high volumes of water (often cold and clean) into the reservoir at high pressures and high flow rates. This fluid raises the pore pressure, which will promote slip across *pre-existing* fractures (hydro-shearing), resulting in increased permeability. This stimulation differs from the hydrofracking done in the oil and gas industry, which uses a mixture of chemicals to actually shatter the rock. The process breaks the rock and creates new cracks or fractures in the rock, often propping them open with sand or other proppant material. Hydraulic stimulation for EGS typically uses lower injection fluid pressures and but larger injection fluid volumes, and does not require proppants.[2]

[1] Geothermal projects regularly inject fluids (geothermal or otherwise) into the geothermal reservoir to maintain reservoir pressure. The corresponding injection rates and pressures are typically significantly smaller than those used for hydraulic stimulation and usually do not cause a *net* increase of fluid volume in the reservoir (an equal amount of fluid is extracted from the reservoir by the production wells during regular operation). As a result, these activities typically are not of concern for causing significant seismic events (which may cause damage at the surface).

[2] Elevated pressure during EGS stimulation may cause creation of new fractures (hydrofracking).

Opening up pre-existing fractures and creating new fractures causes microseismic events also known as induced seismicity. Hydraulic stimulation often creates only small microseismic events that are not felt at the surface and that are a useful reservoir management tool (e.g., for mapping the extent of an EGS reservoir). It does not often lead to medium- or high-magnitude events, but the possibility increases with more aggressive stimulation, especially near large faults that are close to shear failure. Even if earthquakes large enough to be felt occur, they do not pose a risk unless a population center or critical infrastructures are nearby. Induced seismicity causes concern if the associated ground motions are felt or are damaging (Majer et al. 2007). Induced seismicity may become a legal nuisance, causing ceasing or modification of operations, even in the absence of actual damage.

Different magnitude scales have been developed for earthquakes. Historically, the Richter magnitude scale, developed in the 1930s, was widely used and is calculated as the base-10 logarithm of the ratio of the seismic wave amplitude with respect to a reference amplitude at a standard distance. Because the Richter magnitude scale tends to saturate at large magnitudes and is unreliable for measurements at large distances from the epicenter, the standard in seismological communities since the 1970s is the **moment magnitude scale**. The moment magnitude is based on the seismic moment of an earthquake, which is calculated as the product of the average slip, the fault area, and the modulus of rigidity. Unfortunately, this type of magnitude scale is not always included in reports and news articles. Both magnitude scales, however, follow a similar logarithmic trend and usually result in similar magnitude values for the same event. Throughout this document, the seismic moment magnitude scale is labeled as M whereas a magnitude expressed using the Richter magnitude scale is labeled as M_L (with L referring to "local"), following seismological community practices.

Earthquake magnitudes quantify the size of an earthquake on a logarithmic scale to account for the vast spectrum of seismic event size. The magnitude of an earthquake depends on the area of a fault rupture, the amount of slip on that area, and associated rock properties. The fault rupture excites seismic waves, which, in turn, are dependent on various rock properties as they travel from the earthquake location to locations where these waves may excite ground motions that can be felt or cause damage.

Magnitude does not vary as a function of distance from an event, but ground motion does. It is the ground motion at sensitive sites that governs the hazard posed by earthquakes.

1.4 Identifying Risk

The most infamous EGS case history is likely the 2006 Basel 1 EGS project in Switzerland. The project site was located in downtown Basel with known historic seismicity and the presence of nearby active faults. A naturally occurring M 6.0 to 6.9 earthquake in the year 1356 destroyed downtown Basel and is considered the most significant seismological event to have occurred in Central Europe in recorded history (RMS, 2012). In December 2006, a 21-day hydraulic stimulation was planned for the Basel 1 well. Increased seismic activity (with a maximum event of M_L 3.4) resulted in structural damage of nearby buildings and 2,700 damage claims by local residents, which triggered a premature halting of fluid injection (within 6 days of the start of injection), and eventually it terminated the whole project (GPB, 2007; Häring et al., 2008). More information on the Basel 1 EGS project is provided in Example 1 of Appendix C.

The 2006 Basel 1 EGS project is one of the few EGS projects known, among about a dozen EGS projects developed so far worldwide, to have seen damage at the surface caused by induced seismicity. Examples of EGS Projects without surface damage are Fenton Hill, Newberry, Brady Hot Springs, and Desert Peak in the United States, Soultz-sous-Forest and Rittershoffen in France, Rosemanowes in the United Kingdom, Cooper Basin in Australia, and Ogachi and Hijiori in Japan. All of these EGS projects were in locations more remote than the Basel project, and most of these projects saw seismic events of lower magnitude than in Basel. The Basel, Newberry, Brady Hot Springs, and Desert Peak EGS projects are discussed in more detail in Appendix C.

The earthquake activity induced by the Basel 1 EGS project resulted in the development of the "IS Protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems" by the Department of Energy (DOE) in 2008 (Majer et al. 2008) and an updated protocol in 2012 (Majer et al. 2012). This IS protocol was developed to guide geothermal developers in managing induced seismicity and applying EGS technology safely. It suggests seven steps for an operator to follow when given permission to perform activities that may cause induced seismicity:

1. Perform a preliminary screening evaluation.
2. Implement an outreach and communication program.
3. Review and select criteria for ground vibration and noise.
4. Establish local seismic monitoring.
5. Quantify the hazard from natural and induced seismic events.
6. Characterize the risk of an induced seismic event.
7. Develop a risk-based mitigation plan.

Follow-on work included developing a "decision tree towards permitting" for the BLM and DOE by Majer (2014). The decision tree is an example of a preliminary screening evaluation (Step 1 of the IS Protocol) and provided some of the basis for the ISS Worksheet. The decision tree proposed by Majer (2014) has not been implemented at BLM because of the level of seismologic expertise required.

In 2016, Majer et al. developed a guidebook, "Best Practices for Addressing Induced Seismicity with Enhanced Geothermal Systems (EGS)," for the DOE that builds on the IS Protocol and provides additional detail for each of the seven steps, including guidance for evaluating ground vibration and noise criteria and conducting a seismic hazard analysis.

In 2017, the ISS Worksheet (Appendix A) and this supporting guidance document have been developed after literature review and in collaboration with the IS Expert Team. The ISS Worksheet is designed to be applied by non-seismologists at local BLM field offices at the initial stage of permit review when an application is submitted by a geothermal developer. It fulfills Step 1 of the IS Protocol, and it evaluates Steps 2 and 7. The ISS Worksheet guides the user through 17 questions related to operator performance, geothermal project technical details, historical local seismicity, and proximity to faults and population centers. This guidance document is intended to help BLM staff use the ISS Worksheet to assess if any aspect of geothermal hydraulic stimulation project submitted by an operator is of concern which would trigger the need for an expert being involved to carefully asses the seismic risk.

A **seismic hazard** is the probability that an earthquake will occur in a given geographic area, within a given window of time, and with ground motion intensity exceeding a given threshold.

Seismic risk is defined as the probability of loss or damage due to seismicity (Majer et al., 2016). In other words, seismic risk is not the probability of induced seismic events happening, but goes further to consider the probability of damage or loss at the surface caused by induced earthquakes.

The ISS Worksheet does not intend to calculate seismic risk. Rather, it flags if something is of concern (e.g. nearby population center or massive injection rates) which would trigger a review by the State Geothermal Program Lead likely in consultation with a seismologist who would estimate the seismic risk. Based on the answers to the ISS Worksheet questions, there are four possible outcomes:

1. Issues to be resolved with the operator before screening can continue
2. Low level of concern project
3. Medium level of concern project
4. High level of concern project.

Low-level concern projects can proceed with the next steps in the approval process. Projects with higher levels of concern are flagged and need additional review by the BLM State Office and/or a seismologist, which may include an induced seismicity mitigation plan and a probabilistic seismic hazard analysis (PSHA). In some cases, the seismologist may believe that the risks cannot be sufficiently mitigated and may recommend that the BLM deny the permit.

Even when the screening indicates a medium or higher level of concern, indicating a need for analysis by a qualified seismologist or structural geologist before further processing can proceed, there is value to both the BLM and the operator. Denying a permit at the preliminary screening phase would be exceedingly rare, but may save the operator millions of dollars by (1) not developing a project that may be halted prematurely due to seismic activity, and (2) preventing earthquakes that could cause structural damage, resulting in damage claims by local residents. Operators may choose to redesign their project for re-evaluation.

The Basel 1 EGS project is a prime example illustrating the importance of performing a preliminary IS screening. Example 4 in Appendix C illustrates that the Basel 1 EGS project would not have passed the preliminary screening and the project would not have moved forward.

Final approval or rejection is not intended to be based solely on the outcome of this ISS Worksheet. Even when all questions are answered "yes," a second review by a State Office geologist or subject-matter expert before proceeding with the project can be useful for lowering the possibility of human error in the first review. The ISS Worksheet is not intended for evaluating oil and gas operations, wastewater injection, acid stimulation, or geothermal heat pumps.

2 Induced Seismicity Screening Worksheet Questions and Input Data

The ISS Worksheet contains 17 questions grouped into four categories:

1. Screening Worksheet Applicability (questions 1a to 1e)
2. Operator and Project Details (questions 2a to 2e)
3. Seismicity (question 3a)
4. Proximity (questions 4a to 4e).

This section provides guidance on how to evaluate the information derived from the 17 questions, where to find the input data, relevant technical background information, and the reason for including these questions in the ISS Worksheet. Four examples are included in Appendix C to illustrate how to answer the questions when applying the ISS Worksheet to an EGS project.

2.1 Screening Worksheet Applicability

The Induced Seismicity Worksheet is only to be used by the designated (trained) Field Office employee to conduct a broad preliminary assessment of the seismic risk of fluid injection for hydraulic stimulation for a geothermal project. Therefore, the following 6 questions are asked upfront to the screening worksheet is correctly applied:

- 1a. User of this screening worksheet is designated field office employee?
- 1b. All necessary data has been collected to apply this screening worksheet (ref. data checklist in Section 1.1 of this guidance document)?
- 1c. Project concerns geothermal project (i.e. no oil & gas project)?
- 1d. Project concerns geothermal wells deeper than 400 m (i.e. no geothermal heat pumps)?
- 1e. Project does not concern acid stimulation, tracer test, or clean-out?
- 1f. Project does not concern regular fluid injection during normal power plant operation (ref. UIC)?

Only if the answers to these six questions is “yes”, the user can continue applying the worksheet.

2.2 Operator and Project Details Questions

2a. Operator has communication and mitigation plan?

As identified by the U.S. DOE Induced Seismicity Protocol (Majer et al 2012) and the Best Practices Guidebook (Majer et al. 2016), an operator should have a communication and mitigation plan in place. These plans typically are part of the application package submitted by the developer to the BLM to conduct a geothermal hydraulic stimulation job.

A communication plan is necessary to establish a positive relationship with and gain acceptance from the community. Establishing this relationship early may result in the community being more favorably inclined toward the project. In addition, different communities have different risk acceptance levels and socio-economic needs. Engaging the community allows one to assess the risk acceptance level and identify the public concerns.

The communication plan shall explain how the local community will be informed and engaged. Specifically, it is recommended that the communication plan address the following five items, as identified in the U.S. DOE Induced Seismicity Protocol (Majer et al. 2012):

1. Identify the outreach needs
2. Develop a plan to approach community, stakeholders, regulators, and public safety officials
3. Develop a public relations plan to generate interest in the project from local media
4. Set up a local office in the community, ideally including technical displays for visitors
5. Hold an initial public meeting and site visit that covers both technical and non-technical issues.

A mitigation plan is necessary because some level of mitigation might be needed during the project.[3]

The developer should have a plan prepared that explains where IS monitoring stations will be placed, how long the monitoring will take place prior to the project to establish baseline seismicity, the threshold levels of induced seismicity that trigger mitigation, the type of mitigation associated with each threshold level, and a description of how the operator plans to address nuisance and damage associated with these operations. The mitigation plan should specify what type of direct and indirect mitigation measures will be taken if mitigation becomes necessary during the fluid-injection activity (Majer et al. 2012). The most common direct mitigation measure is the traffic light system to control pumping operations based on measured seismicity activity. Indirect mitigation measures can be compensation, community support (e.g., support for local schools and libraries), increased outreach, and continuous seismic monitoring.

[3] An example mitigation plan will be included in the final documentation for this BLM/NREL IS Task.

2b. Operator has excellent track record of compliance?

This question was not explicitly identified as a criterion in the preliminary 2014 IS screening decision tree (Majer 2014) or in the U.S. DOE Induced Seismicity protocol (Majer et al. 2012). However, the IS Expert Team felt that an operator with a poor performance track record (e.g., issued Incidents of Non-Compliance, caught on negligence) should demonstrate that their historical poor performance has been addressed and prove that improvements in operation procedures and compliance with standards/rules have been applied before the project can continue.

The information to answer this question is available from the BLM petroleum/geothermal engineering technician (PET/GET) who inspects the site or applicant and by reviewing previous communication between the BLM and applicant. The answer to this question is no if <u>any</u> of the following is true:

1. The operator has been issued Incidents of Non-Compliance (INC) forms that have been unaddressed
2. The operator has failed to respond satisfactorily to BLM inquiries regarding negligence
3. The operator has a habit of not informing the BLM satisfactorily and on time of any subsurface activity.

2c, 2d, and 2e. Volume, Rate, and Pressure of Injection

In a general sense, the volume (question 2c), rate (question 2d), and pressure (question 2e) of injected fluid will all affect the potential for induced seismicity. Also, factors such as the local subsurface stress values, proximity to faults, and size and extent of existing faults will all affect the potential for induced seismicity. Below is some general guidance that was based on observed induced seismicity examples. Exceeding or limiting the values for any one factor is not a reason for stopping or proceeding with the project, since all factors must be considered together for any specific site. Instead, it is important in these cases to involve a seismologist on the evaluation.

2c. Anticipated net total volume of injection fluid for the project is less than 13 million gallons?

This question is incorporated in the ISS Worksheet due to the relationship between the total injection-fluid volume (for the stimulation project) and the maximum magnitude of an induced earthquake (McGarr 2014, Majer 2014). In theory, a volume of 13 million gallons (5×10^4 m^3) can cause an M3.9 event if all energy is released at once (for granite with shear modulus of 27 GPa) and with $K = 0.5$ (Majer 2014). To incur major structural damage,[4] at least an M5.0 event would be needed within a few km distance (Majer et al. 2012). A list of induced seismic events is shown in Table 1. Only the first two rows apply to EGS, with Basel the only known EGS project to have seen surface damage due to induced seismicity.

[4] Major structural damage is defined as damage to buildings, bridges, or other infrastructure so severe they become unsafe to occupy or access.

Table 1. Select "Maximum Observed Events" Related to Subsurface Fluid Injection
Only the Basel and Cooper Basin examples are EGS-related and would be appropriate activities for the application of the IS Worksheet.

Maximum Observed Event	Location	Size	Year	Injection Volume (million gallon)	Maximum Injection Rate (gpm)	Maximum Injection Pressure (psi)	Activity	Impact	Source
Damage caused by EGS-related event	Basel, Switzerland	M_L 3.4	2006	3	925	4,300	hydraulic stimulation	minor cosmetic damage (e.g. cracks in walls), which resulted in 2,700 damage claims	Majer et al., 2007; 2012
EGS-related event	Cooper Basin, Australia	M 3.7	2003	5	760	11,000	hydraulic stimulation	no damage because project site was in remote desert location	Majer et al., 2007, 2012
Geothermal-related event	Geysers Field, CA	M 5.0	2016	350,000 (for 75 injection wells over 45 years)	14,000 (for 75 injection wells)	Unknown	combination of massive production and injection rates in a tectonically-active region	event was felt by people in several nearby towns but no damage reported	USGS, 2016
Fluid injection-related event	Prague, OK	M 5.7	2011	42	9	525	wastewater injection from oil and gas operations	injured two people, destroyed 14 homes, damaged many other buildings, and buckled pavement	Keranen, 2013

The anticipated volume of injection fluid should be provided by the operator in their Plan of Operations as part of the application package. Unit conversions are necessary if the volume is expressed in different units.[5] If a hydraulic stimulation job includes different fluid injection phases, the total volume is calculated as the sum of the injection volumes planned in each phase. If the operator provides injection data in terms of injection rates and injection time, the total volume (or the volume in each phase) is calculated as the injection rate multiplied by the injection time (for that phase).

2d. Anticipated rate of injection fluid less than 650 GPM?

This question is included in the ISS Worksheet because the injection rate is identified as one as the factors that have an impact on induced seismicity (Majer et al. 2016). Majer et al. (2016) suggest that during a fluid-injection operation, if sufficiently high magnitudes are detected, then rate limitations based on a traffic light protocol should be imposed. Generally, if a magnitude threshold is exceeded, then the traffic light switches to orange, which imposes a reduction in injection rate. Higher magnitudes may trigger a red light, in which case injection is stopped until further notice.

For the purposes of this ISS Worksheet, the IS Expert Team calculated an injection rate of 650 GPM (41 L/s) as the screening threshold, (corresponding to 13 million gallons of fluid injection in 2 weeks for Question 2c).

[5] 1 m^3 = 1000 L = 264 gallon = 8.4 barrels

The anticipated rate of injection fluid should be provided by the operator in their Plan of Operations as part of the application package. Unit conversions are necessary if the volume rate is expressed in different units.[6] If a hydraulic stimulation job includes different fluid injection phases, the volume rate considered is the maximum across the different phases. If the operator provides injection data in terms of total volume and injection time, then the injection rate is calculated as the injection volume divided by the injection time (potentially calculated for each phase).

2e. Anticipated wellhead injection pressure less than or equal to 1000 psi?

This question is included in the ISS Worksheet because the injection pressure is identified as one of the factors that have an impact on induced seismicity (Majer 2016). For induced seismicity to occur, the pressure at the depth of injection must exceed the forces holding any faults in the injection volume from slipping.[7] One of these forces preventing the fault from slipping is the pressure acting perpendicular to the fault (normal stress). Any pressure (injection pressure) added to the water pressure in the borehole will add to the pressure acting against the "normal" forces that are holding the fault from slipping. If the fault if close to slipping, it may take very little added pressure (injection pressure) to induce the fault to slip. If the forces holding the fault from slipping are large, or the natural forces promoting fault slip are small, then it may take a great deal of injection pressure to generate induced seismicity.

The value of 1000 psi injection at the wellhead was chosen because this wellhead pressure would translate in a downhole pressure large enough to overcome natural forces holding the fault from slipping. However, much lower injection pressures can cause induced seismicity, depending on subsurface stress, proximity to faults, and the rates and volumes of injected fluid.

The anticipated **wellhead injection pressure** and **depth of the stimulation target zone** should be provided by the operator in the Plan of Operations as part of the application package. If a hydraulic stimulation job includes different fluid-injection phases, then the wellhead injection pressure considered is the maximum pressure across the different phases.

2.3 Seismicity Question

3a. Historical seismicity within 20 km less than M2.0?

This question is included in the ISS Worksheet because "being in an active earthquake zone" was one of the questions included in the 2014 preliminary IS decision tree (Majer 2014). An "active earthquake zone" was defined as an area that experienced seismicity (naturally or induced) > M1.5 in the last 5 years within 10 km (Majer 2014) or within 30 km (Majer et al. 2013). Based on this information, the IS Expert Team:

1. Set an average value of 20 km as the distance threshold for the ISS Worksheet; and
2. Changed the time period from "5 years" to "recent history" because some scientists within the earthquake community state that an active earthquake zone should have a time scale of hundreds or thousands of years instead of 5 or 10 years. For example, an active fault in California is defined as fault that has moved in the past 35,000 years (Majer et al. 2016).

The operator should have identified the historical seismicity in the area to characterize the background seismicity as part of the mitigation plan. Historical seismicity includes both natural and induced

[6] 1 m^3/day = 0.0116 L/s = 0.184 GPM = 8.4 U.S. barrels/day

[7] At almost any site, there are natural subsurface forces acting to make faults slip; however, friction on the fault surfaces, rock strength, and other forces are preventing the faults from slipping.

seismicity. A map is likely included showing historical seismicity, and a ruler can be used to measure distance to the project site. In addition, it is recommended to consult the USGS earthquake database (http://earthquake.usgs.gov/earthquakes/search/) as well as news articles to identify any other seismic events of M2.0 or larger not listed by the operator. The project site location corresponds to the coordinates (longitude/latitude) of the wellhead of the well considered for fluid injection.

2.4 Proximity Questions

3a. Closest significant population center more than 10 km away?

This question is included in the ISS Worksheet because seismic activity can only be of high risk if it is close enough to a population center that it may cause significant annoyance or disturbance to the local population, or close enough to critical infrastructure that it may pose a risk to existing (or future) structures (Majer et al. 2007). Some sites are very remote, and thus, there is little public concern regarding induced seismicity. The 2014 preliminary IS screening decision tree (Majer 2014) did not specify a distance-to-population-center criterion, only a distance-to-sensitive-site criterion (see Questions 3c & 3d). As recommended by the IS Expert Team, a population-center-proximity criterion is included in the ISS Worksheet. The same distance threshold (10 km) is used for population centers as was used for a sensitive facility (see Question 4e); but in this case, it does not result in immediate consultation with the State Office when answering “no” (as is the case for Question 4e).

A significant population center is defined as a community with at least 100 people. The operator should identify the well that will be used for fluid injection in the operations plan as part of the application package. The coordinates of the injection zone[8] should be used as project location, which becomes the center of a circle with 10-km radius drawn in Google Earth. If infrastructure in a significant population center is within the circle, the answer to Question 3a is “no.”

4b. Closest population center with historical opposition more than 15 km away?

A specific question concerning population centers with historical opposition is included in the ISS Worksheet because Majer et al. (2012) identified that *“… different communities may have different acceptance levels of risk, and/or possibly different socioeconomic circumstances*.” Majer (2014) listed a “hostile public” as a factor that could automatically disqualify a site. A hostile public may become less hostile with an effective communication plan (see Question 2a). Therefore, immediate disqualification is not applied in this ISS Worksheet; instead, an additional screening by seismic experts is triggered if a population center with historical opposition is within 15 km of the project site.

The same tools and data used for answering Question 4a can be applied for addressing this question—with the threshold now at 15 km instead of 10 km. Whether or not a population center has had historical opposition is subjective. It is recommended to first consult with the operator, who should have obtained a feeling for this after developing the communication plan. Also, review of news articles and knowledge within the BLM on past projects in the area can provide a sense of where the community stands with respect to induced seismicity, hydraulic stimulation, and development of energy projects (in particular, geothermal and oil and gas projects). For this question, communities with a population less

[8] Deviated wells are very common in geothermal reservoirs. Wellhead locations can differ by up to a km from the injection zone, depending on the deviation of the well and depth of the well.

than 100 people should be considered because one individual can take legal actions potentially resulting in the project being halted in court for years.

4c. Proximity to closest sensitive or critical site/facility is more than 20 km away?

Note: A sensitive site/facility is any of the following: archeological or historic sites: national park, state park, or national natural landmark deemed vulnerable to felt ground motion (such as dams); research laboratory; chemistry laboratory; hospital; semiconductor manufacturing facility; or facility with sensitive electronics (electron microscope, photolithography machines, electron deposition machines, laser interferometers, laser metrology systems, or machining equipment, etc.)

This question is similar to the 15-km proximity criterion to a sensitive/site facility in the 2014 preliminary IS screening decision tree (Majer 2014) and results in requiring additional expertise review at the Field Office level, potentially in collaboration with the State Office, instead of immediate elevation to the State Office level (as in Question 4e). As recommended by the IS Expert Team, the distance threshold is set to a more conservative value of 20 km instead of 15 km.

The same tools and data used for answering Question 4a can be applied for addressing this question.

4d. Closest fault with length larger than 0.5 km more than 10 km away?

This question is included in the worksheet because nearby active faults are reasons for concern for induced seismicity as stated by several references:

- "*The maximum event will depend upon the size of the fault available for slippage*" (Majer et al. 2007)
- "*Large or damaging earthquakes tend to occur on developed or active fault systems. In other words, large earthquakes rarely occur where no fault exists, and the small ones that do occur do not last long enough to release substantial energy*" (Majer et al. 2012)
- "*As a general rule, EGS projects should be careful with any operation that includes direct physical contact or hydrologic communication with large active faults*" (Majer et al. 2012)
- "*Near large faults (ones that may generate events larger than acceptable levels)*" is identified as a factor that may automatically disqualify site (Majer, 2014).

The 2014 preliminary IS decision tree (Majer 2014) explicitly includes a criterion: "Is the expected diameter of pressured influence less than 3 times distance to any critically stressed faults greater than area of 500 meters by 500 meters?" This area can maximally cause a M3.5 earthquake, using the Kanamori and Anderson equation:

$$\text{Log } A = 1.21M - 5.05 \qquad \textit{Eq. 1}$$

where M = Magnitude and A = fault area in km^2. (Majer 2014)

This criterion is quite technical and cannot always be answered by BLM field office personnel. Therefore, the criterion was conservatively simplified by the IS Expert Team to "within 10 km of fault with length larger than 0.5 km." Note, however, that nearly all faults that have been associated with induced seismicity have been discovered by the earthquake locations due to the induced seismicity. They are buried faults that were not accessible to geologists in the field for mapping.

Known faults in the EGS area should have been identified by the operator's seismic expert and included in the Plan of Operations as part of the application package. A map is likely provided with known faults, well location, and scale. In addition, it is recommended to consult the USGS Quaternary faults website (http://earthquake.usgs.gov/hazards/qfaults/map/#qfaults) to identify any other faults with length longer than 0.5 km within 10 km of the project site. This faults database, which includes the lengths of the faults, can be downloaded as a shapefile to use in geospatial software for easy measurement of distance from project site to faults. The project site location corresponds to the coordinates (longitude/latitude) of the wellhead and bottom-hole location (if different) of the well considered for fluid injection.

4e. Closest sensitive or critical site/facility more than 10 km away?

This question is included in the ISS Worksheet because a project site close to a sensitive facility (e.g., historical artifacts, hospitals) was identified as a factor that may disqualify a site (Majer 2014). Sensitive sites have very low tolerance to ground motion (Majer et al. 2016). In contrast, a critical site (e.g., nuclear power plant) may have high tolerance for ground motion but because of the dire consequences if damage occurs, much lower probability ground motion must be accommodated. Acceptable induced seismicity ground motion could be much less than what most buildings and people can tolerate. The 2014 preliminary IS screening decision tree (Majer 2014) has a 15-km proximity criterion to a sensitive site/facility that triggers a seismic risk and hazard analysis by experts. It was recommended by the IS Expert Team to include in the ISS Worksheet a similar criterion that automatically elevates the project to the State Office level but with a smaller distance threshold at 10 km instead of 15 km. The State Office will conduct an in-depth review (likely in consultation with industry or academic experts) to assess the seismic risk of the project, taking into account the presence of a nearby sensitive or critical site/facility.

The same tools and data used for answering Question 4a can be applied for addressing this question. A sensitive site/facility is any of the following: archeological sites: national park, state park, or national natural landmark deemed vulnerable to ground motion; research laboratory; chemistry laboratory; hospital; semiconductor manufacturing facility; or facility with electron microscope, photolithography machines, electron deposition machines, laser interferometers, laser metrology systems, or machining equipment.

3 Interpreting and Responding to ISS Worksheet Output

The ISS Worksheet has four possible outcomes with different BLM actions for each outcome:

3.1 Resolve Issues with Operator

In case Questions 1a and/or 1b are answered "no," an issue has arisen with the operator that needs to be resolved before screening or further processing of the permit can continue. BLM staff should reach out to the operator to explore if the operator can resubmit an acceptable communication or mitigation plan (Question 1a) and/or explain how past negligence or non-compliance has been addressed, resolved, and prevented from happening again in the future (Question 1b). If the issues are resolved, the screening can continue with Question 1c; otherwise, the screening is terminated and the IS Expert Team recommends that the BLM reject the project.

3.2 Initial Screening Passed

If all questions are answered "yes," then the ISS Worksheet did not identify any reason for concern of induced seismicity, and the project is considered to have **low level of concern**. The IS Expert Team recommends that the BLM continues with the next steps in the approval process. The State Office should be informed of the outcome of the initial screening and may still require that the full DOE IS Protocol be implemented by the operator (e.g., install geophones network to detect seismicity, conduct educational workshops with local community if local community is present engage qualified expert to conduct analysis to forecast or calculate a qualitative seismic hazard and to characterize the probability or risk of damage or harm, should such an even occur).

3.3 Medium level concern: Proceed with evaluation and involve State Office Geothermal Program Lead

If the answer to any of the Questions in Section 2, 3 or 4 except Question 4e is "no," then the project is considered to have **medium level of concern**. The BLM Field Office level should involve the State Office Geothermal Program Lead who may obtain the services of a seismic expert and potentially apply the Induced Seismicity Protocol before a decision can be made. The risk would typically increase with more questions answered "no." It is recommended that the seismologist reviews these questions and answers and conducts a full seismic hazard and risk analysis to make a decision on the risk level of induced seismicity. If the **seismologist** concludes that the seismic risk is **low**, then the IS Expert Team recommends that the BLM approve the project to proceed under the condition that the DOE IS Protocol is implemented by the operator. If the **seismologist** concludes that the seismic risk is **medium** or **high**, then the IS Expert Team recommends that the BLM may reject the project.

3.4 Higher level concern: Do not proceed until first contacting State Office Geothermal Program Lead

If the answer to Question 4e is "no," then the project site is relatively close to a sensitive site/facility, and the project is considered to have **high level of concern**. A sensitive site/facility has low tolerance to nearby seismic events—even of relatively low ground motion from events that are very likely to occur by any hydraulic stimulation job. The IS Expert Team recommends that that the BLM Field Office immediately contacts the State Office Geothermal Program Lead who will conduct an in-depth review (likely in consultation with industry or academic seismic experts).

The seismologist should determine the maximum probable event from the EGS activity over its lifetime, then determine the maximum event that nearby facilities or people are likely to tolerate. If the design EGS seismicity is larger, the project is considered to have **high seismic risk**.

The operator could be given the chance to redesign the project or its mitigation approach. For example, the operator could reduce the design earthquake by mitigating through engineering methods or other method (such as insurance). If this is uneconomical, the IS Expert Team recommends that BLM reject the project.

By rejecting the project at this initial stage (if mitigation is impractical/uneconomical), BLM prevents the operator from implementing the DOE Induced Seismicity protocol (costly for small operators) on a project that would have had a relatively high chance of failure.

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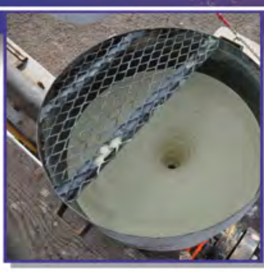

A Research Observatory for a Sustainable Future

Newberry Geothermal Energy

Establishment of the Frontier Observatory for Research in Geothermal Energy (FORGE) at Newberry Volcano, Oregon

Appendix J

Preliminary Induced Seismic Mitigation Plan

April 27, 2016

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Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
BHTV	borehole televiewer
BLM	Bureau of Land Management
cm	centimeter(s)
DCC	Deschutes County Code
DOE	U.S. Department of Energy
DOGAMI	Department of Geology and Mineral Industries
EA	Environmental Assessment
EGS	enhanced geothermal system(s)
FEMA	Federal Emergency Management Agency
FOA	Funding Opportunity Announcement
FONSI	Finding of No Significant Impact
FORGE	Frontier Observatory for Research in Geothermal Energy
ft	foot (feet)
g	gravity
GPa	gigapascal(s)
gpm	gallons per minute
HP	horsepower
Hz	hertz
in.	inch(es)
ISMP	Induced Seismicity Mitigation Plan
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
L	liter(s)
LBNL	Lawrence Berkeley National Laboratory
LiDAR	light detection and ranging
M	magnitude(s)
m	meter(s)
MEQ	micro-earthquake
mi	mile(s)
M_L	local earthquake magnitude
M_{max}	maximum magnitudes
MMI	Modified Mercalli Intensity
MSA	microseismic array

MW	megawatt(s)
NEGSD	Newberry Enhanced Geothermal System Demonstration
NEPA	National Environmental Policy Act of 1969
NEWGEN	Newberry Geothermal Energy
NNE	north-northeast
NNVM	Newberry National Volcanic Monument
OAR	Oregon Administrative Rules
ORS	Oregon Revised Statute(s)
PGA	peak ground acceleration
PGV	peak ground velocity
PNSN	Pacific Northwest Seismic Network
PSHA	probabilistic seismic hazard assessment
psi	pounds per square inch
s	second(s)
SGH	Simpson Gumpertz & Heger
S_{hmin}	minimum horizontal stress
SMS	strong-motion seismometer
SSE	south-southeast
SSW	south-southwest
T&R	Treadwell & Rollo
TZIM	thermally degradable zonal isolation material
URS	URS Corporation
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
V	volt(s)
W	watt(s)
WHP	wellhead pressure

Appendix J

Preliminary Induced Seismic Mitigation Plan

J.1 Summary

According to the Funding Opportunity Announcement (FOA) for the Frontier Observatory for Research in Geothermal Energy (FORGE) (DE-FOA-0000890), the selected FORGE site must comply with the current version of the "Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems" (Majer et al. 2012). Further, the FOA states that a Preliminary Induced Seismicity Mitigation Plan (ISMP) should be developed during Phase 1 that includes "a discussion and evaluation of the regional setting, structure, and stratigraphy as related to seismic risk, as well as a summary of any monitoring data collected prior to initiating the cooperative agreement."

Lastly, FORGE Phase 2A objectives include "establishing baseline seismic monitoring to comply with the Protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems and Best Practices for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems and to incorporate data into the hazard evaluation portion of the Preliminary Induced Seismicity Mitigation Plan." Phase 2A requires deployment of "a telemetered seismic monitoring array comprised of at least 5 surface stations capable of recording seismic events with magnitudes as small as magnitude 1.0, and preferably magnitude 0.0 and a minimum of 30 days of recorded seismic data." Clearly, planning for the Phase 2A microseismic array (MSA) needs to be described in the preliminary ISMP.

An enhanced geothermal systems reservoir is created by injecting fluid at high pressure into a rock formation, which increases fracture permeability and generates seismic vibrations, or "induced seismicity," that can be detected by seismometers and used to map enhanced geothermal system (EGS) reservoir growth.[1] Most induced seismic events have a magnitude less than 2.0 and are not felt at the surface. However, some EGS projects have generated events large enough to be felt and cause minor damage. Thus, it is critical that EGS projects follow procedures to evaluate, monitor, and mitigate the risk of felt or potentially damaging induced seismicity.

AltaRock Energy Inc. (AltaRock), supported by the U.S. Department of Energy (DOE) Energy Efficiency & Renewable Energy Geothermal Technologies Program (Award Number DE-EE0002777), conducted the Newberry EGS Demonstration (NEGSD) from 2011 through 2015. The National Environmental Policy Act (NEPA) permitting required by the NEGSD largely focused on development of an ISMP to allay concerns that the demonstration might result in excessive induced seismicity and unacceptable seismic risk. The ISMP developed for NEGSD (AltaRock 2011, hereafter referred to as the 2011 ISMP) was being developed at the same time as the Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems (Majer et al. 2012) that is now required on all EGS projects and the Newberry Geothermal Energy (NEWGEN) FORGE site. Hence, a complete ISMP has already been developed for the NEWGEN FORGE site. The 2011 ISMP requires updating in some areas because of 1) a better theoretical and empirical understanding of induced seismicity from geothermal, wastewater, and oil and gas hydraulic fracturing worldwide; 2) a better understanding of the seismic response of the NEWGEN FORGE site to hydraulic stimulation; and 3) well stimulation activities at the NEWGEN FORGE site under the proposed FORGE project will be operationally more varied than those of the NEGSD, which

[1] A primer on seismicity is provided in Section 0 for readers who may be unfamiliar with some terms.

focused on hydroshearing and zonal isolation involving treatments of thermally degradable zonal isolation materials (TZIM).

In this preliminary NEWGEN ISMP, the 2011 ISMP and the results of the NEGSD are incorporated into seven steps of the Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems. Further effort during FORGE Phase 2 will be needed to turn this preliminary NEWGEN ISMP into the final NEWGEN ISMP needed for the NEWGEN FORGE project. Thanks to significant previous effort during the NEGSD related to monitoring and analysis of induced seismicity, finalizing the ISMP will require far less effort than expected. Furthermore, the final ISMP will be among the most robust and well-supported of such documents in the world.

J.2 Background Information on the Proposed NEWGEN FORGE Site

Newberry Volcano in Central Oregon has been an area of ongoing geothermal energy interest since the 1970s. The Newberry Volcano National Monument (NNVM or Monument) was created in 1990 by a stakeholder group including the U.S. Forest Service, geothermal energy companies, and local citizens. The goal of creating the NNVM was to preserve the scenic beauty and the volcanic features inside the Newberry Volcano caldera, while providing for geothermal development and other uses on adjacent lands. During Monument creation, land that had been leased for geothermal development inside the caldera was exchanged for land outside the Monument boundaries with the proviso that the presence of the Monument would not preclude development of projects suitable to the site outside the Monument. A map of Newberry Volcano showing the NNVM boundary, the Newberry Unit (a collection of about 19,000 acres of U.S. Bureau of Land Management (BLM) geothermal leases operated by a subsidiary of AltaRock), and the NEWGEN FORGE site is shown in Figure J.1.

J.2.1 NEWGEN FORGE Site Selection and History of Geothermal Development

Geoscience investigations indicate that Newberry Volcano is one of the most promising EGS sites in the United States. It has a large conductive thermal anomaly yielding high-temperature wells, but with permeability orders of magnitude less than conventional hydrothermal wells. The NEWGEN site is highly favorable for the FORGE for many reasons, including temperature at depth, geologic stress regime, data available for resource characterization (including hydrology, geology, temperature gradient, and background seismicity), and a strong history of active stakeholder engagement in the local community.

In 1994, an Environmental Impact Statement was completed for CalEnergy Newberry for the “Newberry Geothermal Pilot Project” on the volcano’s western flank. In June 1994, the U.S. Forest Service (USFS) and the BLM issued a joint Record of Decision to implement the Newberry Geothermal Pilot Project. The approved project included exploration, development, and production operations for 14 well pads, a 33 MW power plant, a 115 kV transmission line, and supporting facilities on the west flank of Newberry Volcano, outside of the NNVM. In 1995, CalEnergy drilled four exploration holes, including two production-size bore holes. The CalEnergy wells showed very high temperatures (over 600°F at 9200 ft, or over 315°C at 2800 m), but extremely low permeability and were not productive (Spielman and Finger 1998).

In 2007, an Environmental Assessment (EA) of the Newberry Geothermal Exploration Project was completed for Davenport Newberry, which had acquired adjacent leases in 1997. A Finding of No Significant Impact (FONSI) was issued by BLM and USFS for this project, including temperature gradient drilling, geophysical exploration, and drilling of two deep exploratory wells. Davenport completed the drilling of exploratory wells NWG 55-29 and NWG 46-16 in July and November 2008, respectively. These holes both reached depths of over 10,000 ft (3000 m) and exhibited maximum temperatures of more than 600°F (315°C), but were not commercially productive.

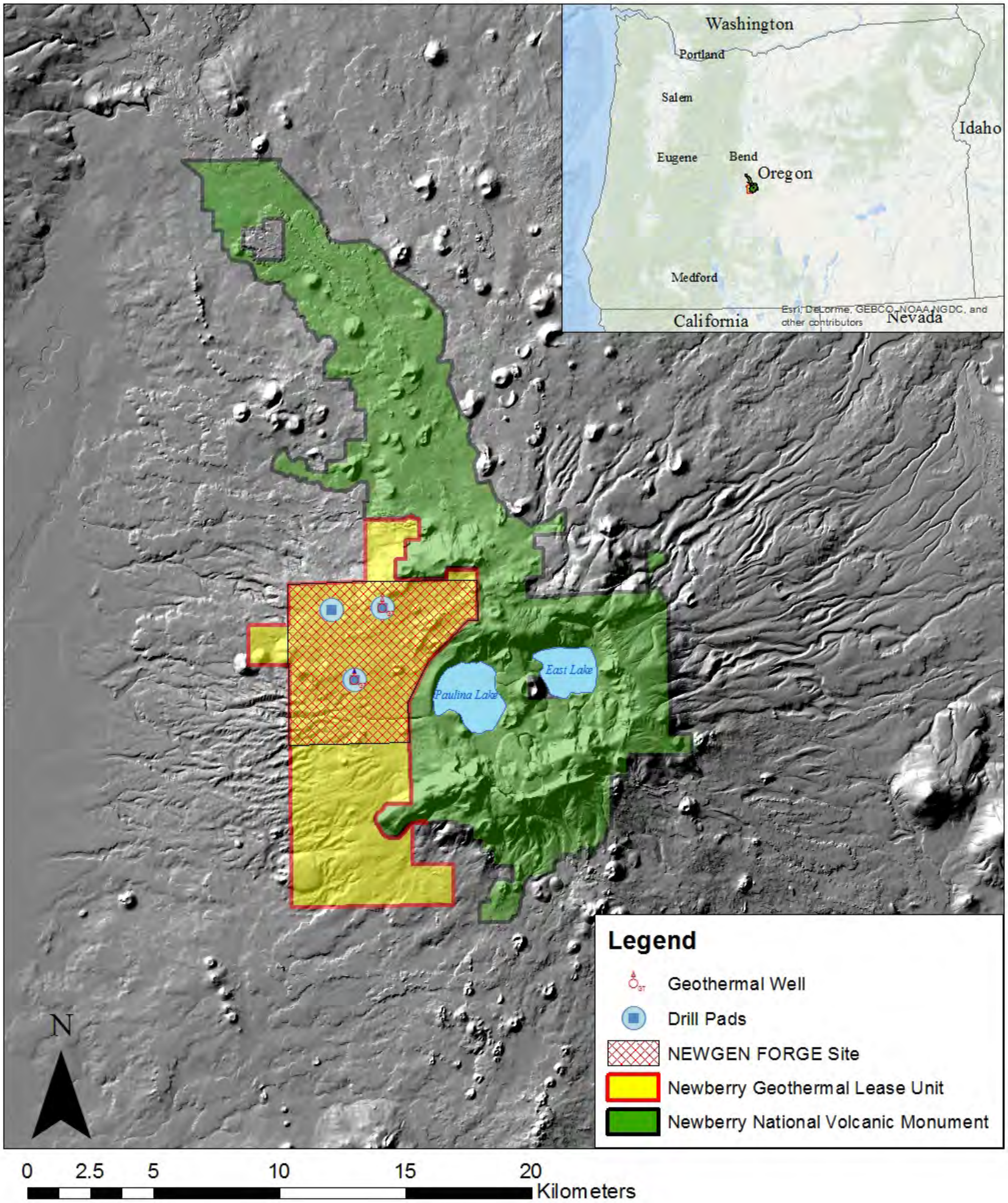

Figure J.1. Map of Newberry Volcano showing the NNVM, Newberry Unit, and NEWGEN FORGE site.

In 2009, to prepare a proposal to the DOE under the NEGSD Project FOA, AltaRock developed an extensive EGS site selection process. Criteria for EGS site selection included 1) temperature at depth; 2) tectonic stress; 3) geology; 4) fracturing and joint spacing; 5) existing resource information; 6) geophysics; 7) social, political, and environmental factors, including the ability to secure permits; and 8) economics. Two critical components of criteria 7 were environmental impact and seismic hazard susceptibility. Ten potential sites were evaluated using AltaRock's site selection process; the Newberry Volcano site scored highest for many reasons and an agreement was made with Davenport to partner on the proposal. The proposal was awarded, resulting in the NEGSD project that AltaRock led from 2010 through 2015.

Based on comments received at public meetings during Phases I and II of the NEGSD, AltaRock confirmed the initial pre-demonstration impression of a favorable social and political environment for geothermal development. Furthermore, the social and political support for NEGSD has continued to build as the community has learned more about geothermal energy and become comfortable with the low risk of induced seismicity at the site.

J.2.2 Newberry EGS Demonstration – 2011 ISMP

The 2011 ISMP is 56 pages long and includes 14 appendices. Development of the 2011 ISMP started with a contract with the URS Corporation Seismic Hazards Group (URS) to perform a comprehensive study of seismic risk at the NEGSD site and surrounding area. The objectives of the study were to 1) evaluate the baseline seismic hazards in the project area, including the nearby City of La Pine; 2) estimate the potential increase in seismicity rate and the maximum magnitude of an earthquake induced by the hydroshearing in injection well NWG 55-29; and 3) evaluate the increased seismic risk imposed by hydroshearing activities. The URS report and an addendum covers the entire area of the NEWGEN FORGE project and was incorporated into the 2011 ISMP as Appendices F and G.

In addition to the URS work on seismic hazard and risk, other third-party, independent consultants provided expertise to the 2011 ISMP effort. Their analyses included the following:

- assessment of M_{max}, the magnitude of the largest likely induced event during NEGSD, by Fugro WLA (William Lettis and Associates) (2011 ISMP--Appendix E)
- structural assessment of USFS assets in NNVM by Simpson Gumpertz & Heger (SGH; 2011 ISMP--Appendix H)
- geotechnical assessment of steep slopes and a dam on Paulina Lake by Treadwell & Rollo (T&R; 2011 ISMP--Appendix I).

Combining the results of the consultants, AltaRock developed procedures for control and mitigation of induced seismicity. The 2011 ISMP defined limits (or "triggers") that, if activated, would have initiated mitigation actions up to and including stopping injection and immediately flowing the well to reduce reservoir pressure. The largest seismic events detected during 2012 and 2014 reached the magnitude that required no further increase of injection rate and wellhead pressure (WHP). This did not affect operations during either stimulation because there were no plans to increase injection rate or WHP at the time of the events.

Due to the timing of the NEGSD during a period of heightened concern regarding the risk of induced seismicity and before the DOE had fully approved the *Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems* (Majer et al. 2012), the 2011 ISMP included some extra analyses worth mentioning. First, geoscientists from the AltaRock studied the history of injection-induced seismicity, starting with the Rocky Mountain Arsenal in 1967 and proceeding up through the Deep Heat Mining project in Basel, Switzerland. Some of the most relevant lessons learned from these projects are described in the 2011 IMSP, while details of AltaRock's analysis can be found in articles by Cladouhos et al. (2010, 2011).

Second, the 2011 ISMP included a section on "Recent Injection-Induced Seismicity Theory." The theory of induced seismicity has progressed a great deal in the last 5 years; therefore, much of this section is now out of date. However, the NEWGEN team is dedicated to further advancing the theory related to induced seismicity and mitigation of risk. We anticipate that if FORGE is awarded to NEWGEN, the site of the NEGSD on the flank of Newberry Volcano will once again be at the cutting edge of induced seismicity research and development.

Lastly, in writing the 2011 ISMP, AltaRock found that the audience—regulators from USFS, BLM, DOE, and local stakeholders—needed some education in seismology in order to understand the issues related to induced seismicity. Therefore, we wrote a primer on seismicity, which is also produced here as Section 0.

J.2.3 Conceptual Geologic Model

A conceptual geologic model is being developed as part of the NEWGEN project work currently underway. Over 40 years of geothermal research and exploration have taken place at Newberry Volcano. Bringing together data from geological, geophysical, geochemical, hydrological, seismic, and other studies, the comprehensive model will compile large- and small-scale information essential to understanding EGS development at Newberry Volcano. The model will be compiled in Earth Vision, a three-dimensional (3D) viewing platform that will allow remote access to researchers from across the country and around the world. Surficial geologic maps, stratigraphic columns, light detection and ranging (LiDAR), well log, seismic, gravity, magnetotelluric, and other data will be combined to generate the most comprehensive 3D subsurface model possible for Newberry Volcano. The software will allow multiple end-member modeling scenarios to be developed, and is flexible to accommodate new data as they become available. The geologic model will promote data interpretation and aid decision-making by reducing uncertainty. The model will be hosted at Pacific Northwest National Laboratory with remote access for researchers to view and access data. Further information about the conceptual geologic model can be found in Appendix A.

J.2.4 Tectonic and Geologic Setting

This section reviews the most salient aspects of the conceptual geologic model (Appendix A) for natural and induced seismicity risk. Newberry Volcano is located at the intersection of three distinct structural zones—the NNE-trending range bounding faults of the Basin and Range, the N-trending graben faults of the Cascade Range, and the NW-trending Brother's Fault Zone—each with a different tectonic history, deformation style, and fault orientation (Figure J.2).

In addition, the local stress state at the NEWGEN FORGE site may be complicated by its proximity to ring fractures associated with caldera collapse. Cladouhos et al. (2011) provide further information about the regional setting of Newberry Volcano.

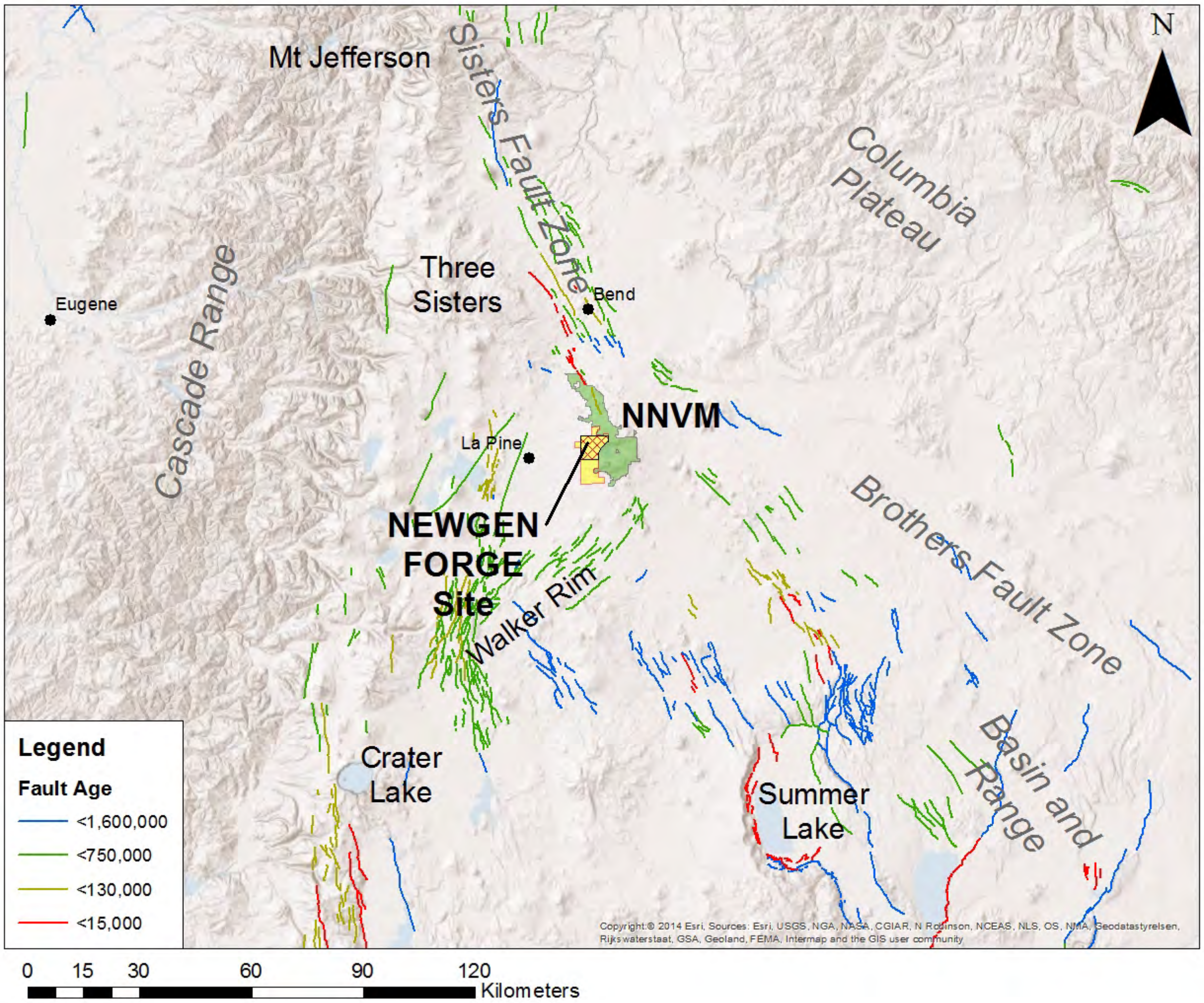

Figure J.2. Regional map showing the location of the Newberry Volcano (NNVM, NEGSD and NEWGEN sites) at the intersection of three structural trends in Central Oregon. Colored lines are faults from the U.S. Geological Survey Quaternary Fault and Fold Database of the United States.

Four caldera ring fractures have been mapped on the northwest flank of Newberry Volcano (Sherrod et al. 2004). In the U.S. Geological Survey (USGS) database (Personius 2002b), the ring fractures are classified as Class B: "Geologic evidence demonstrates the existence of Quaternary deformation, but either 1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or 2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A." In the entry for these faults Personius (2002b) states "these faults are everywhere concealed, and have been mapped on the basis of the topographic expression of these escarpments." Despite the tenuous nature of their identification, the ring fractures have been the target of two wells and two core holes drilled by CalEnergy Exploration. However, no geothermal fluids were encountered during these attempts (confidential CalEnergy report). Temperature core hole 88-21 encountered a highly sheared zone at a depth of around 3400 ft, which was initially interpreted as a ring fault dipping around 65 degrees toward the central caldera. However, only very minor fluid losses were encountered in this zone, and the equilibrated temperature profile measured across this interval was conductive, also indicating no fluid flow or permeability.

NWG 55-29, the NEGSD well, was drilled within 2 mi of the caldera rim and near the projection of ring fractures, so it was possible that it would intersect ring fractures. However, there is no evidence of ring fractures or faults in the NWG 55-29 well bore from drilling logs, mud logs, borehole televiewer data (see below), or cuttings analysis (Letvin 2011).

AltaRock joined the Oregon LiDAR consortium to add La Pine, the city nearest to the NEGSD and NEWGEN FORGE sites, to the 2010 LiDAR survey of Newberry Volcano and the Deschutes National Forest. In particular, AltaRock was interested in better characterizing the La Pine Graben faults shown in the USGS fault and fold database at the western edge of the valley (Personius 2002a), the ring fractures (Personius 2002b), and checking for evidence of faults or fractures in the NEGSD area. AltaRock's analysis of the 880 km^2 of new LiDAR data (Figure J.3) is discussed in detail by Cladouhos et al. (2011) and Grasso et al. (2012).

The ring fractures mapped in the USGS database are not prominent in AltaRock's LiDAR analysis. The ring fractures are expressed as curved lineaments defined by fissures and an alignment of vents that end more than 3 km (1.8 mi) from NWG 55-29. Dip-slip fault offset along the ring fractures is not observed in the LiDAR surfaces. To conclude, based on the results of CalEnergy Exploration, Davenport deep drilling, and LiDAR topographic mapping, the ring fractures do not appear to be active faults at a distance of 3 km (1.8 mi) to the northeast of NWG 55-29, nor is there any evidence of the ring fractures nearer NWG 55-29. Therefore, for the 2011 ISMP the ring fractures were not considered to be at risk of slipping. The final NEWGEN ISMP will need to re-evaluate this conclusion based on possible stimulation of NWG 46-16.

On the west side of the LiDAR image AltaRock has mapped a series of short (<6 km), discontinuous normal faults that occur in nested grabens and are often related to volcanic flows and cones. The USGS fault and fold database includes many of these faults, but in less detail. The USGS database also includes two long (30 and 35 km), NNE-trending faults in the La Pine Graben fault set west of La Pine and cutting Wikiup Reservoir (Figure J.2). However, no evidence of these longer faults can be seen in LiDAR data. This is not surprising, because the notes in the USGS database for these faults indicate that "the graben margin faults inferred from the gravity data by Ake et al. (2001) have no topographic expression or demonstrated offset in Quaternary deposits" (Personius 2002a). AltaRock's examination of the maps and figures in Ake et al. (2001) confirms that these faults are drawn on the basis of inflections in gravity profiles. Nevertheless, the seismic risk caused by faults is included in the URS seismic hazards report (Wong et al. 2010). This document makes no comment about whether these faults, which are 15 km away, do or do not exist at depth. It is outside of the scope of this document to settle the issue.

Grasso et al. (2012) indicate clear structural trends evidenced by LiDAR mapping of fault scarps and volcanic vent alignments across the Newberry Volcano edifice. Fault orientation south of the caldera is primarily NNE-SSW and rotates to NNW-SSE trending faults north of the caldera. Extension in the east-west direction is evidenced by topographic down-step from east to west across the edifice of several hundred meters. Volcanic vents, cinder cones and fissures are common in the area and appear to be aligned with fault orientations in many areas. The frequency and volume of eruption coupled with significant volcanic ash production may obscure some surface expression of these features; however, LiDAR data indicate clear structural trends across the edifice (Figure J.3).

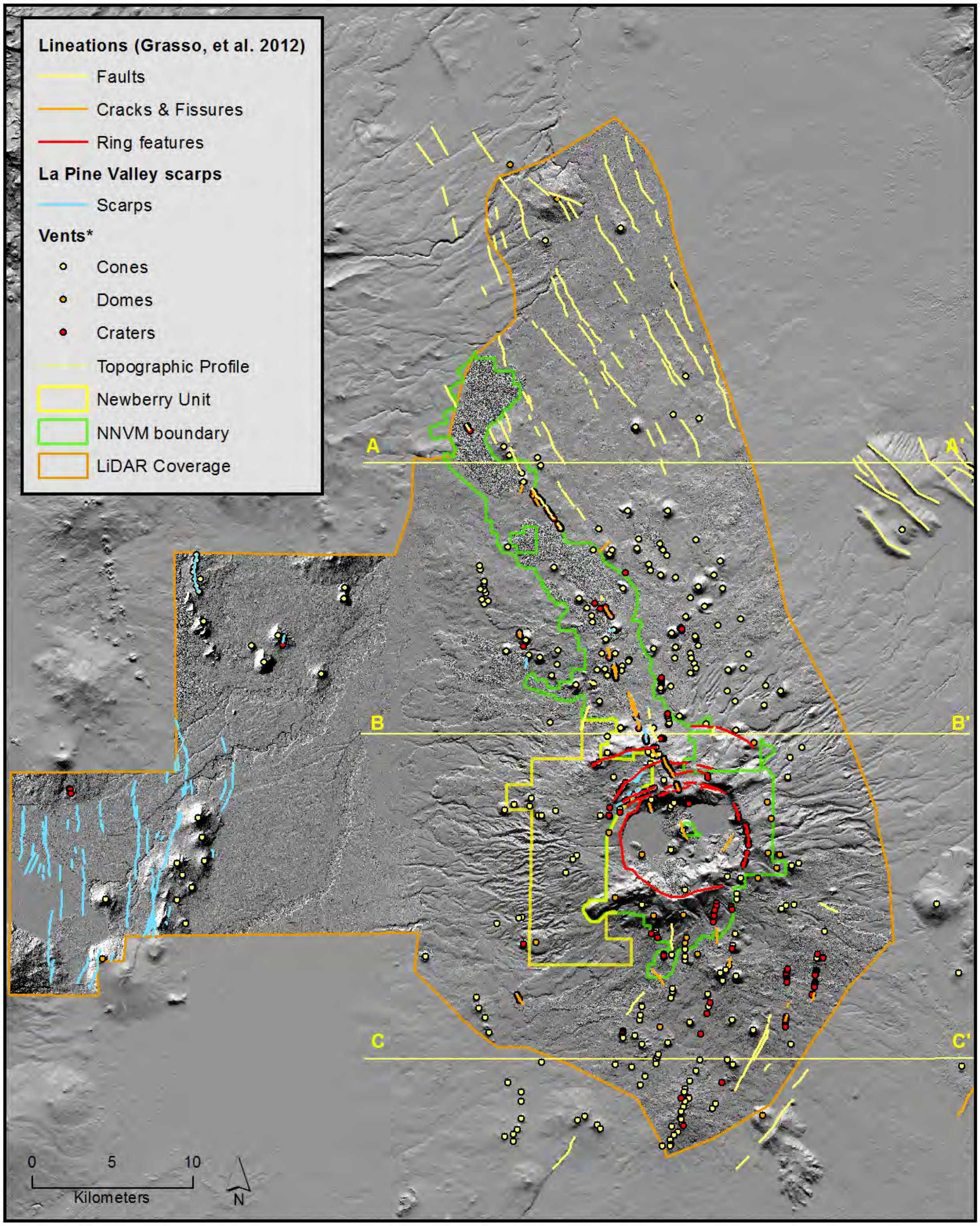

Figure J.3. Faults, fissures, ring features, and volcanic vents across the Newberry Volcano edifice and La Pine valley (at lower left edge) as mapped from LiDAR-based digital elevation model (Grasso et al. 2012). Dark gray area denotes LiDAR coverage; light gray is 10 m background digital elevation model.

The orientation of normal faults and fissures mapped with LiDAR can provide a first approximation of the minimum principal stress (extension) direction. The average fault orientation on the west side of the LiDAR image (Figure J.3) and the average fissure orientation on the east side of the image differ by only about 10° (Cladouhos et al. 2011). This suggests a normal fault regime with roughly east-west extension across the area shown in Figure J.3. This inferred regional stress orientation is simpler than might be expected for Newberry Volcano based on the juxtaposition of three different structural trends evident in Figure J.2.

In October 2010, NWG 55-29 was logged by the USGS and Temple University using a high-temperature borehole televiewer (BHTV). Stress-induced borehole breakouts were observed over many depth intervals in the well. Breakouts, caused by compressive failure of the borehole wall, have been analyzed by the USGS and Temple University to determine the orientation of the minimum horizontal stress and provide constraints on the relative magnitudes of the horizontal principal stresses, using image-log analysis techniques applied in other deep geothermal wells (e.g., Davatzes and Hickman 2006).

Davatzes and Hickman (2011) report that clear borehole breakouts are distributed throughout the BHTV image log and indicate a consistent minimum horizontal stress (S_{hmin}) of 92.0° +/- 16.6°. The lack of rotation of the stress direction implies that there are no actively slipping faults within the borehole. Boreholes near active fault zones can show horizontal axis stress rotations as large as 70° and 90°, as were observed in image logs from Coso (Davatzes and Hickman 2006) and Dixie Valley (Hickman et al. 2000), respectively.

Davatzes and Hickman (2011) also report a natural fracture population of over 350 fractures in the 739 m (2425 ft) logged interval in NWG 55-29. They have identified two dominant fracture sets that strike NNE-SSW and dip approximately 50° to the west and east. Poor expression of the fractures indicates that many of them might be partially healed. The relationship between the natural fracture orientations and S_{hmin} suggests a favorable setting for hydroshearing in NWG 55-29, which is also likely to be found elsewhere in the NEWGEN FORGE project area.

J.2.5 Natural Seismicity at the NEWGEN FORGE Site

The regional seismic network at Newberry Volcano was greatly improved in 2011 and 2012. In 2009, the only station at Newberry Volcano was NCO, a single-component, short-period seismometer on the east flank and only two micro-earthquakes (MEQs) (M 1.6-2.3) were detected at the Newberry Volcano in the prior 25 years (PNSN 2015). In 2011, the USGS installed six three-component broadband seismometers and one three-component short-period sensor (PNSN 2015). In 2012, four of the borehole stations in the NEGSD MSA were added to the Pacific Northwest Seismic network. The seismic monitoring of Newberry Volcano is now comprehensive; events smaller than M 0.0 are locatable. Since 2012, 72 natural MEQs with M 2.3 to -1.0 have been located within 10 km of the NEWGEN FORGE site (Figure J.4).

For further information about MSA and injection-induced seismicity associated with the NEGSD, see sections below.

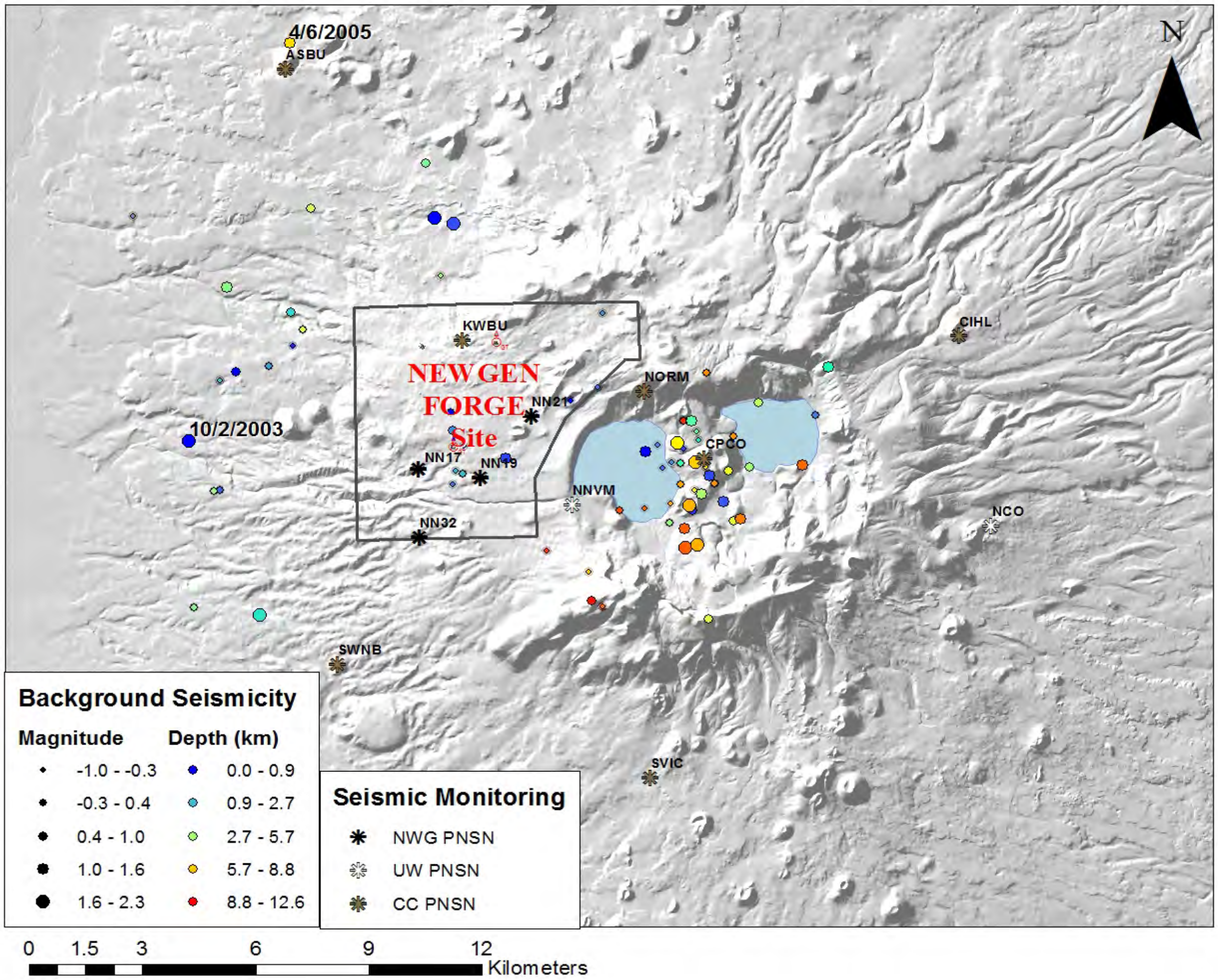

Figure J.4. Background seismicity within 10 km of NEWGEN FORGE site. Only two events were located (labeled with dates) before the network was improved.

J.2.6 Summary of Induced Seismicity during the Newberry EGS Demonstration

Two stimulations were performed over the course of the NEGSD, one in 2012 (Phase 2.1) and one in 2014 (Phase 2.2). The MSA performed well during both stimulations, recording 174 auto-picked microseismic events in 2012 and 400 auto-picked events in 2014. In both cases, auto-picked events were reviewed by Lawrence Berkeley National Laboratory (LBNL) and Foulger Consulting and reprocessed to provide the best location and magnitude results. No changes were made to the MSA between 2012 and 2014.

During Phase 2.1, AltaRock successfully deployed, monitored, tracked, and recorded seismic activity using a specialized seismic array. Stimulation equipment was installed and tested, and included water piping, high-pressure pumps, electrical control equipment, and TZIM/tracer injection equipment. High-level systems controls and data acquisition systems were used to enable high-accuracy data collection. As a result, the project team definitively demonstrated quantitative stimulation techniques that successfully induced and sustained fluid flow into an EGS injection well. The work conducted was guided by the permit requirements, geologic conceptual resource model, Stimulation Plan, ISMP, Water Usage Plan, and Groundwater Monitoring Plan. All of these plans will provide useful guidance for work at the NEWGEN FORGE project site.

Baker Hughes HPump horizontal 14-stage centrifugal pumps with 800 HP, 60 Hz, 460 V motors, and Electrospeed 3© Variable Speed Drives were used for stimulation in 2012 and 2014. The pumps were installed with a high-pressure piping and valve configuration, which allowed them to operate in series or in parallel. The maximum injection pressure that could be achieved by the equipment is approximately 20 MPa (2900 psi), with an associated flow rate up to 63 L/s (750 gpm). More information about pumps, piping, and infrastructure used can be found in the NEGSD Phase 2.1 (AltaRock 2014) and Phase 2.2 Reports (AltaRock 2015).

Phase 2.1 stimulation was carried out in three stages separated by injection of TZIM used to block open fractures and initiate flow into new zones. During Stage 1, injectivity began to improve when the injection pressure exceeded 12.4 MPa (1798 psi) and the flow rate reached 20.6 L/s (326 gpm). Stage 1 injection operations were carried out for 18 days before mechanical issues with the pumps led to temporary shutdown. The first microseismic event recorded during this stage took place 12 hours after initial pumping at 9.3 MPa, followed 42 hours later by six events beginning at 12.5 MPa (1812 psi), indicating pressures at or above this would sustain hydroshearing in NWG 55-29. Wellhead pressure was cycled between 12.4 and 15.2 MPa (1798–2205 psi) during Stage 2. Stage 3 ran for 4 days, reaching a maximum WHP of 16.7 MPa (2422 psi). In total, 174 microseismic events ranging from M <0.0 to M 2.39 during Phase 2.1, demonstrated the efficacy of the MSA for recording and locating microseismic events.

During Phase 2.1, microseismicity in the EGS zone began on October 17, 2012, and continued for 4 months. Seismic events during stimulation were located automatically in real time by software that detected seismic signals observed from all of the seismometers simultaneously, and that had clear enough P- and S-waves to locate them in proximity to the well. The MSA network functioned well during stimulation and post-stimulation, although borehole stations returned significantly higher quality P- and S-wave data than surface stations. This is likely due to waveform attenuation by unconsolidated material (typically volcanic cinders, ash, and pumice) surrounding the shallow surface stations. Events automatically detected by the software were then reviewed by seismologists in order to qualitatively adjust the P- and S-wave arrival times as an initial analysis of the event locations. In most cases, preliminary locations were determined within 8 hours of occurrence (Cladouhos et al. 2013; AltaRock, 2014).

AltaRock developed a project-specific ISMP (AltaRock 2011b; BLM 2011) for the NEGSD that satisfied the requirements of the Induced Seismicity Mitigation Protocol adopted by the DOE (Majer et al. 2008, 2012). This included predicting the largest possible induced MEQ and developing predefined thresholds of event magnitudes and ground motion, accompanied by appropriate mitigation actions.

The first shallow seismic event with a magnitude greater than 1.0 occurred on November 3, just after the WHP had exceeded 12 MPa (1740 psi), and was followed by a drop in WHP to ~6MPa (870 psi) due to pump malfunction. At this time, there was uncertainty about whether the shallow events were being well-located, or if their locations were an artifact of inaccurate phase picks and/or a poor velocity model. In any case, the WHP and flow rates were kept low during most of November while pumps were repaired. Shallow seismicity with smaller magnitude (moment magnitude [Mw] < 1) did continue to occur even at low WHPs. At the time, we surmised that thermal expansion of previously injected water was causing the seismicity, so we did not expect that diversion at the well bore could cause the shallow events to cease.

In mid-November, after the seismologists (Ernie Majer at LBNL and Bruce Julian at Foulger Consulting) determined that the shallow depths were likely *real*, AltaRock planned to inject TZIM as soon as the pumps were repaired and brought back online (e.g., see November 18 seismic report, Appendix D). When the stimulation pumps were brought back online, TZIM was injected before returning to higher WHP. Although the microseismicity did seem to initially deepen, the shallow events soon returned during

Stage 2 of stimulation. After two stronger shallow events occurred on December 1, the decision to proceed to Stage 3 was made and the mixing unit personnel were called back to the site. After TZIM treatment, Stage 3 did not have any shallow events (Mw > 1.0) until the last day of stimulation, December 7. The strongest seismic event recorded during Phase 2.1 occurred on the last day of stimulation (12/7/2012) and had a Mw of 2.39, which exceeded the initial ISMP Mw limit of 2.0. The mitigation action for this limit was to wait 24 hours before increasing WHP or flow rate. Because the event occurred on the last day of planned stimulation, no modification to operational plans was necessary and the well was shut-in later that day. Ground motion at the NNVM strong-motion seismometer (SMS) due to the Mw 2.39 event was an estimated peak ground acceleration (PGA) of 0.1% g, far below the action threshold set in the 2011 ISMP of 1.4% g. From the seismometer closest to the event a PGA of 0.3% g was estimated. That level of ground motion would not necessarily have occurred at the surface, due to the highly attenuating cinders blanketing the volcano flanks. In any case, there were no reports of any felt seismicity from the field crews onsite for this or any other event.

Ultimately, the 2012 stimulation zone was found to be shallower than initially expected based on microseismic data (Cladouhos et al. 2013). Further investigation concluded that a failure in the surface casing of the stimulation well allowed the majority of the injected water to leave the casing and enter the subsurface at a depth shallower than was intended in the project plan. More information can be found in Cladouhos et al. (2013), Petty et al. (2013), and the NEGSD Phase 2.1 Report (AltaRock 2014). The casing was repaired via a tie-back cemented to the surface in early 2014, prior to Phase 2.2 stimulation.

Phase 2.2 stimulation was carried out in a manner similar to Phase 2.1. During two rounds of stimulation the MSA detected 400 microseismic events ranging in magnitude from M 0 to M 2.26. After stimulation round one, perforation shots were used to increase the number of fluid exit points through the casing. The first microseismic event occurred after 2 and a-half days of injection when the WHP exceeded 180 bar (2600 psi) (Figure J.5). After 2 more days of injection, the second event occurred when the WHP exceeded 193 bar (2800 psi) and continued at higher rates of over 30 events per day from September 30 through October 2, with a peak of 42 events/day on October 1. After 5 days of increasing seismicity and improving injectivity, the seismicity rate dropped by more than 50%.

At the beginning of Round 2, while injecting to cool for 44 hours in preparation for the perforation shots below 155 bar (2250 psi) no microseismic events were detected. After the perforation shots, injection continued for 17 hours and the first event of the second round was created at a WHP of 162 bar (2355 psi), and seven more events were detected over the next 6 hours while the WHP was below 180 bar (2600 psi). After increasing the WHP to 187 bar (2700 psi) there was a 17.5-hour seismic gap followed by a six-event swarm over 23 minutes. The rate of seismicity that day (November 16) reached 19 events/day, with a peak rate of 22 events/day at a WHP of 193 bar (2800 psi) on the final day of stimulation (November 20). Thus, we can conclude that the hydroshearing pressure is around 180 bar (2600 psi). This is significantly higher than determined in 2012, even before leaks developed in the casing.

The most reliable moment magnitudes for the induced microseismic events were determined by LBNL, and represent 350 of the 400 events detected during Phase 2.2. The 350 LBNL magnitudes were used to determine the Gutenberg-Richter Law b-value of 1.0 (Figure J.6). The only two events above M 2.0 during the stimulation were an M 2.1 on October 4 and an M 2.3 on November 17. There were 23 events between M 1.0 and 2.0. The rollover of the size distribution below M 0.0 (Figure J.6) indicates that the seismic system's lower sensitivity threshold was near M 0.0.

At the end of each day the size distribution of the previous 100 events was plotted and the b-value calculated (as shown in Figure J.7). This figure shows that although the overall b-value was 1.0, the sliding window of 100 events started low (0.85) and trended upward (1.1). Dips in the trend were associated with events with M > 1.3 on 10/5, 10/12, 10/13, 11/16, and 11/17. McGarr (2014) proposed a simple relationship between the maximum moment of induced seismicity and volume change due to extraction or injection of fluid:

$$Mo(max) = G\ V_{inj} \tag{J.1}$$

where Mo(max) is the moment of the largest *possible* induced event, G is the modulus of rigidity of the rock mass, and V_{inj} is the injected volume of fluid in cubic meters (we only need consider injection here). McGarr (2014) compiled data from injection projects worldwide to compare them to the theoretical limit on induced seismicity magnitudes. In order to track seismic risk at Newberry Volcano, NEGSD operators plotted cumulative injected volume, cumulative moment magnitude, and maximum moment magnitude and overlaid them on the McGarr (2014) data compilation (Figure J.8). For NEGSD data points, the values were plotted daily, and cumulative moment magnitude was included as well as the maximum moment. The ratio of seismic energy to volume of injected water at the NEGSD site was significantly lower than at other sites that have experienced seismicity due to fluid injection. Thus, Newberry Volcano appears to have a much lower seismogenic index (i.e., Shapiro et al. 2010) than other sites. The NEGSD data points fall far below the line plotted from the empirical formula developed by McGarr (2014) on a plot of maximum seismic moment to injected volume.

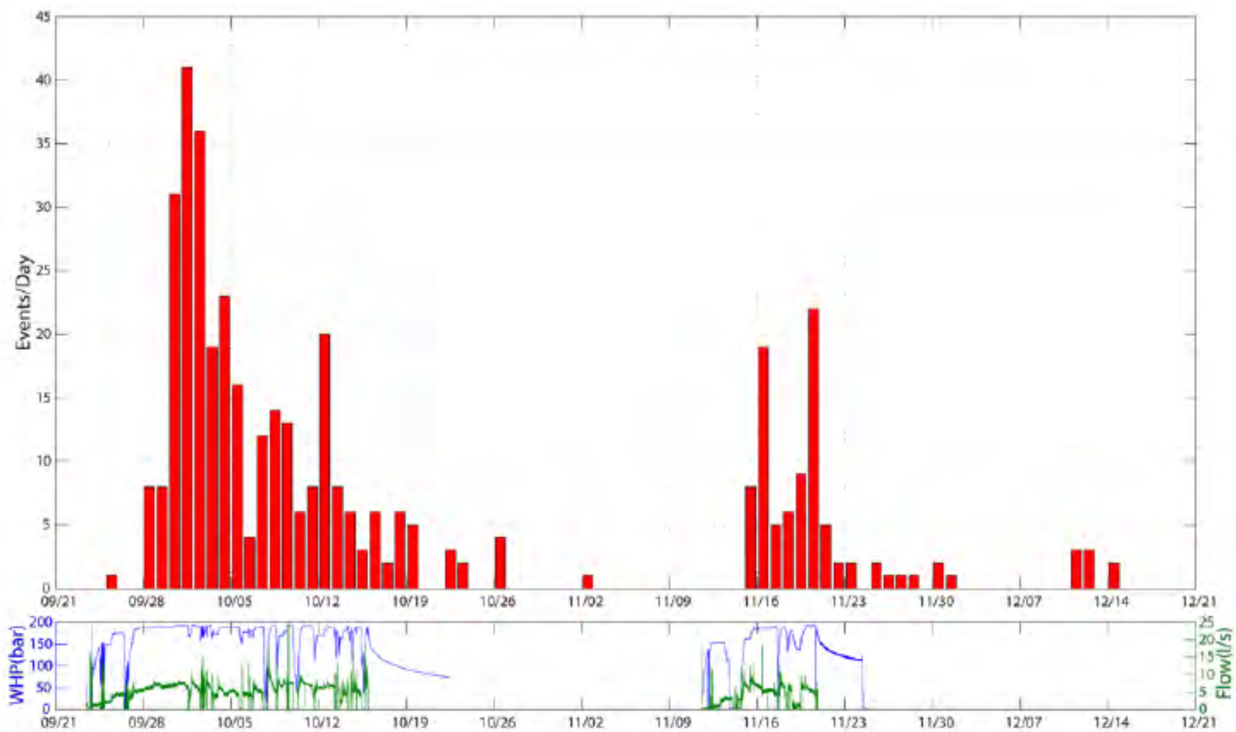

Figure J.5. Daily rate of seismicity detected during Phase 2.2 stimulation at the NEGSD site. Note correlation with WHP and flow rate.

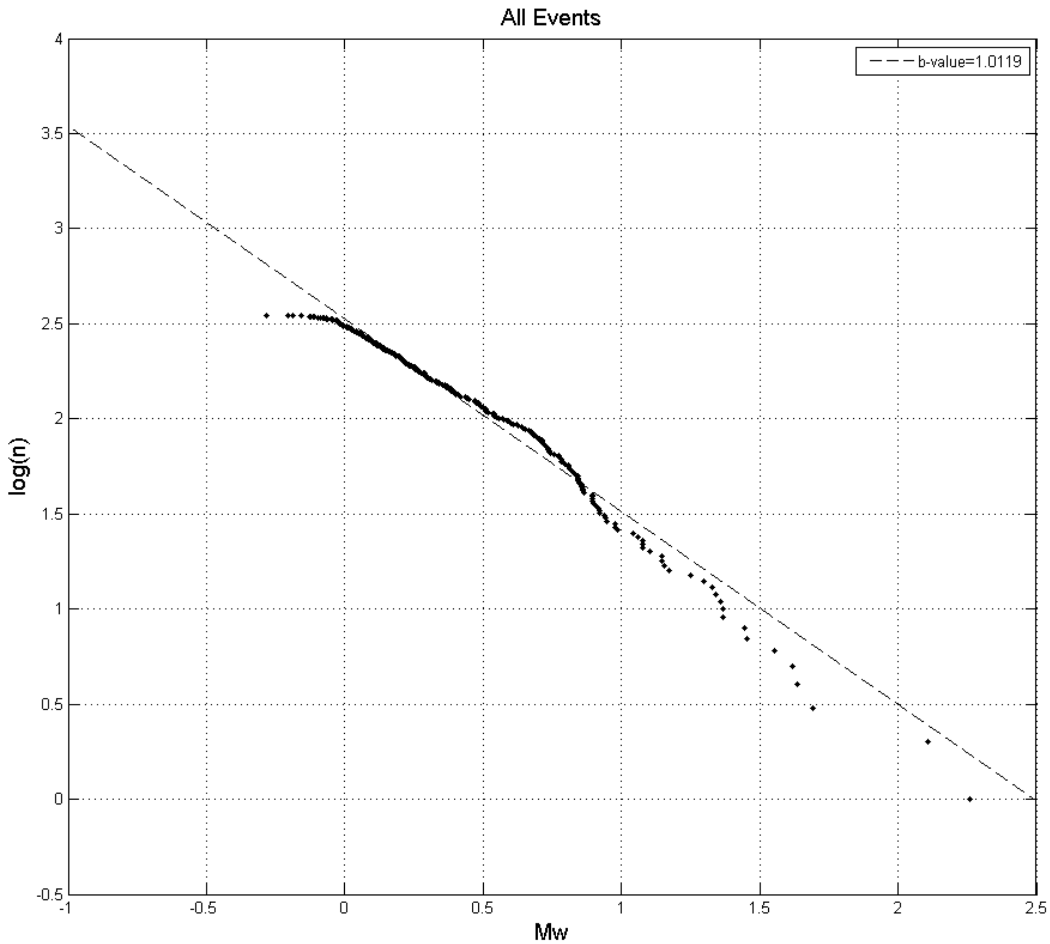

Figure J.6. Log-log plot of size distribution of MEQs. Slope of line is b-value in the Gutenberg-Richter Law.

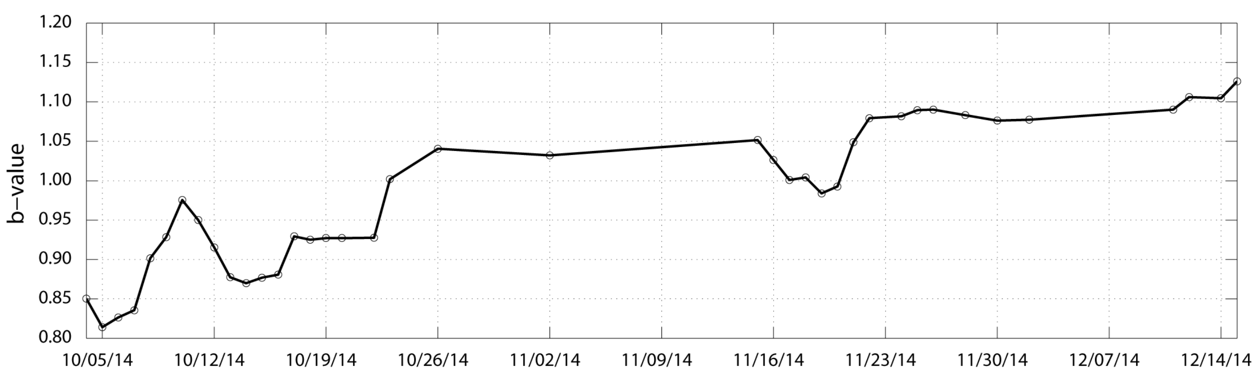

Figure J.7. Evolution of b-value during stimulation. Calculated from last 100 events including the date shown.

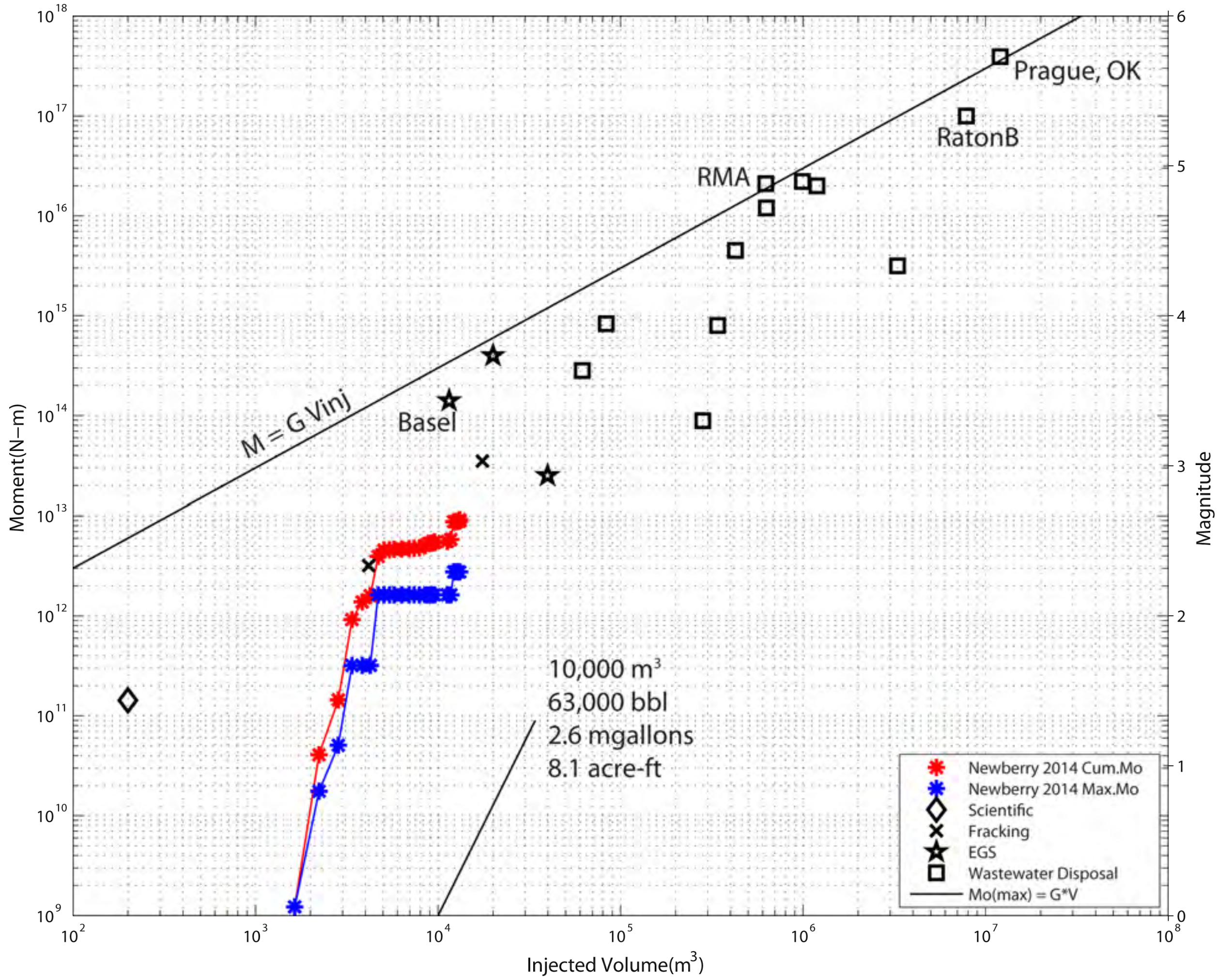

Figure J.8. Maximum seismic moment and magnitude as functions of total volume of injected fluid. Data compiled by McGarr (2014).

Figure J.9 shows the MEQs detected during the 2014 stimulation of NWG 55-29. The NWG 55-29 seismic cloud extends approximately 1500 m (4921 ft) in the east-west direction and 1500 m (4921 ft) vertically.

In summary, many of the lessons learned from previous work during the NEGSD will be applicable to the NEWGEN FORGE effort. These include the following:

- Permitting and environmental compliance activities have already been carried out at Newberry Volcano as part of the NEGSD project and the CalEnergy Exploration efforts within the NEWGEN project area; regulating agencies are familiar with EGS, the project area, and have been adaptable to changing situations based on the outcome of field activities.
- Public outreach activities have garnered local, regional, and national support from residents and political leaders alike. Website, blog, and Facebook pages already have an established following.
- Groundwater monitoring before, during, and after stimulation showed no connection between the EGS reservoir at NWG 55-29 and the local groundwater system; a Groundwater Monitoring Plan has already been designed and implemented, and is easily modifiable for the NEWGEN FORGE work.

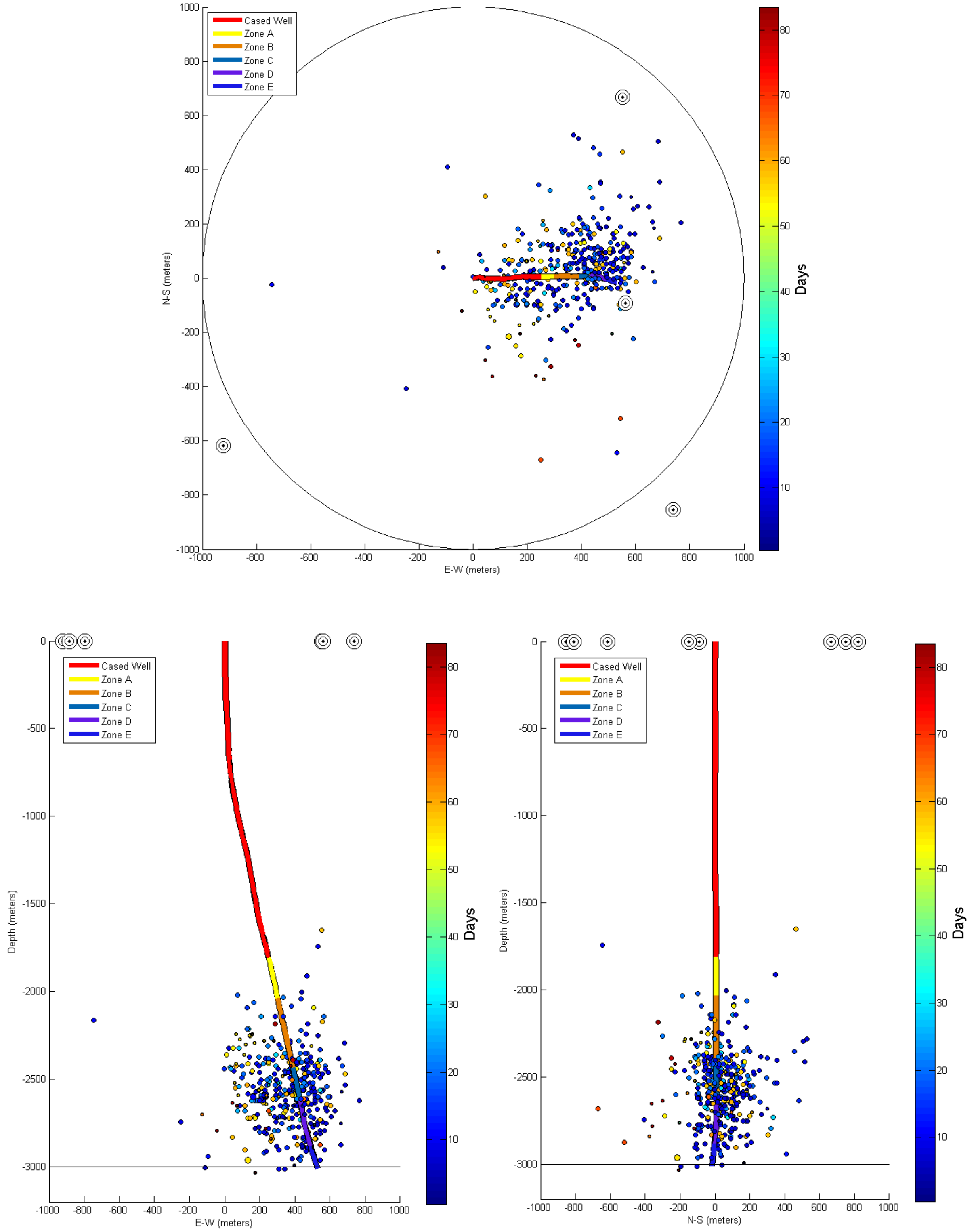

Figure J.9. Location map (top) and cross sections (bottom left looking north; bottom right looking west) of all located events from initial seismic catalog during the NEGSD 2014 stimulation of NWG 55-29.

- The design, installation, operation, and maintenance of the MSA system was very successful; microseismic events were successfully located by auto-picking software and refined by seismologists using the same data, and velocity models have been improved as well. Telemetry and solar power systems worked well under harsh environmental conditions.
- The 2011 ISMP was successfully implemented with no seismic events exceeding predicted threshold magnitude values.
- Stimulation provided valuable field experience with EGS technology for project participants, local and national contractors, academic, and other groups involved.
- Hydroshearing pressure has been shown to be around 180 bar (2600 psi) at a depth of 2,900–3,000 m in NWG 55-29; this will inform future stimulation design and operating parameters to improve successful EGS reservoir practices at the NEWGEN FORGE site.

J.3 Induced Seismicity Mitigation Protocol – Summary

The DOE requires that EGS demonstration projects throughout the United States follow the guidelines provided by the *Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems* (Majer et al. 2012). This protocol includes the following steps:

- Step 1: Perform preliminary screening evaluation.
- Step 2: Implement Communications and Outreach program.
- Step 3: Identify criteria for ground vibration and noise.
- Step 4: Establish seismic monitoring.
- Step 5: Quantify the hazard from natural and induced seismic events.
- Step 6: Characterize the risk from induced seismic events.
- Step 7: Develop risk-based mitigation plans.

The following narrative summarizes how each of these steps was implemented for the 2011 ISMP and updates that will be performed during Phase 2 to transform this preliminary ISMP to the final NEWGEN ISMP. Following the summary, Sections J.4 through J.10 provide further details about the current status of ISMP development. Each step will be updated and adapted throughout the NEWGEN FORGE project based on experience and best practices in research and industry when new information becomes available.

J.4 Step 1. Preliminary Screening Evaluation

Preliminary seismic investigation of the NEWGEN FORGE site has included the URS study (summarized in Section J.4.2, details provided in Section J.8), LiDAR lineament mapping and structural analysis (see Section J.2.4.), and review of the relevant scientific literature. Additionally, the NEGSD project has provided significant data on background and induced seismicity at Newberry Volcano.

J.4.1 Step 1a. Review of Laws and Regulations

Regulatory Oversight

The project is located entirely within the Deschutes National Forest, managed by the USFS. The majority of NEWGEN FORGE project activities will take place on federal geothermal leases on these lands, which are administered by the BLM. Because the project occurs on federal lands, any proposed activities on the NEWGEN FORGE site will require NEPA compliance.

With regard to NEPA, the BLM will be the lead agency because the majority of the NEWGEN FORGE project activity would occur on land under geothermal leases issued and administered by the BLM.

Because some of the project activities may occur on lands where surface disturbance is under the authority of the Forest Service, Forest Service will be a cooperating agency for the preparation of any NEPA documents.

We foresee that BLM, as they have in the past, will elect to prepare an EA and the NEWGEN team will work with BLM to conduct this analysis. The NEWGEN team has worked closely with the BLM and USFS on three previous EAs and was successful in helping these agencies complete the EAs. Induced seismicity will be an issue of concern for NEPA compliance as it was during the NEGSD project. The successful completion of the NEGSD EA, which includes the 2011 ISMP, and the NEGSD project will provide valuable background data for any new NEPA compliance necessary.

Laws and Regulations Reviewed

As a participating member of the NEWGEN team, AltaRock has conducted a review of relevant federal, state, and local laws and regulations, and has determined that laws and regulations are not so restrictive that any effects of induced seismicity would not be allowed. No laws or regulations in Oregon specifically prohibit or regulate induced seismicity. In the absence of laws and regulations related directly to induced seismicity from EGS activities, AltaRock reviewed laws and regulations related to activities that could potentially cause vibration or induced seismicity, such as the impounding of reservoirs, and mining and quarrying (Cypser and Davis 1998), both activities that are not uncommon in Oregon.

The following laws, regulations, and administrative requirements, and Oregon Revised Statutes (ORS) were reviewed for the NEGSD project and will also be relevant to the NEWGEN FORGE project:

- National Environmental Policy Act of 1969, as amended
- Noise Control Act, 42 U.S.C. § 4901
- Clean Water Act
- 2009 ORS Chapter 517, Mining and Mining Claims
- 2009 ORS § 540.350, Dams, Dikes and Other Hydraulic Works
- 2009 ORS Chapter 467, Noise Control
- 2009 ORS Section 197, Comprehensive Land Use Coordination
- 2009 ORS § 401.918, Emergency Management and Services, Seismic Safety Policy, Advisory Commission
- 2009 ORS § 467.120, Agricultural and Forestry Operations, Mining or Rock Processing
- 2009 ORS § 469.501, Energy Facility Siting, Construction, Operation and Retirement Standards
- Oregon Water Resources Department, Division 20, Dam Safety
- Oregon Department of Geology and Mineral Industries, Division 20, Geothermal Regulations
- Oregon Department of Geology and Mineral Industries, Division 30, Oregon Mined Land Reclamation Act
- Oregon Department of Environmental Quality, Administrative Rules, Division 35, Noise Control Regulations
- Deschutes County Code (DCC), Chapter 8.08, Noise Control: County Noise Control Ordinances
- DCC Chapter 18: County Zoning

- DCC Chapter 23.76: County Comprehensive Plan, Energy
- City of La Pine, Comprehensive Plan, March 2010.

Dams, Reservoirs, Mining, and Quarrying

Laws and regulations governing dams do not specifically refer to induced or triggered seismicity or earthquakes, but do prohibit the construction of "any dam, dike or other hydraulic structure or works, the failure of which would result in damage to life or property" (2009 ORS § 540.350, 2009 ORS Chapter 517, Oregon Water Resources Department, Oregon Administrative Rules [OAR] Division 20, Dam Safety; emphasis added). Under 2009 ORS § 540.350, governing the building of dams, approval of the site and plans does not relieve the owners of liability to damage to life or property. The Oregon Water Resources Department also provides guidelines and rules on dam safety, which include "hazard ratings" for dams based on the type and extent of damage to people or property that occurs if a dam fails. No information, guidelines, or policy were found that suggested that reservoir-induced seismicity was a serious concern in Oregon. The focus appears to be on dam failure in the event of natural seismicity and flooding as a result of failure.

Mining and quarrying laws and regulations similarly aim to minimize or eliminate damage to people and property, but do not specifically have regulations directed at induced seismicity (Oregon Department of Geology and Mineral Industries [DOGAMI] Division 30, 632-030-0005, 2009 OAR Chapter 517). For example, Section 632-030-0025 of DOGAMI, Division 30, lists requirements for an operating permit, including how to minimize damage to property and people, and 2009 OAR § 517.990 provides that a person who "knowingly and recklessly causes substantial harm to human health or the environment" without a permit is subject not just to civil penalties, but also criminal penalties.

EGS and Strict Liability

AltaRock also reviewed the standard for strict liability in Oregon to determine whether a theory of strict liability would be applied to induced seismicity. While the NEWGEN FORGE project will likely be held to a high standard of care, it is also likely that if individuals are injured or property is damaged, Oregon courts will apply trespass, negligence, or nuisance theory of liabilities rather than strict liability.

Whether an activity is abnormally dangerous is a question decided by the courts, and the standard used is whether an activity is "extraordinary, exceptional, or unusual, considering the locality in which it is carried on; when there is a risk of grave harm from such abnormality; and when the risk cannot be eliminated by the exercise of reasonable care" (*Buggsi, Inc. v. Chevron USA, Inc.,* 857 F. Supp. 1427, 1432 [D. Or. 1994]; *see also Tri-County Metropolitan Transit District v. Time Warner Telecom of Oregon,* Dist. Court. D. Or. 2008, finding that drilling under mass transit rail lines in an urban setting was not an ultra-hazardous activity).

Several factors suggest that a court may not apply a standard of strict liability to the NEWGEN FORGE project. For example, the activity is not located in a populated area, and "the existence of a high degree of risk of some harm to persons and property" is shown to be low in subsequent sections of this plan (see Restatement (second) of Torts § 519). Furthermore, the existence of stringent laws and regulations controlling a particular activity are also taken into account, and Oregon does not provide induced seismicity guidelines to other industries such as mining. It is likely, therefore, that Oregon courts would not apply a theory of strict liability to EGS activities.

If individuals are injured or property is damaged, it is likely that the individual could, however, claim compensation under trespass, negligence, or nuisance theory of liabilities. A similar conclusion was reached for an analysis of Colorado law and induced seismicity (Cypser 1996). AltaRock's research did not reveal any cases under which an individual sought compensation for induced seismicity in Oregon.

Geothermal Energy and Deschutes County

The only statute that AltaRock believes deals directly with induced seismicity from a geothermal project is the DCC Chapter 23.76 (County Comprehensive Plan, Section on Energy). This chapter states that geothermal investigations are occurring in the county near Newberry Crater and that "problems with objectionable smells from released gases, possible groundwater contamination, earth subsidence or quakes are all hazards to be considered in geothermal energy use" (emphasis added). The chapter further provides that the County's support of geothermal development shall be conditioned upon satisfactory evidence that sufficient safeguards are provided for "induced seismicity." This chapter suggests that Deschutes County does not prohibit activity based on the likelihood of induced seismicity.

J.4.2 Step 1b. Determine the Radius of Influence

The 2011 ISMP used a maximum magnitude (M_{max}) for an induced seismic event of 3.5 (see Section J.8). Given the results of the NEGSD (Section J.2.6), this value of M_{max} remains reasonable. Wong et al. (2010) developed a shake map [Figure J.10]) centered on NWG 55-29. The radius of influence for PGA > 1% g is about 10 km.

The largest induced seismic event of the NEGSD was M_w 2.39. Ground motion at the NNVM SMS due to a M_w 2.39 event was an estimated PGA of 0.1% g, far below the action threshold of 1.4% g set in the 2011 ISMP. From the seismometer closest to the event, a borehole seismometer at NN17, a PGA of 0.3% g was estimated. That level of ground motion would not necessarily have occurred at the surface because of the highly attenuating cinders blanketing the volcano flanks. In any case, there were no reports of any felt seismicity from the field crews onsite for this or any other MEQ. Due to winter conditions, no visitors were near the site.

J.4.3 Step 1c. Identify Potential Impacts

The population centers closest to the NEWGEN FORGE site are Bend, Sunriver, Three Rivers, and La Pine. All four of these population centers are located outside of the zone within which perceivable shaking (PGA > 0.01 g) may occur (Figure J.10).

Populations in the zone where perceivable shaking may occur (radius < 10 km) are limited to visitors to the NNVM and the adjacent Deschutes National Forest. This transient population is primarily limited to summer months due to winter snow closures. The 2011 ISMP estimated that 659 people could be within the zone where perceivable shaking may occur during the peak summer season daytime hours. During the night, up to 333 people might be within the zone where perceivable shaking may occur.

During Phase 1 of NEGSD the USFS provided AltaRock with a list of 52 key assets within the NNVM, which include various buildings, two bridges, a road, a dam, and three slope faces. These assets include all structures between the 0.06 g and 0.10 g contour lines of PGA in Figure J.10 as well as many other structures located within the 0.01 g to 0.05 g contour lines. The list includes Paulina Lake Lodge and associated cabins, East Lake Lodge and associated cabins, Paulina Lake Guard Station and associated USFS structures, and other structures along the Paulina-East Lake Road. The dam and collocated bridges span Paulina Creek at the outlet of Paulina Lake, adjacent to Paulina Lake Lodge.

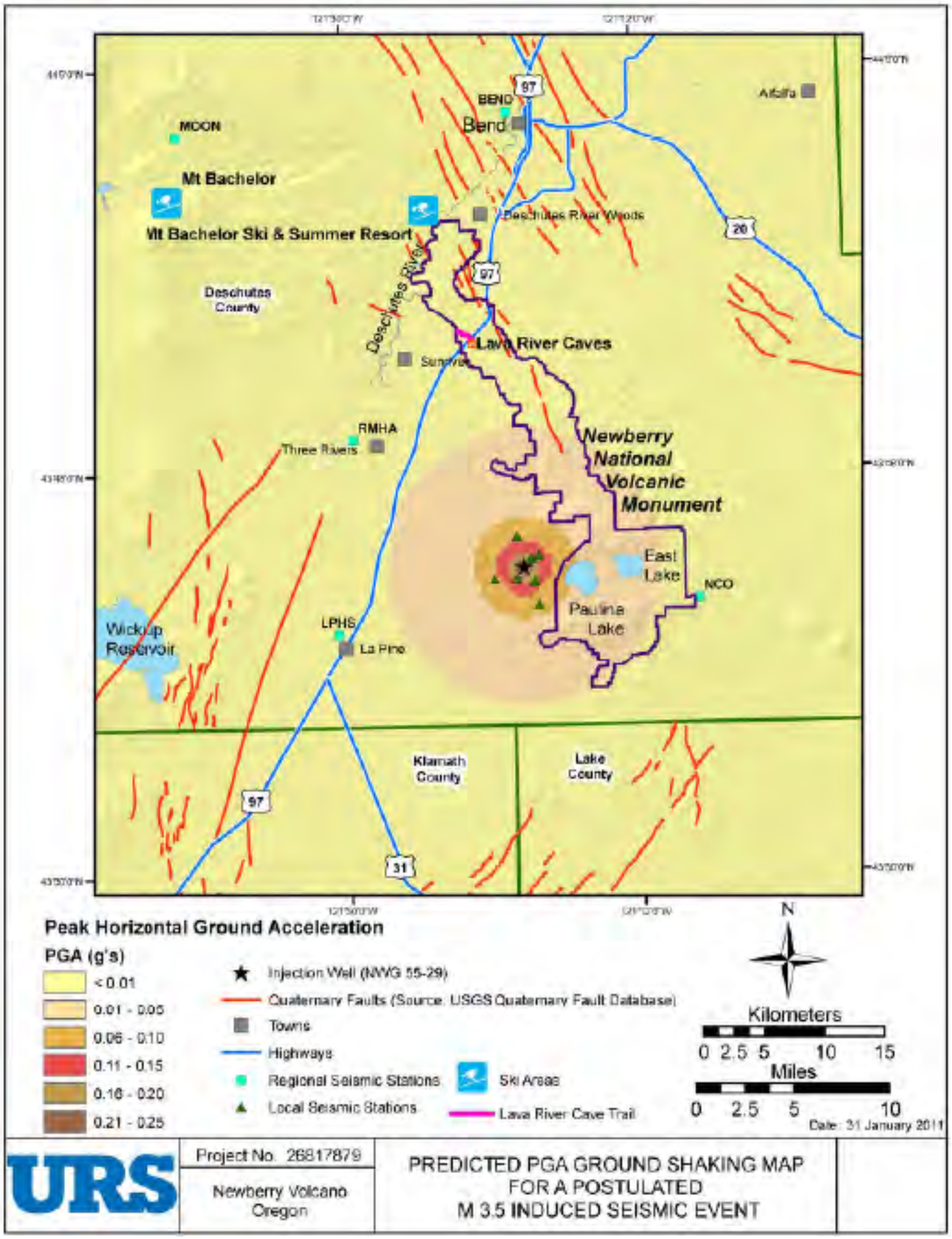

Figure J.10. Shake map from URS Addendum Figure 1 (Wong et al. 2011). Only Class A Quaternary faults are shown, so the Class B Newberry Caldera ring fractures are not shown. (Hazards from natural and induced seismic events are further described in Section J.8.)

J.4.4 Step 1d. Potential Damages

Third-party engineering evaluations of the potentially vulnerable buildings and bridges in NNVM were provided as Appendix H and I of the 2011 ISMP. Summary results are presented below.

For the 12 NNVM structures scored, the PGA resulting in a 10% probability of collapse was determined to be between 0.25 and 1.1 g. Further analysis indicates that in a "worst case" 0.10 g PGA the probability that an M 3.5 seismic event could produce the collapse would be 1.2% or less for all NNVM structures. SGH noted that the bridge is constructed "on fairly competent bedrock." SGH calculates the PGA limit for the bridge to be 0.28 g, similar to most susceptible buildings.

SGH also evaluated thresholds for cosmetic damage to buildings and recommended that the peak particle velocity be limited to 2 cm/s to minimize the potential for cosmetic damage to the buildings. This correlates to an approximate PGA of 0.025 g. As will be discussed in sections below, mitigation measures designed to slow induced seismicity will begin at a PGA of 0.014 g, well below the shaking level that might cause cosmetic damage, and an order of magnitude below the shaking level that would cause collapse of NNVM buildings.

J.4.5 Step 1e. Overall Risk Level

When the 2011 ISMP was developed, prior to hydraulic stimulation of NWG 55-29, the overall risk would have likely been assigned to "Level II: Low – Can proceed with planning but may require additional analysis to confirm." After two EGS stimulations in 2012 and 2014, with extensive new data collection and analysis, the overall risk can be confidently assigned as "Level I: Very Low – proceed with planning."

J.5 Step 2: Communications and Outreach Program

The NEWGEN team has developed a Communications and Outreach Plan that builds on the experiences of the NEGSD public outreach work. The Communications and Outreach team will use the plan to guide outreach activities before, during, and after field activities at the NEWGEN FORGE site. Public outreach efforts will include maintaining an up-to-date online presence including:

- the NEWGEN blog, found at www.blog.newberrygeothermal.com
- the NEWGEN Facebook page, found at www.facebook.com/NewberryEGS
- the NEWGEN website, found at www.newberrygeothermal.com.

In addition, monthly public outreach meetings will be held in the local area during months when field operations take place. These will provide a forum for the public to engage personally with the project team; NEWGEN technical staff will be present to provide a project update and field questions and concerns from stakeholders. Public outreach meetings will be advertised via the NEWGEN blog, Facebook page, and website. Local media sources will also be notified.

Local media in the Bend and La Pine area include several newspapers, television stations, and online news sources. The communications plan includes maintaining active contact with these groups as well as national media outlets to foster positive engagement and accurate reporting.

J.5.1 Communications and Outreach Plan

The NEWGEN Communications and Outreach Plan (Appendix G) is designed to inform stakeholders about EGS, induced seismicity, NEWGEN, and FORGE, and clearly state the benefits and potential that EGS holds for adding baseload renewable energy to the grid. The plan also addresses concerns about safety, while highlighting the benefits to the community and region of locating FORGE at the NEWGEN site. The NEWGEN team will demonstrate credibility, engage new partners, solicit broad support from political and community leaders, and build a strong case for the NEWGEN FORGE project through forward communications and outreach (Figure J.11).

Figure J.11. David Stowe, NEWGEN Public Outreach Coordinator, speaks to students from Oregon State University during a field trip to the NEGSD site. Local outreach events like this significantly improved local support for the project and will be continued throughout the course of the NEWGEN FORGE project.

J.5.2 Field Activities with Potential Stakeholder Impact

Due to the potential for induced seismicity well stimulation is a NEWGEN field activity that has potential for stakeholder impact. Therefore, prior to initiation of well stimulation, notices will be published in the local newspapers and contact information (phone numbers, email addresses, websites, etc.) will be provided for interested citizens to receive more information, ask questions, and report concerns. The project web sites will be updated to inform the public that field activities have begun. Public meetings will be held monthly during active field operations to discuss the results with stakeholders. These public meetings will include presentations to explain preliminary results and the next steps and time for questions and answers so that community members can voice their concerns. Public meetings will be advertised at least 1 week in advance in local papers and on the NEWGEN website and blog.

For example, during the NEGSD, the 2011 ISMP required that prior to seismicity-inducing field activities users of Road 500 be notified. The road, which leads to Paulina Peak, has a history of frequent rock-fall due to a road cut. Temporary signs placed at the top and top and bottom of the road included a phone number to call in the case of rock slides on the road. This indirect mitigation action was established in cooperation with USFS staff. No excess rock-fall was observed in 2012 or 2014 due to induced seismicity; therefore, this requirement should be re-evaluated for the NEWGEN ISMP to determine if it is necessary.

J.5.3 Communications and Outreach after Field Activities

After field operations deemed to have potential impacts on stakeholders, including but not limited to well drilling, stimulation, and flow testing, the results of the operations will be communicated to the public and other stakeholders through web sites, social media, press releases, peer-reviewed publications, public outreach meetings, and required DOE reporting. Plans for future activities will also be reported, including the potential for cancellation of the project and site reclamation, or continued activities including stage-gate review, stimulation activities, and drilling of production wells, etc.

In addition to the public outreach described above, frequent regulatory and technical communications with government agencies and laboratories will continue throughout the project, with increased frequency during field site activities. Based on defined magnitude threshold values, event-specific communications in response seismic events will be carried out in accordance with the NEWGEN ISMP.

J.6 Step 3. Identify Criteria for Ground Vibration and Noise

The ISMP developed for the NEGSD included two different independent engineering analyses that derived the following conclusions:

- The theoretical maximum magnitude of an induced seismic event at Newberry Volcano is M 4.0.
- The probability of a seismic event with a magnitude between M 3.0 and M 4.0 is less than 1%.
- There is no difference in seismic hazard between the natural seismicity and the hazard introduced by EGS-induced seismicity.
- If an M 3.5 seismic event did occur, the potential for damage at the nearest structures within the NNVM would be light, corresponding to a Modified Mercalli Intensity of VI.

These conclusions provide strong evidence that the NEWGEN site on the west flank of the Newberry Volcano is an appropriate and ideal location for the proposed FORGE. Reservoir stimulations carried out in 2012 and 2014 as part of the NEGSD support the above-mentioned predictions. In 2012, the largest induced seismic events recorded during 2012 and 2014 were M 2.39 and M 2.26, respectively. Further characterization of the potential effects of induced seismicity is provided below.

J.6.1 Populations within the Potential Shake Zone

The population centers closest to the demonstration site are Bend, Sunriver, Three Rivers, and La Pine (Table J.1). Bend, 23 miles from NWG 55-29, is by far the largest, with a 2010 population of 76,639. The other towns have a combined year-round population less than 6000, although the Sunriver population soars to 20,000 in the summer. All four of these population centers are located outside of the zone within which perceivable shaking (PGA > 0.01g) may occur (12–13 km from NWG 55-29).

Table J.1. Number of people outside area of perceivable shaking as determined by Wong et al. (2011).

CITY	POPULATION	DISTANCE FROM MEZ-EGS/01
Bend	76,639(a)	37 km (23 mi)
Sunriver	1,318(b) (20,000 in summer)©	20 km (12.4 mi)
Three Rivers	2,353(b)	15 km (9.3 mi)
La Pine	1,653(a)	15 km (9.3 mi)

Deschutes County Oregon Population 1990–2010
Population and Housing Occupancy Status: 2010 Cities and Census Designated Places
Sunriver Area Chamber of Commerce

Populations in the zone where perceivable shaking may occur are limited to visitors to the NNVM and the adjacent Deschutes National Forest. This transient population is primarily limited to summer months due to winter snow closures (Table J.2). An estimated 659 people could be within the zone where perceivable shaking may occur during the peak summer season daytime hours. During the night, up to 333 people might be within the zone where perceivable shaking may occur. Some visitors are also present during winter days and overnight stays, accessing the area only by foot, ski, or snowmobile. These populations are probably 10 to 100 times lower than summer populations.

Table J.2. Number of visitors within area of perceivable shaking as determined by AltaRock (2011).

LOCATION	SEASON TOTAL 2010 (MAY–OCT)	PEAK MONTH TOTAL (AUGUST)	ESTIMATED DAILY AVERAGE DURING PEAK SEASON
DAYTIME	56,118	20,405	659
Entrance Station	56,118[a]	20,405[a]	659[b]
Paulina Lake VC[c]	3,707[a]	1,994[a]	65[b]
OVERNIGHT	29,891	ND	333
Campgrounds[c]	20,502[a,d]	ND	228[e]
Paulina Lake Cabins[c]	4,896[f]	ND	55[f]
East Lake Cabins[c]	4,493[g]	ND	50[g]

ND = no data
(a) Statistics provided by Rod Bonacker (USFS) via email on June 14, 2011.
(b) Calculated by dividing the Peak Month Total (August) by 31 days.
(c) Visitors to these locations are also counted at the Entrance Station.
(d) Season total extends through March 2011.
(e) Calculated by dividing the Campground Season Total by 90 days (length of peak season); likely overestimated because Campground Season Total extends through March 2011.
(f) Estimate assumes Paulina Lake Cabins are 80% occupied for 80% of the peak season.
(g) Estimate assumes East Lake Cabins are 80% occupied for 80% of the peak season.

J.6.2 Vulnerability of Structures

As part of the 2011 ISMP, key assets within the NNVM, including various buildings, two bridges, a road, a dam, and three slope faces, were scored for seismic vulnerability. The assets include all structures between the 0.06 g and 0.10 g contour lines of PGA in Figure J.10, as well as many other structures located within the 0.01 g to 0.05 g contour lines. The list includes Paulina Lake Lodge and associated cabins, East Lake Lodge and associated cabins, Paulina Lake Guard Station and associated USFS structures, and other structures along the Paulina-East Lake Road. The dam and collocated bridges span Paulina Creek at the outlet of Paulina Lake, adjacent to Paulina Lake Lodge. One of the slopes crosses a road cut on Road 500 leading to Paulina Peak, which is prone to rock-fall that results in rocks on the roadway. The two other slopes are located on the north sides of Paulina and East Lakes, respectively, which USFS presented as a slope stability concern. The vulnerability of structures in and around La Pine were not assessed because analysis by URS (Wong et al. 2011) indicated that damage at that distance (15 km, 9 mi) is extremely unlikely.

On June 9, 2011, a SGH structural engineer and a T&R geotechnical engineer accompanied Rod Bonacker of the USFS to conduct a visual inspection of the bridges, the dam, and 15 representative buildings and cabins. The purpose of the visit was to become familiar with the construction types of the buildings and the bridges. They determined that the buildings are all of wood-frame construction. The older vintage buildings are log cabin style, while the newer buildings are more traditional modern wood-frame construction, all with either a stone or concrete foundation. The three structures at the outlet of Paulina Lake were also inspected: the small (3 to 4 ft high) dam, the older (1954) and integral concrete bridge, which is no longer in use, and the new (2008) steel bridge installed over the concrete bridge. The talus slopes could not be observed in the field due to snow cover. On June 22, 2011, AltaRock presented the preliminary results of the field visit to the BLM, USFS, and DOE, and proposed the methodologies for evaluating the assets. All agencies agreed that the proposed method would adequately characterize the structural vulnerability of these assets.

The results of the SGH structural engineering evaluation of the buildings and bridges are included in Appendix H of the 2011 ISMP. Twelve representative structures were scored using the national standard document, FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*. For the 12 NNVM structures scored, the PGA resulting in a 10% probability of collapse was determined to be between 0.25 and 1.1 g. Further analysis indicates that in a "worst case" 0.10 g PGA the probability that an M 3.5 seismic event could produce the collapse would be 1.2% or less for all NNVM structures. SGH noted that the bridge is constructed "on fairly competent bedrock." SGH calculates the PGA limit for the bridge to be 0.28 g, similar to most susceptible buildings.

SGH also evaluated thresholds for cosmetic damage to buildings and recommended that the peak particle velocity be limited to 2 cm/s to minimize the potential for cosmetic damage to the buildings. This correlates to an approximate PGA of 0.025 g. As will be discussed in sections below, mitigation measures designed to slow induced seismicity will begin at a PGA of 0.014 g, well below the shaking level that might cause cosmetic damage, and an order of magnitude below the shaking level that would cause collapse of NNVM buildings.

The T&R geotechnical engineering evaluation of the dam and steep slopes is provided in Appendix I of the 2011 ISMP. The dam is described as a concrete wall .9–1.2 m (3–4 ft) high and 30–35 cm (12–14 in.) thick, connected to a concrete bridge on the downstream side. Both concrete structures are "keyed into and bottomed in" bedrock. According to the evaluation, no concrete dam is known to have failed as a result of earthquake-induced ground motion, including a 113 m (372 ft) high concrete arch dam that survived accelerations of 0.6 to 0.8 g caused by an M 6.6 earthquake. Therefore, the engineers conclude that "the probability of additional damage to the dam is low and the probability of failure of the dam is extremely remote."

The likelihood of landslides on the slopes of concern in the NNVM was evaluated by comparing the *maximum stable slope inclination* for the five rock types exposed to the slope inclinations measured from LiDAR imagery. The T&R geotechnical engineer concluded that "all geologic units have a low to very low risk of a deep seated landslide during static and minor earthquake loading with PGA's up to 0.1g." T&R provides further support for this conclusion from a survey conducted by the USGS (Keefer 1984) of landslides caused by earthquakes, which concluded that for a landslide to occur during an M 4 earthquake, the epicentral distance would need to be less than 0.2 km (.1 mi). At Newberry Volcano, the nearest slope of concern is more than 4 km (2.5 mi) away from the project site.

In 2011, the USFS expressed concern about snow avalanches being triggered by induced seismicity. While possible, the 2011 ISMP considered this a very low risk. Despite the low risk, a plan to post signage to warn winter users of avalanche risk was developed. The final NEWGEN ISMP may need to revisit this concern.

J.6.3 NEGSD Damage Claim Procedures

Although all assessments have determined that it is extremely unlikely that any damage would occur, as part of the 2011 ISMP, a process to receive reports of damage, and to assess and rectify damage claims was prepared. Instructions and a tentative form to report damage were developed and would have been publicly provided if shaking measured by the SMS had reached PGA > 0.028 g. A licensed, independent civil engineer would have been hired to evaluate all claims and identify the appropriate response. Also developed was a procedure for compensation to be implemented in the event that damage was reported. The damage claim procedures will be re-evaluated for the final NEWGEN ISMP.

J.7 Step 4: Establish a Seismic Monitoring System

The MSA installed for NEGSD will serve as the basis for further improving seismic monitoring. For the temporary MSA required during NEWGEN Phase 2A, the currently operating four borehole stations plus Cascade Volcano Observatory stations already exceed the minimum requirement.

For the Phase 2C NEWGEN MSA a minimum of seven of the existing borehole stations and three surface stations will be re-occupied and reused. Expansion of the MSA to the north to better cover the NEWGEN FORGE site will require up to seven new borehole stations and four surface striations. The MSA will be expanded and operated by qualified members of the NEWGEN team and be deemed operational by regulatory groups, including the DOE, BLM, and USFS, in advance of any field activities that may potentially generate induced seismicity.

J.7.1 Current Seismic Monitoring

A review of historic data demonstrates that Newberry Volcano is essentially aseismic (Wong et al. 2010). In the pre-instrumental period, between 1891 and 1980, no earthquakes greater than M 5.0 occurred within 100 km of Newberry Volcano. Since the instrumental period began in 1980 with the expansion of the Pacific Northwest Seismic Network (PNSN) into Oregon, the historic record is probably only complete for events of $M_L \geq 3.0$. Since 1980, there have been only six $M_L \geq 3.0$ earthquakes within 100 km of the Newberry Volcano, most of which occurred in 1999 during a single swarm located 98 km southeast of Newberry Volcano. Wong et al. (2010) concluded that based on the instrumental record, no earthquakes have been recorded within 10 km of Well NWG 55-29 or Newberry Volcano. Four microseismic events have been recorded below the edifice of Newberry Volcano at distances of 10–15 km (6–9 mi) from NWG 55-29 (see Figure 5 in Wong et al. 2010). These events, which occurred in 2004 and 2005 at depths between 4 and 8 km, all had $M_L \leq 2.2$ (ANSS 2011).

In 2012, seven surface and eight borehole seismometers were installed during the NEGSD project. The Institute of Earth Science and Engineering provided 2 Hz three-component geophones for all borehole and surface stations. Borehole geophones were gimbaled and capable of being installed in boreholes with up to 10 degrees of deviation from vertical. Geotech Instruments DR-24 digitizers were configured and installed with each geophone. Electronics were powered by two solar panels installed on nearby trees and connected to two solar batteries inside the Hoffman boxes containing the digitizers.

Borehole station installation was completed in three basic steps. A holelock was lowered into the borehole via a wireline while mounted on a 24 V downhole impact wrench powered from the surface by an electrical cable. Once lowered to the installation depth, the wrench was activated, which rotated the threaded bottom of the lock relative to the top and pushed out carbide steel teeth that latched the holelock to the steel casing. The installation tool was removed, leaving the holelock in place. Next, a gyroscope connected to a laptop computer was first oriented (to north) at the surface and then lowered to the installed holelock where it was oriented by a bishop's hat and groove on the holelock. The gyroscope's downhole orientation was determined at least twice and then pulled back to the surface, where its orientation was re-checked. Geotech Instrument's holelock orientation software allowed the holelock's orientation to be determined. The downhole lock orientation (in degrees clockwise from north) was then used to orient the key on the geophone's holelock adapter. Finally, the geophone was lowered downhole on a Kevlar-reinforced, six-conductor data cable. Flexible conduit protects the cable from damage between the borehole and Hoffman box connection. Figure J.12 shows a borehole seismometer installed as part of the NEGSD MSA.

Figure J.12. Borehole seismometer, cable, and winch trailer used to install the NEGSD MSA.

The surface recording and telemetry equipment was installed inside a 91 × 91 × 46 cm (36 × 36 × 18 in.) Hoffman instrument box situated within approximately 5 m (16 ft) of the installed sonde. Each box contained two 100 amp-hour deep-cycle gel batteries, a Geotech Instruments DR-24 digitizer, solar panel charge controllers, and a cell phone modem. In a tree adjacent to each box, two 90 W solar panels, a global positioning system antenna for precision time, and a cell phone antenna were installed. Each cell phone modem was given a static Internet Protocol address, which allowed remote communications to any digitizer.

In addition to the 15-station MSA installed during NEGSD work, to measure any ground acceleration (shaking) generated by stimulation of NWG 55-29, an SMS was installed at an unused building above Paulina Lake, about 3 km (1.9 mi) southeast of NWG 55-29. This site proved to be noisy due to cultural activities and the way in which the sensor had been installed; therefore, the site was demobilized when the NEGSD was completed in 2015. The location of the SMS for NEWGEN FORGE project monitoring will be re-evaluated. It may be advantageous to install at least two SMS instruments as part of the NEWGEN project.

The original 15-station MSA at the NEGSD project site was reduced to 4 borehole stations plus the SMS in 2015. These stations live-stream seismic data directly to PNSN for review. In addition, the USGS and the Cascade Volcano Observatory maintain nine seismic monitoring sites at Newberry Volcano. Data from these sites are available publicly via the PNSN seismic monitoring website (Figure J.13; http://www.pnsn.org/seismograms/NN17).

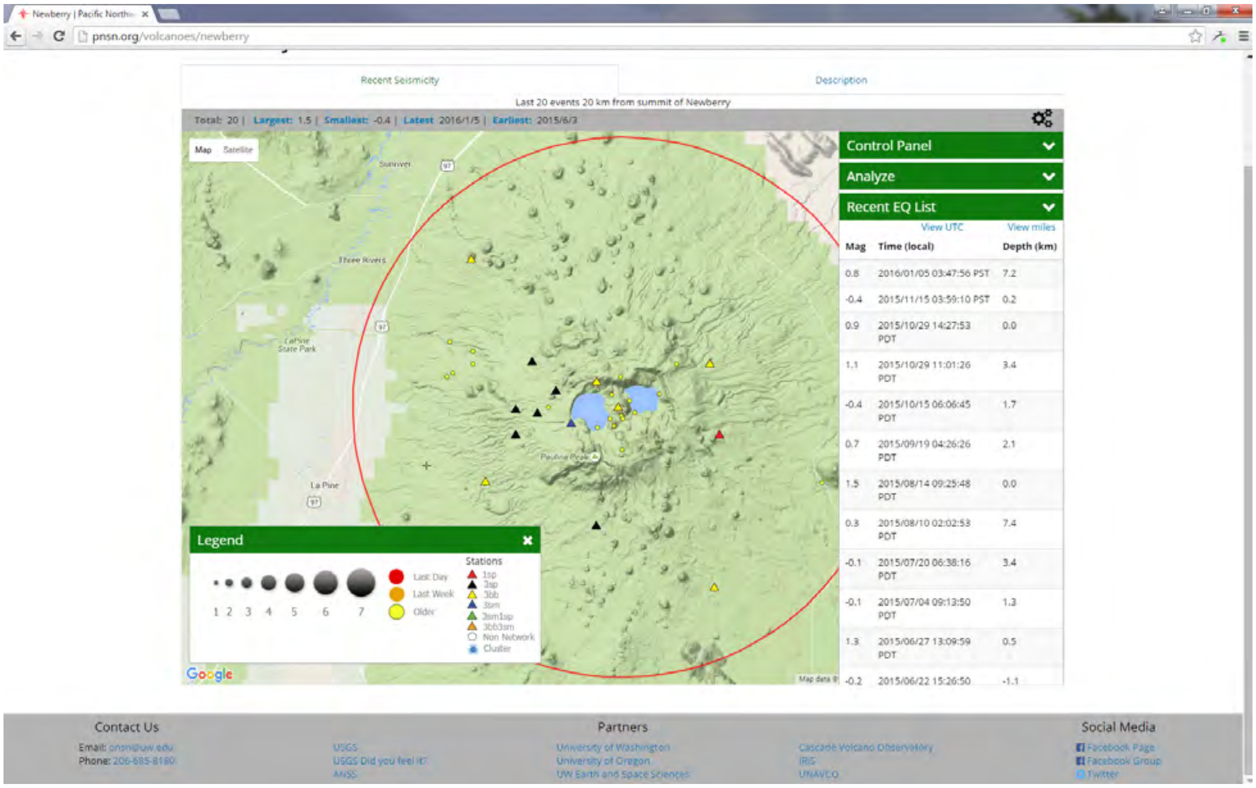

Figure J.13. Pacific Northwest Seismic Network webpage showing the stations (triangles) operating as of January 22, 2016, and earthquake information for events recorded within 20 km (12.4 mi) of the summit between June 3, 2015 and January 22, 2016.

Lessons learned from the NEGSD site will be incorporated into the design and implementation of the NEWGEN MSA design, installation, and operation and maintenance plan. Previous stimulation work in 2012 and 2014 showed that a well-designed, properly installed and operated MSA is capable of detecting small magnitude seismic events at Newberry Volcano. During the 2012 stimulation of NWG 55-29, about 175 events were located in the stimulation zone with magnitudes between M 0.0 and M 2.3 (Cladouhos et al. 2013). Between March 1, 2013 and September 20, 2014, about 60 natural seismic events were located on the Newberry Volcano edifice (PNSN 2015). This apparent increase in Newberry Volcano seismicity since 2012 is due to a much-improved seismic monitoring network that has better detection abilities, and not EGS activities. In 2014, the NEGSD MSA located 400 events ranging in magnitude from M 0 to M 2.26, demonstrating that the NEGSD MSA design and operation functioned as intended and is capable of detecting both natural and induced seismic events.

Seismic monitoring equipment removed in 2015 is currently in storage and available for deployment at the NEWGEN FORGE site. AltaRock's team of experienced staff is capable of installation, operation, and maintenance of this equipment with little outside (contractor) support. For the preliminary Phase 2A MSA, NEWGEN's plan is to restore at least one of the three inactive borehole sites (NN-09, NN07, NN-24, or NN-18) and stream the data to PNSN. Seismologists at the University of Oregon, a NEWGEN Extended Consortium member, will perform waveform template matching on the background data to increase the natural seismicity catalog size and double-difference relocations to improve the location accuracy.

J.7.2 Proposed Phase 2C Seismic Monitoring System

An expansion of the current seismic monitoring system surrounding the NEWGEN FORGE site is proposed here in order to improve seismic monitoring coverage surrounding Pads 17 and 16, which are 3 km north of Pad 29, the center of the NEGSD MSA. The new design will include the addition of up to seven new borehole sensors and four new surface monitoring stations (NM61-64). Installation of the proposed system requires drilling seven new wells for borehole sites (NN51-57) and reoccupation of three sites previously used as part of the NEGSD MSA (NM06, NM22, NM42). In addition, real-time telemetry will be reinitiated at four of the currently installed borehole stations at which the surface equipment has been temporarily stored (NN07, NN09, NN18, NN24). In total, the proposed system will include 15 borehole and 7 surface monitoring sites, and an SMS at NNVM. This design is preliminary and will be further evaluated during Phase 2B as the final ISMP is developed; for example, an additional SMS closer to NWG 46-16 and Pad 17 may be warranted. Figure J.14 details the locations of the existing and proposed monitoring sites.

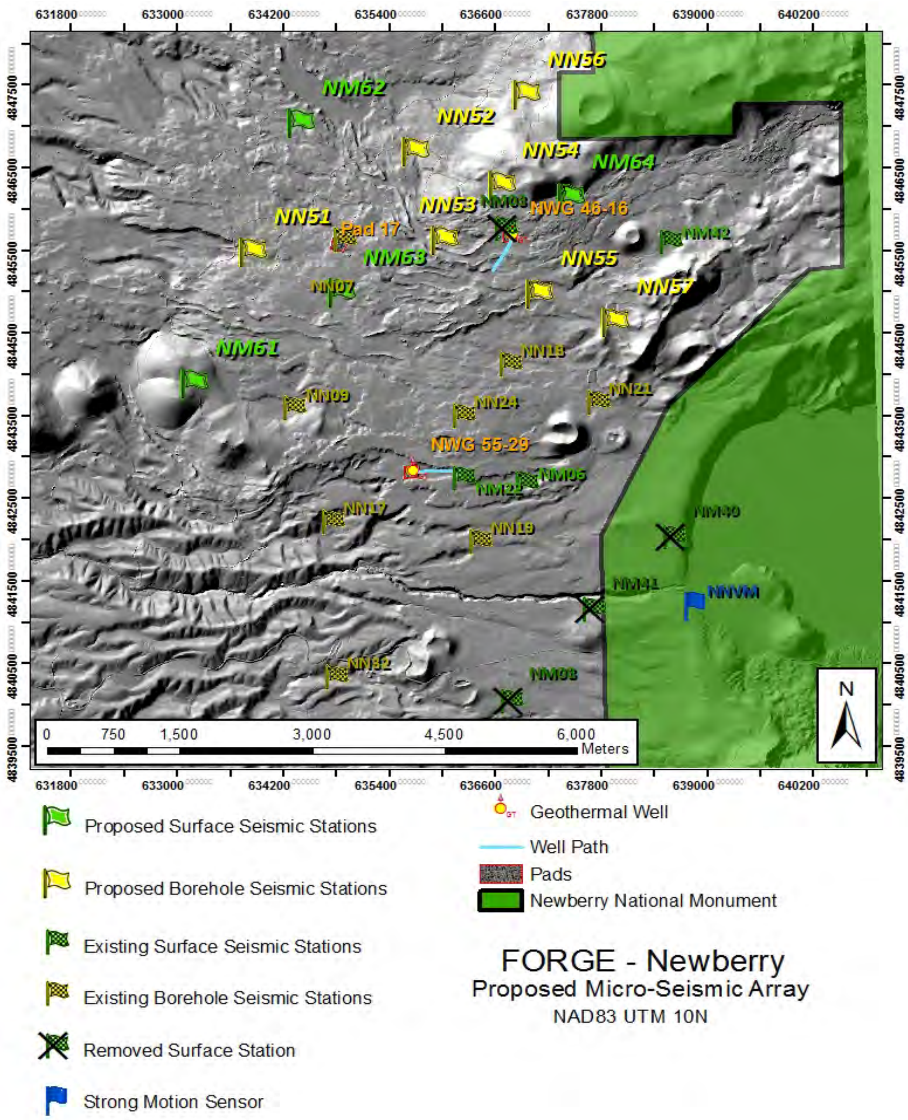

Figure J.14. The proposed seismic monitoring system at the NEWGEN FORGE site would include up to 22 monitoring sites—5 borehole sensors and 7 surface monitoring stations.

J.7.3 Seismic Monitoring

Stimulation operations at the NEWGEN FORGE site will be monitored in real time by appropriate staff both onsite and offsite. At the operational center located near the well site, seismologists and engineers will be able to monitor and compare the injection rate, wellhead and downhole pressure, event locations, maximum event size, the size distribution of microseismicity (the b-value), and other parameters 24 hours a day.

During the NEGSD stimulations, daily activity reports were transmitted to the stakeholders. The daily report was accompanied by several graphs that included surface pressure, bottom-hole pressure and flow rate versus time, and temperature versus depth. If induced seismicity had occurred that day, the daily report included information about the magnitude and location of the events. The frequency and detail of reporting during NEWGEN FORGE operational activities will be determined during later phases.

During the NEGSD all seismic data were first streamed directly to AltaRock's Seattle office and then provided in real time to LBNL and PNSN, where software automatically determined preliminary locations (epicenters) and magnitudes without review by a seismologist. The data flow for seismic data during NEWGEN FORGE operations is yet to be determined. Seismologists and engineers on the NEWGEN team will review the microseismic data and provide timely refinements and analysis of induced microseismic event hypocenters and magnitudes, as well as the development of the EGS reservoir with respect to the NEWGEN plans and goals.

J.8 Step 5. Quantify Hazard from Natural and Induced Seismic Events

Based on review of relevant scientific literature, industry best practices, lessons learned from the NEGSD Phase I and II reports, and work by URS, the NEWGEN FORGE site has a low likelihood of naturally occurring earthquakes of large enough magnitude to be felt or cause damage to local structures. It is also unlikely that any induced seismic event due to well stimulation activities at the NEWGEN FORGE site will incur events larger than M 3.5–4.0; the calculated maximum probability of a M > 4.0 event is 0.09%.

J.8.1 Baseline Hazard from Natural Seismicity

A baseline probabilistic seismic hazard assessment (PSHA) was developed for the 2011 ISMP by Wong et al. (2010) and provided as Appendix F of that report. Potential natural seismic sources included known tectonic faults, potential volcanic earthquakes within 100 km of the site, and the Cascadia Subduction zone megathrust. The risks of natural earthquake at Newberry Volcano were poorly known at that time due to lack of seismic monitoring.

Since 2010, a better understanding of both Newberry Volcano seismicity and regional seismicity will warrant an update of the 2010 PSHA. Fortunately, PNNL has a strong background in PSHA and can lead the effort to update the 2011 ISMP in this regard.

J.8.2 Hazard from Induced Seismicity

Maximum Magnitude Predictions

M_{max} and earthquake rates are the two most important inputs into seismic hazard analyses. The magnitude of an earthquake is proportional to the area of the fault that slips in an event and the amount of stress that is released (i.e., stress drop). Several conditions must be met for a potentially damaging earthquake to occur. There must be a large enough fault, stresses must be high enough to cause slip, and the fault needs to be pre-stressed and near failure. As recognized by many, the characteristics of induced seismicity are controlled by the characteristics and distribution of preexisting fractures and faults, and the local stress field in the volume of rock surrounding the well where fluid is being introduced (Majer et al. 2007).

Two basic approaches were used to estimate the potential M_{max} for NEGSD activities—analogs from other EGS and geothermal projects and theoretical models. Because few EGS projects have been undertaken worldwide, finding suitable analogs is challenging. Theoretical approaches depend on an a priori knowledge of the rupture characteristics of future induced seismicity, which requires subsurface characterization of the affected volume of rock around the well. This information is now available due to the NEGSD. The largest events induced during the NEGSD stimulations were an M 2.39 in 2012 and an M 2.26 in 2014. The implications of these events have not yet been fully evaluated to determine the impact on the M_{max} analysis performed for the 2011 ISMP. At this stage, we suggest that the M_{max} analysis below is still valid, but can be further updated during Phase 2B based on the NEGSD results.

To develop site-specific, theoretical models of M_{max} for NEGSD, AltaRock commissioned the William Lettis & Associates division of Fugro Consultants (Fugro). The Fugro assessment included additional analysis of LiDAR data, updated physical and injection plan parameters, a model incorporating high heat flow at Newberry Volcano, and estimates of the probability of the different M_{max} levels. The Fugro report is included as Appendix E of the 2011 ISMP and summarized below.

Additional lineament analyses of LiDAR data did not disclose any significant features within a 1 km radius of NWG 55-29 that could be activated by EGS stimulation. Within a 5 km radius, mapped lineaments are associated with drainage and depositional features on the flanks and margins of the Newberry Volcano (Figure 8 of Appendix E). None of these lineaments were identified as faults and, in any case, their orientations make them unlikely to slip in the current stress field determined from the BHTV breakouts and active tectonic features mapped in the broader region (Cladouhos et al. 2011).

Fugro used three alternative approaches to evaluate M_{max} for the NEGSD project based on physical properties of the surrounding rock mass and proposed injection process. These approaches provide single-valued deterministic estimates of M_{max} for specific combinations of physical parameters estimated for the site (Table J.3).

The first method, taken from Brune (1970), is based on dynamic stress drop, which controls the absolute amplitude of radiated seismic waves, and corresponding ground shaking. For an induced event created by slip on a fault with a 500 m (1640 ft) radius (the radius of the maximum dimension of the proposed EGS reservoir) and a stress drop of 3 MPa, an M_{max} of 3.89 is calculated.

Table J.3. Summary of the three deterministic approaches used to estimate M_{max}. Only the highest M_{max} estimated by each method is shown in this table. M_{max} based on a wider range of input values is shown in Appendix E of the 2011 ISMP.

TECHNIQUE	CHARACTERISTICS	HIGHEST M_{max}
Brune (1970)	Dynamic stress drop, 500 m (1640 ft) radius, 3 MPa stress drop	3.89
McGarr (1976, 2014)	Injected volume of 30,545 m^3 (8 million gallons)	3.24
Leonard (2010)	Based on fault area 1000 m (3280 ft) strike length and 1473 m (4833 ft) vertical extent limited by shallow (3.5 km) brittle-ductile transition	3.98

The second method, based on McGarr (1976, 2014), relates the sums of the seismic moment released in earthquakes to a change in volume. In the case of fluid injection, it is the volume added to the system by injection. Using a crustal rigidity of 3.5 GPa and the planned injected volume of 8 million gallons for a single fracture stage (~30,000 m^3), an M_{max} of 3.28 is calculated.

The third method, from Leonard (2010), is based on a set of internally consistent scaling relationships between seismic moment and rupture area, length, width, and average displacement. The length of the fault plane of an M_{max} event can be constrained to be the target length of the EGS reservoir, 1000 m (3280 ft). The vertical extent of the fault plane can be constrained by the depth to the brittle-ductile transition below NWG 55-29, which is an extremely shallow 3.5 km (2.2 mi) due to the high heat flow. Using these constraints on a 50° dipping fault plane, an M_{max} of 3.98 is calculated. The three M_{max} values calculated by Fugro substantiate the earlier estimate by URS of a M_{max} ranging from 3.5–4.0.

The final approach used by Fugro relies on the "seismogenic index" developed by Shapiro et al. (2010). Shapiro et al. (2007) observed that the number of induced earthquakes with magnitudes larger than a given value increases approximately proportionally with the injected fluid volume. Using the seismicity rate of induced events and the fluid injection rate, Shapiro et al. (2010) derived a seismogenic index. This parameter can be used to compare the induced seismicity effects of injection conducted at different project locations. The Shapiro et al. (2010) analysis is appealing because it provides a probabilistic prediction of maximum magnitude based on a relatively modest amount of site-specific information.

Fugro calibrated and tested the Shapiro et al. (2010) method using data from the initial 14-day injection sequence at the Paradox Valley site and found that the observed $M_{max} = 0.9$ falls within the 95% confidence region of the predicted $M_{max} < 1.2$ (Figure 9 of Appendix E). The median prediction of M_{max} (4.39) and the observed M_{max} (4.3), over a 4-year long-term injection in which more than 2 million metric tons (>500 million gallons) of waste were disposed, are also in agreement.

Applying the method of Shapiro et al. (2010) to the NEGSD parameters, Fugro found that the probability of the injection activity at Newberry Volcano inducing an event with M > 3.0 is less than 1% over a 50-day period that would include injection and pressure dissipation (flow-back). At a 95% probability, the maximum induced event is predicted to be M < 2.2. The median (probability = 0.5) M_{max} for the most conservative assumptions is less than M = 1.0 (Table J.4).

Table J.4. Calculated probability of event occurrence.

EVENT MAGNITUDE	EVENT PROBABILITY	
	MINIMUM	MAXIMUM
>1	0.7%	40%
>2	0.1%	6%
>3	0.01%	0.8%
>4	0.002%	0.09%

In light of the largest seismic events induced during previous EGS projects and three deterministic models, an upper bound for M_{max} for the NEGSD of M 3.5 to 4.0 is defensible. Applying the recently developed Shapiro model, the probability of an event with M > 3.0 is less than 1%, with the most likely (median) M_{max} < 1.0.

Given the results of the NEGSD project (Section J.2.6), the M_{max} analysis and probabilities appear to be reasonable for the NEWGEN FORGE project as well. During Phase 2B, the NEWGEN technical team will revisit the analysis provided above in light of the 2012 and 2014 NEGSD stimulation results and update M_{max} calculations if warranted.

J.9 Step 6 Characterize Risk of Induced Seismic Events

AltaRock contracted with URS to conduct an independent Induced Seismicity and Seismic Hazards Risk Analysis for NEGSD (Wong et al. 2010) and it is provided as Appendix F of the 2011 ISMP. The tasks performed in the Wong et al. (2010) analysis included the following:

- review of available data from previous EGS projects,
- evaluation of local and regional faults for seismic risk,
- site-specific probabilistic seismic hazard analysis, and
- seismic risk evaluation.

The executive summary of the report by Wong et al. (2010) concludes:

> The results of the probabilistic seismic hazard analysis indicate that there is no difference in hazard at La Pine, Sunriver, and the project site NWG 55-29 between the baseline conditions (which incorporates the hazard from both natural tectonic and volcanic seismicity) and the EGS-induced seismicity. As a result, potential EGS- induced seismicity poses no seismic risk to the residents in the neighboring communities.
>
> However, potentially larger EGS earthquakes of M 3.0 and higher, should they occur, will probably be felt in La Pine and Sunriver, but not at damaging levels of ground motions (>0.10 g). Individual residents within 10 km of the project site will feel the larger events. The strength of shaking will depend on the size of the event, and distance to and site conditions at each location. The effects of induced seismicity will be more of a nuisance than a hazard to the vast majority of local residents because of the small size of the events and distances to centers of population.

URS also developed shake maps based on a predicted upper-range seismic event of M 3.5 at 1 km depth (3280 ft) in the target well (Wong et al. 2011). The shake map predicts PGAs of 0.25 g at the wellhead, 0.10 g at Paulina Lake, and less than 0.01 g at La Pine (Figure J.10). For natural earthquakes, a PGA of 0.10 g is perceived by humans as strong shaking and the potential for damage is light (Wald et al. 1999). However, it has been observed that perceived shaking and damage due to EGS-induced seismicity is typically lower (Majer et al. 2007).

Based on results from the NEGSD we believe that the model used by URS to generate the shake map (Figure J.10), which is based on data from The Geysers geothermal field in California, overestimated the shaking that might occur and thus represents a cautious approach. A shake map calibrated to The Geysers geology and geophysics will overestimate the shaking expected at Newberry Volcano; greater shaking is expected for a seismic event of a given magnitude at The Geysers due to the presence of competent bedrock near the surface, which more readily propagates seismic energy due to higher internal friction.

The surface geology at the NEWGEN FORGE site is dominated by thick unconsolidated volcanic materials, which have lower internal friction and absorb more seismic energy, thereby reducing shaking (Aki and Richards 1980). A clear improvement to the 2011 ISMP will involve an improved site response model for the NEWGEN FORGE site. The NEWGEN seismic team will use data collected during the NEGSD as well as Phase 2A data to create a Newberry-specific site response model for a new shake map, rather than relying on site response from The Geysers as the URS shake map (Figure J.10) did.

A risk-based mitigation plan was developed as for the 2011 ISMP. The plan stipulated mitigation actions if induced seismicity exceeded predefined limits in any one of the following three categories: 1) EGS reservoir growth outside the target stimulation zone or toward undesirable locations, 2) seismic event magnitudes in the reservoir that could lead to larger events, or 3) shaking that could disturb visitors to or threaten structures in the NNVM. For each category, intermediate levels were designed to proactively manage potential problems. The limits are based on earthquake magnitudes and shaking as recorded on the SMS.

The 2011 ISMP provides complete details about

- the limits used to proactively manage seismic risk,
- reporting requirements to inform stakeholders when any induced seismicity limit is exceeded, and
- mitigation actions and communication to be undertaken in the event that a limit is exceeded.

The limits and corresponding mitigation actions are summarized in Figure J.15. A decision tree like the one shown below is now commonly called a traffic light system.

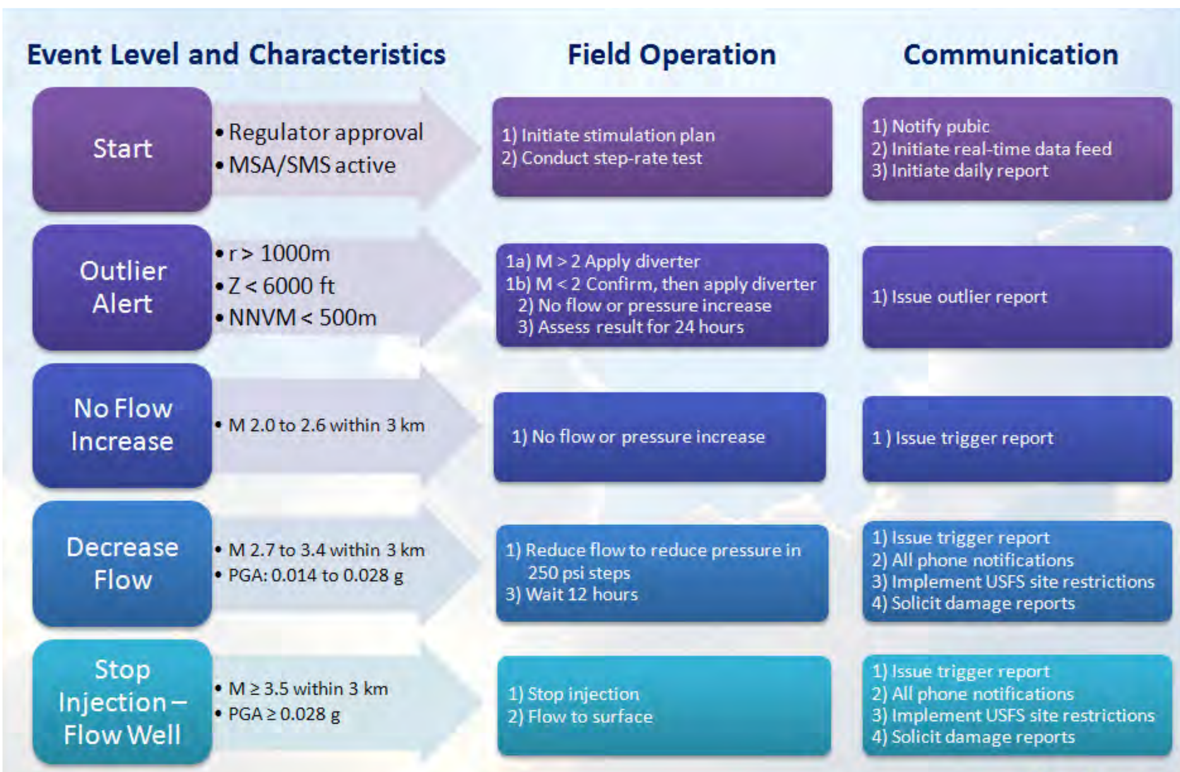

Figure J.15. Decision tree for triggers and mitigation actions (NEGSD example).

Important details of FORGE operational procedures will not be known until Phase 2C and/or Phase 3. Therefore, it is premature to propose a NEWGEN risk-based mitigation plan at this time. The action levels and mitigation steps of the 2011 ISMP are provided above as a starting point for guidance to an improved NEWGEN ISMP.

The final ISMP will serve as the initial guide for risk-based seismic mitigation at the NEWGEN FORGE site. New data collected during site characterization will provide the basis for future updates to the ISMP, and appropriate adjustments will be made over the course of the project as new data become available. Updates to the ISMP may include, but are not limited to, defining specific threshold values based on magnitude or g-force detected by the MSA and SMS; and identifying specific mitigation actions to be taken in response to induced seismicity magnitude or frequency.

J.10 Conclusion

In this preliminary NEWGEN ISMP, the 2011 ISMP and the results of the NEGSD are incorporated into seven steps of the "Protocol for Induced Seismicity Associated with Enhanced Geothermal Systems." Further effort during FORGE Phase 2 will be needed to turn this preliminary NEWGEN ISMP into the final NEWGEN ISMP needed for the NEWGEN FORGE project. Thanks to significant previous effort during the NEGSD related to monitoring and analysis of induced seismicity, finalizing the ISMP will require far less effort than expected. Furthermore, the final ISMP will be among the most robust and well-supported of such documents in the world.

J.11 Seismicity Terms and Background

The topics and concepts covered in this document are necessarily technical. This subsection provides some basic background on seismicity and earthquakes.

Earthquake – This term is used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the Earth. A shaking or trembling of the Earth that is volcanic or tectonic in origin.

Seismic Waves – When an earthquake occurs, it releases energy in the form of seismic waves that radiate from the earthquake source in all directions. The different types of energy waves shake the ground in different ways and also travel through the Earth at different velocities. The fastest wave, and therefore the first to arrive at a given location, is called the P-wave. The P-wave, or compressional wave, alternately compresses and expands material in the same direction it is traveling. The S-wave is slower than the P-wave and arrives next, shaking the ground up and down, and back and forth, perpendicular to the direction it is traveling. Surface waves follow the P- and S-waves.

Seismic Event – A generic term for occurrences in which energy is briefly released in the Earth's crust, resulting in a series of seismic waves. Because an earthquake implies to the layman a shaking of the Earth that is felt by humans or animals, the term seismic event or microseismic event is often used by geoscientists when communicating with the public about minor and micro-earthquakes (Table J.5). Many seismic events are too small to be felt, and can only be measured by precision instruments.

Table J.5. Comparison of quantitative and qualitative measures of ground shaking.

MMI[a]	PEAK GROUND ACCELERATION (g)	PEAK GROUND VELOCITY (cm/s)	PERCEIVED SHAKING	POTENTIAL DAMAGE
I	< 0.0017	<0.1	Not Felt	None
II-III	0.0017 – 0.014	0.1 – 1.1	Weak	None
IV	0.014 – 0.039	1.1 – 3.4	Light	None
V	0.039 – 0.092	3.4 – 8.1	Moderate	Very light
VI	0.092 – 0.18	8.1 – 16	Strong	Light
VII	0.18 – 0.34	16 – 31	Very Strong	Moderate
VIII	0.34 – 0.65	31 – 60	Severe	Moderate/Heavy

(a) Continues to Modified Mercalli Intensity (MMI) XII, but not relevant for this discussion. Please see Intensity definition below for discussion of MMI.

Earthquake Size Distributions – It has long been recognized that small earthquakes are far more common than big earthquakes. This relationship can be expressed by a formula called the Gutenberg-Richter relationship:

$$\log (N) = a - bM$$

where N is the number of events having a magnitude greater than or equal to M, and a and b are parameters fit to the data. The parameter b, called the b-value, is usually close to 1, which means that for each logarithmic decrease in magnitude there are about 10 times as many earthquakes (Table J.6). Most of the earthquakes generated by the NEGSD projects had have magnitudes less than 2.0. Worldwide there are estimated to be over 36,000 events of this size range per day.

Table J.6. Worldwide, annual counts of earthquakes by magnitude.[a]

CLASS	MAGNITUDE	ANNUALLY AVERAGE	DAILY AVERAGE
Great	8 and higher	1	
Major	7 – 7.9	15	
Strong	6 – 6.9	134	
Moderate	5 – 5.9	1319	4
Light	4 – 4.9	13,000 (estimated)	36
Minor	3 – 3.9	130,000 (estimated)	360
Micro	2 – 2.9	1,300,000 (estimated)	3,600
Micro	1 – 1.9	13,000,000 (estimated)	36,000

USGS Earthquake Magnitude Policy

Shear Slip – Slip is the relative displacement of formerly adjacent points on opposite sides of a fault, measured on the fault surface. Shear slip can occur seismically or aseismically (without creating seismic waves).

Seismometer and Seismogram – A seismometer is an instrument used to record the seismic waves generated by earthquakes on a *seismogram*.

Seismic Array – Many seismometers are installed in networks or arrays spread across the area of interest to locate seismic events in the region. To determine the location of seismic events, seismologists identify the arrival times of P- and S-waves on the seismograms of all instruments that have recorded the seismic waves. These arrival times are commonly called P-picks and S-picks. Theoretically, three P-picks and three S-picks can be used to triangulate the location of a seismic event. In practice, on a microseismic array like that described below, five P-picks and two S-picks will yield acceptable location accuracy, and seven P-picks and three S-picks will yield good location accuracy (Gillian Foulger, personal communication).

Hypocenter and Epicenter – The hypocenter is the point within the Earth where an earthquake rupture starts. The epicenter is the point directly above it at the surface of the Earth.

Magnitude – The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded on a seismogram at a certain period. The original magnitude scale was the Richter scale, usually denoted as M_L.

Moment and Moment Magnitude – Moment is a physical quantity proportional to the slip on the fault times the area of the fault surface that slips; it is related to the total energy released in the seismic event, and is denoted M_o. The moment can be estimated from seismograms. The moment is then converted into a number similar to other earthquake magnitudes by a standard formula. The result is called the moment magnitude (M_w). Moment magnitude provides an estimate of earthquake size that is valid over the entire range of magnitudes, a characteristic that was lacking in previous magnitude scales, like the Richter scale. Therefore, seismologists now prefer the moment magnitude scale and it is common practice to use just magnitude and M to refer to moment magnitude.

Comparative Energy Release – The formula relating moment magnitude (M_w) to moment (M_o) in dyne-cm is:

$$M_w = \log_{10}(M_o) / 1.5 - 10.7$$

Practically, this means that for each increase in moment magnitude, there is a 31.6 × ($10^{1.5}$) increase in total seismic energy. That is, an M 3.5 event releases the same amount of energy as about 32 M 2.5 events.

Intensity – The intensity is a number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the Earth's surface and on humans and their structures. The Modified Mercalli Intensity (MMI) scale is most commonly used in the United States. There are many intensities for an earthquake, depending on where the observer is located, unlike the magnitude, which is one number for each earthquake. Table J.7 shows the qualitative MMI scale. Table J.8 relates the MMI that would be typically felt at the earthquake epicenter to ranges of magnitudes.

Ground Velocity and Acceleration – Ground velocity is a measure of how fast a point on the ground is shaking as a result of the passage of the seismic waves of an earthquake. During an earthquake, ground shaking also produces acceleration, the change from one velocity to another. Ground velocity and acceleration decrease with distance from the earthquake’s epicenter. The peak ground velocity and PGA are the largest velocity and acceleration, respectively, recorded by a particular station during an earthquake. Both peak ground velocity (PGV) and PGA can be used to quantify the potential for damage from an earthquake. Engineers typically use PGV, or particle velocity, while seismologists more commonly use PGA. Ground velocity and acceleration are both measured on special seismometers called SMS. PGA is typically quantified with respect to gravity (g). Table J.8 compares intensity, PGA, and PGV.

Table J.7. First eight of twelve levels of the Modified Mercalli Intensity Scale.

I. Not felt except by a very few under especially favorable conditions.

II. Felt only by a few persons at rest, especially on upper floors of buildings.

III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

Continues to XII, but not relevant for this discussion.

Table J.8. Comparison of magnitude and maximum MMI.[(a)]

MAGNITUDE	TYPICAL MAXIMUM MODIFIED MERCALLI INTENSITY AT EPICENTER
1.0 – 3.0	I
3.0 – 3.9	II – III
4.0 – 4.9	IV – V
5.0 – 5.9	VI – VII
6.0 – 6.9	VII – IX
7.0 and higher	VIII or higher

USGS Magnitude/Intensity Comparison

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Damage and Repair of Puna Well KS-14

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Keywords

Puna Geothermal Venture, Kilauea 2018 Eruption, Workover, Redrill

ABSTRACT

KS-14 was the most productive well in the Puna Geothermal Field but the Kilauea eruption in May 2018 caused extensive damage to the well. At the beginning of the eruption the shut-in wellhead pressure increased from 500 to 1840 psig and was reduced by pumping heavy mud into the well. After the eruption ended and access was restored, a rig moved onto the well and cleaned out the mud but found damaged casing in the area of an active fault. The casing damage was repaired with a cemented liner, but the well was unintentionally sidetracked below the liner. The subsequent redrill encountered a sealed fault where a high productivity fracture zone used to be, so drilling continued deeper to a new production zone where the well was completed and returned to service.

1. Introduction

The Puna Geothermal Venture (PGV) Power Plant on the east side of Hawaii Island in the state of Hawaii, USA was generating approximately 40 MW in early 2018. Well KS-14 was the best production well producing enough steam and water to generate 18 MW. KS-14 was shut in several times during 2017 and WHP never exceeded 500 psig. Kilauea Volcano erupted in the vicinity of PGV starting in May 2018 and caused considerable damage to the wellfield above and below ground. Figure 8 shows the KS-14 wellbore diagram with the original hole and two redrills.

2. Eruption

Production was stable until May 1st when frequent earthquakes began to occur. Gas flow at the plant increased and brine pH decreased. KS-14 valves were throttled to 18% open on May 2nd and wellhead pressure (WHP) increased to 803 psig. The plant was shut down when lava began erupting in nearby Leilani Estates on May 3rd. KS-14 valves were closed and WHP increased to 1840 psig and then declined slowly to 1100 psig by May 17th. Ground cracks appeared in the project area including one going through the KS-14 cellar. Leveling surveys indicated up to a meter of uplift in the area. Lava was erupting from several vents along the south side of the lease 1000 feet from the KS-14 wellhead, see Figure 1. The State of Hawaii was concerned about the safety of the wells and requested downhole plugs, so preparations began to kill the wells and install bridge plugs.

Figure 1. Erupting vents on south side of wellfield.

3. Well Kill

Water was pumped into KS-14 on May 18 to try to quench steam that might be causing the high pressure. Injection started at 1 barrel per minute (bpm) with 1200 psig WHP declining to 1140 psig after one hour. Injection was increased to 2 bpm at 1180 psig WHP for an hour. Then injection was increased to 3 bpm and the pressure immediately increased to 2000 psig so pump rate was reduced to 1.5 bpm and WHP dropped to 1120 psig. The cause of the higher pressure is unknown but could be due to a limited volume to pump into or higher temperatures nearby. Injection was reduced to 1 bpm and pumping continued through the night.

At this point it was apparent that heavy mud would be required to kill the well, but first salt water would be pumped to see if it would be effective. Salt water was pumped into KS-14 on May 19th at 0.5 bpm. Pressure went down to 940 psig after pumping a total of 198 bbls of 9.9 ppg salt water, as predicted by well kill calculations, so heavy mud was mixed on May 20th.

On May 21st, 226 bbls of 16.5 ppg mud was pumped into KS-14 and WHP was reduced to 460 psig. The heavy mud could not be pumped out of the bottom of the pit, so it was diluted and 87 bbls of 10 ppg mud reduced the pressure to 320 psig.

Site access was limited by SO_2 gas for a couple of days. KS-14 WHP was 540 psig on May 22nd and 675 psig on May 23.

On May 24th, one bbl of water was pumped into KS-14 and pressure increased to 800 psig and then declined back to 655 psig in four hours indicating that the well was essentially plugged.

KS-14 WHP was 740 psig on May 25th. In the morning of May 26th, KS-14 WHP was bled down to 40 psig and then rose back to 170 psig by noon then dropped back to 100 psig on May 27th. Lava flowing from the Leilani Estates vent blocked access to the PGV site on May 29th. Bridge plugs had been installed in the five other production wells by this time.

Lava flow decreased significantly in early August and eruption of lava ended on August 8th. Road access to the site was restored in December 2018.

4. Well cleanout post-eruption

A workover rig, Rig 4, was moved onto KS-14 in April 2019. A 10-1/2" bit cleaned out scale from 778 to 2297 feet where it torqued up. The well was taking 40 to 100 barrel per hour (bph). Open-ended drillpipe washed to 2301 feet and a camera was run and could see deformed casing and holes in the casing, shown in Figure 2. A 5-7/8" mill was run to 2303 feet and then a 7-5/8" bit cleaned out through tight hole at 2330 feet to 3071 feet. The well then kicked and 182 psi and 366°F were recorded on the vent line. Mud weight was increased to 10 ppg and a 9-7/8" bit cleaned out 50% scale and 50% formation from 1980 to 3023 feet, lost circulation at 2345 feet, encountered a tight spot at 2894 feet, and took several kicks. Pressure-temperature (PT) surveys run on April 22 and 23 recorded a maximum temperature of 576°F at 2200 feet, see Figure 3. High temperature fluid could not have been coming up the wellbore at this time due to the heavy barite mud plugging the wellbore. It was decided that the workover rig was too small to repair KS-14, so a cast iron bridge plug was set at 2010 feet with sand and cement pumped on top. Rig 4 moved off and preparations began to move in a full-size drilling rig.

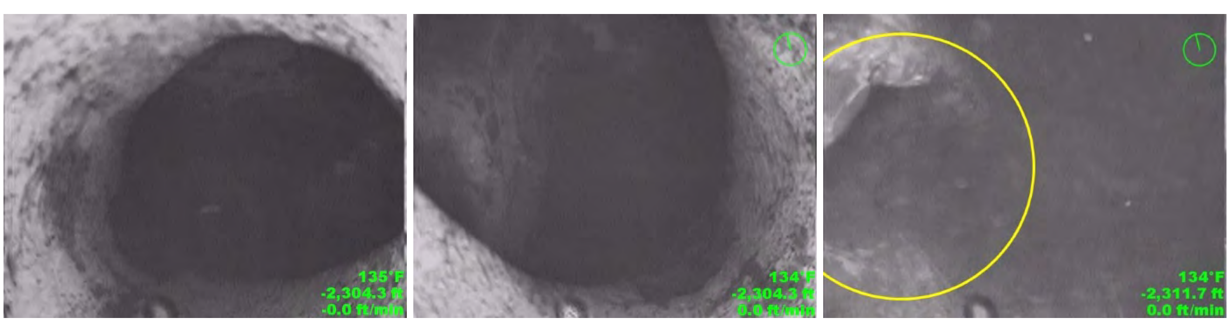

Figure 2: Camera survey showing deformed casing, left two photos, and hole, right photo.

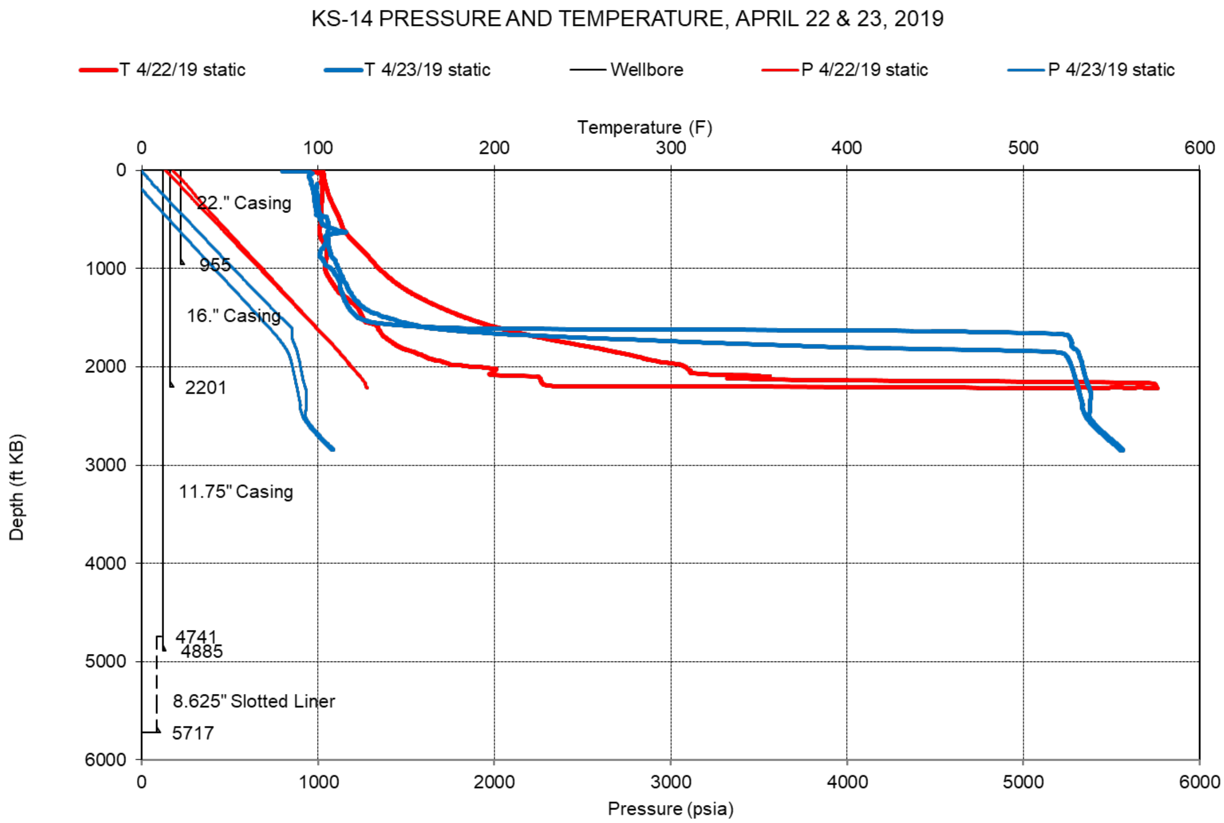

Figure 3. Pressure-temperature surveys April 22 and 23, 2019 with KS-14 wellbore on left.

5. Repair

Rig 1 moved onto KS-14 in July 2019 and work began on August 1st. The cement and bridge plug were drilled out with a 10-1/2" bit and 10.3 ppg mud with 75 bph losses after the plug released. The hole was washed and reamed down to 4729 feet in three days and the plug remains were drilled to 4730 feet.

A caliper log was run and showed severe casing damage at 2100 feet and from 2186 to 2210 feet. See Figures 4 and 5. The log was not good below 2210 feet due to mud that packed on the fingers. The tool set down at 2700 feet and could not go any deeper.

A cement plug was pumped on bottom and was tagged at 4626 feet. Then a reaming assembly was run with a 10-1/2" string mill and 10-1/2" bit and washed and reamed to 4622 feet. A tight spot was encountered from 4085 to 3900 feet coming out of the hole, possibly indicating additional casing damage.

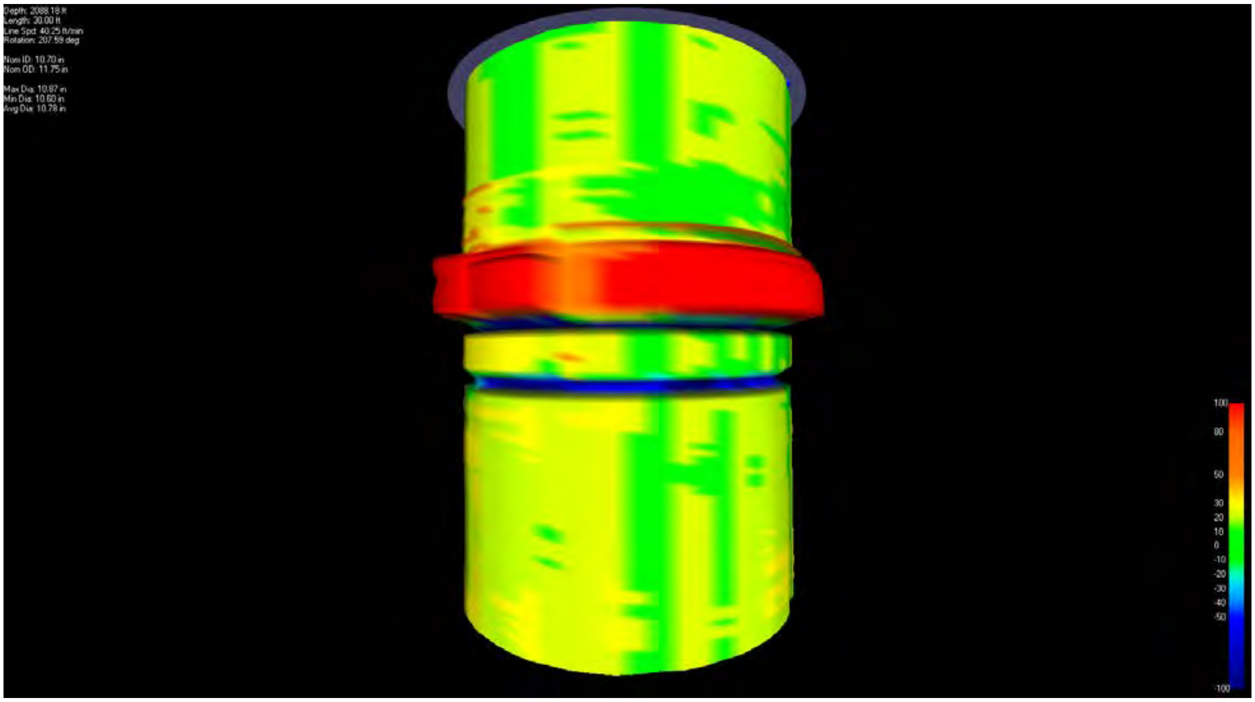

Figure 4. 30 feet of caliper centered at 2100 feet. Green is nominal pipe i.d. (10.7"), blue is reduced diameter (8.4") and red is enlarged diameter (14.5").

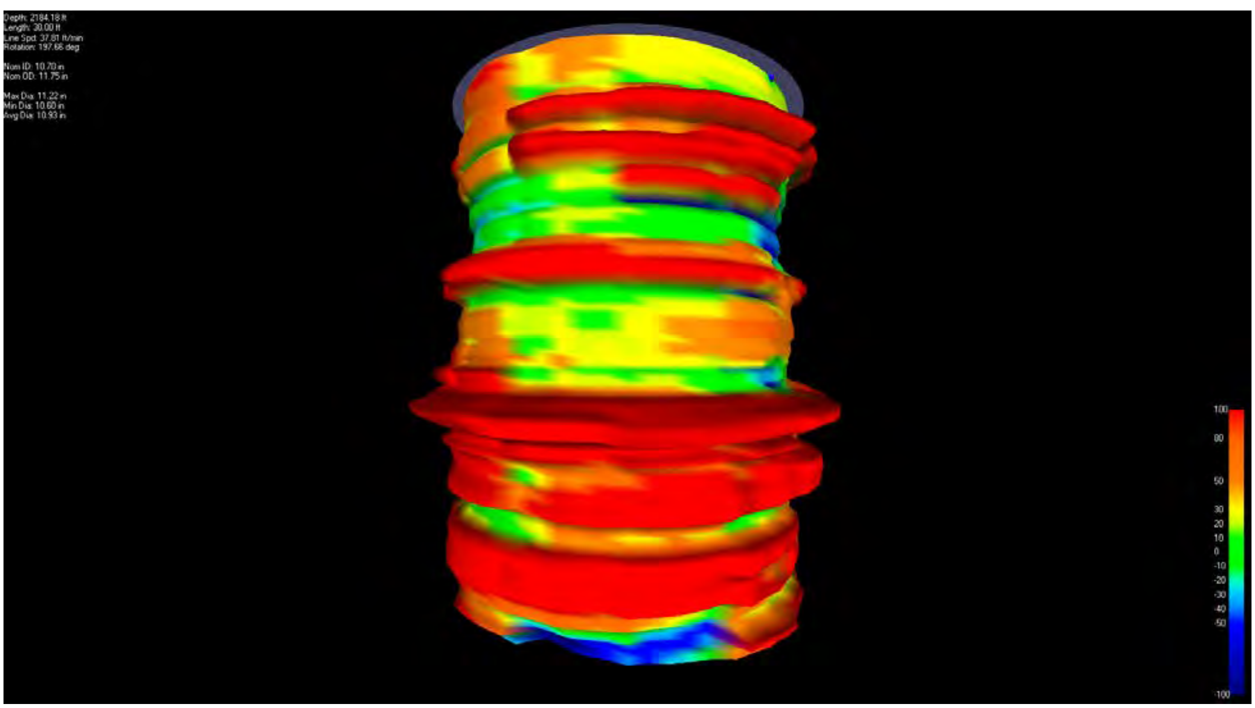

Figure 5. 30 feet of caliper centered at 2200 feet.

To stabilize and plug the damaged casing, five cement plugs were set from the bottom up with high viscosity mud between. The first two plugs were tagged shallower than expected indicating no losses below 3336 feet. The last three plugs were tagged deep indicating loss zones above 3000 feet and a small loss zone above 2497 feet.

The cement was cleaned out to 4625 feet with pressure tests to 130 psi surface pressure every 100 feet with 2 to 14 gpm losses. Then 8-5/8" casing (scab liner) was run to 4582 feet where it set down and was worked down to 4609 feet where it was stuck. With full circulation, 129 bbls of 13.5 ppg cement was pumped to cement the liner. After waiting, cement was tagged at 1877 feet and cleaned out to the liner top at 1880 feet with a 10-1/2" bit. The liner top broke down during pressure testing so 33 bbls of 15 ppg cement was pumped and 21.3 bbls were squeezed into the liner top. Top of cement was tagged at 1705 feet.

Cement was drilled out with a 10-1/2" bit to the liner top and pressure tested. Then the liner was cleaned out with a 6-3/4" bit and pressure tested. Drilling continued through cement below the shoe of the 8-5/8" casing but started getting formation returns at 4660 feet and had 100% formation returns by 4678 feet. Drilling continued to 4770 feet with 100% formation returns. A tight spot suggested that an unintentional sidetrack had occurred at 4635 feet.

6. Redrill

Redrill No. 1 was drilled with a conventional BHA and 6-3/4" bit while waiting for directional tools. After drilling to 5364 feet with full circulation indicating lack of commercial permeability, cement was pumped to plug and abandon Redrill No. 1.

Redrill No. 2 was directional drilled to 5565 feet where the directional tools were pulled and replaced with slick BHA and 6-3/4" bit to drill into the production zone. The KS-14 production fracture was crossed at 5580 feet with full circulation, indicating sealing of the fracture at this depth. Drilling continued to 5727 feet (total depth) with numerous drilling breaks and mud losses starting at 5614 feet. An injection test showed very low injectivity but when the bit was run back in the hole it tagged fill at 5305 feet and washed down to 5650 feet before losing circulation again. The hole was cleaned out to 5727 feet and an injection test without PT surveys indicated high injectivity. The hole was cleaned out again several times, getting stuck once due to formation running in on the BHA. With the deep permeable zone isolated by fill bridging the wellbore, two cement plugs (100 and 200 linear feet) were pumped on top of fill to stabilize the formation. The cement was cleaned out and another 300 foot cement plug was pumped and then cleaned out. A 5" slotted liner was run and set on bottom at 5727 feet with top at 4592 feet. Injection testing showed commercial injectivity, so the rig was released.

7. Production

A static pressure-temperature survey run on November 20, 2019 measured 632°F at the bottom of KS-14RD2, see Figure 6. The maximum temperature of the original KS-14 production zone was 596°F so although KS-14RD2 is significantly less permeable than KS-14 was, it will still be productive due to higher temperatures after the eruption. The upper part of the wellbore was still cool from the repairs.

In December 2019, KS-14RD2 was pressured up to 650 psig with nitrogen to depress the water level and then the nitrogen was released to the gathering system. After liquid was heard at the surface it was diverted through 3” bleed lines to an injection well at a low rate with water to quench the steam. It stabilized at ±1400 psig wellhead pressure (WHP) and ±500°F wellhead temperature (WHT) in a few days. After nine days, KS-14RD2 was flowed to the plant at a higher rate and WHP increased to 1760 psig and WHT to 610°F. Then it was shut in. Plant repairs were still in progress and the substation which was covered by lava was still under construction.

PT surveys in December 2019 and May 2020 show that the temperature from 2100 to 2500 feet has declined while temperature below 3000 feet has recovered. The May profile is similar to the temperature profile before the eruption. A blockage in the wellbore prevented survey tools from reaching the bottom.

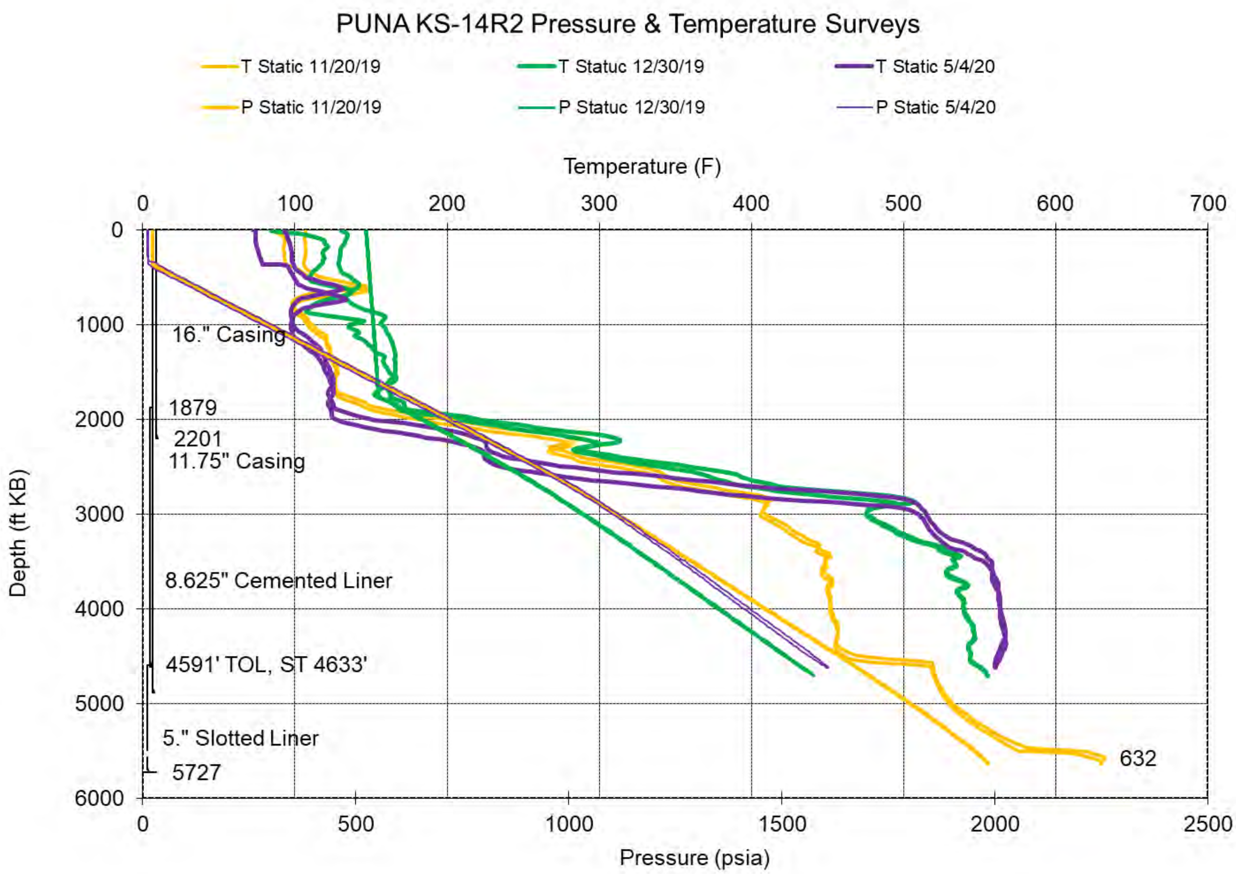

Figure 6. Pressure-temperature surveys after completion of KS-14RD2.

8. Analysis

KS-14 was drilled with a complex directional plan shown in Figure 7. At 2300 feet it was kicked off to the east until approximately 4000 feet where it turned back to the south. Coincidentally, this caused the wellbore to follow what is now named Reactivated Fault Zone #1 (RFZ#1) from 2300 to 4600 feet. This fault zone is identified from minerology and drill breaks in several wells. The damage seen in the KS-14 wellbore from 2100 to 4635 feet was likely caused by movement of the fault during the eruption. High temperatures that caused kicks during the initial cleanout at 2300 feet could have been due to an influx of hot fluid during the eruption, but more recent lower temperatures suggest that the heat has dissipated.

The KS-14 fracture that was highly productive in KS-14 original hole and KS-16ST was not productive in the KS-14RD2 fracture encountered 50 ft deeper during the redrill. Lack of permeability in the original KS-14 fracture and lower permeability in the KS-14RD2 fracture suggests that the eruption closed the fractures, but higher temperatures suggest an influx of heat occurred during the eruption.

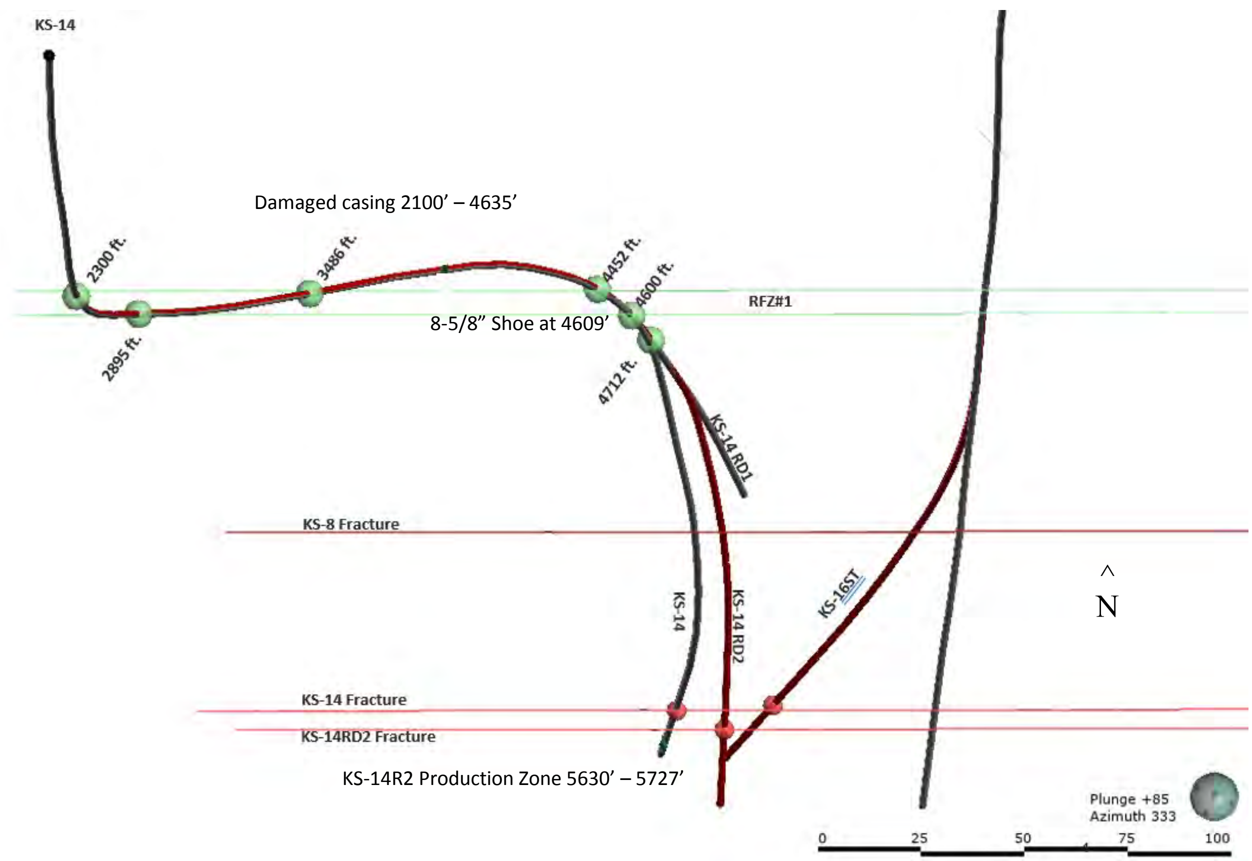

Figure 7. View of KS-14 wellbore looking down parallel to fractures. Green circles indicate intersection of wellbore with Reactivated Fault Zone #1. Red circles indicate production zones.

9. Conclusion

The eruption of Kilauea Volcano in May 2018 caused extensive damage to the KS-14 well. Correlation of 11-3/4" casing damage with RFZ#1 suggests that movement of the fault caused the damage. The highly productive KS-14 fracture was apparently squeezed shut by the eruption. Fortunately, there is another fracture ~30 feet deeper and although it is not as permeable as the original KS-14 fracture, it will produce power due to higher temperatures since the eruption.

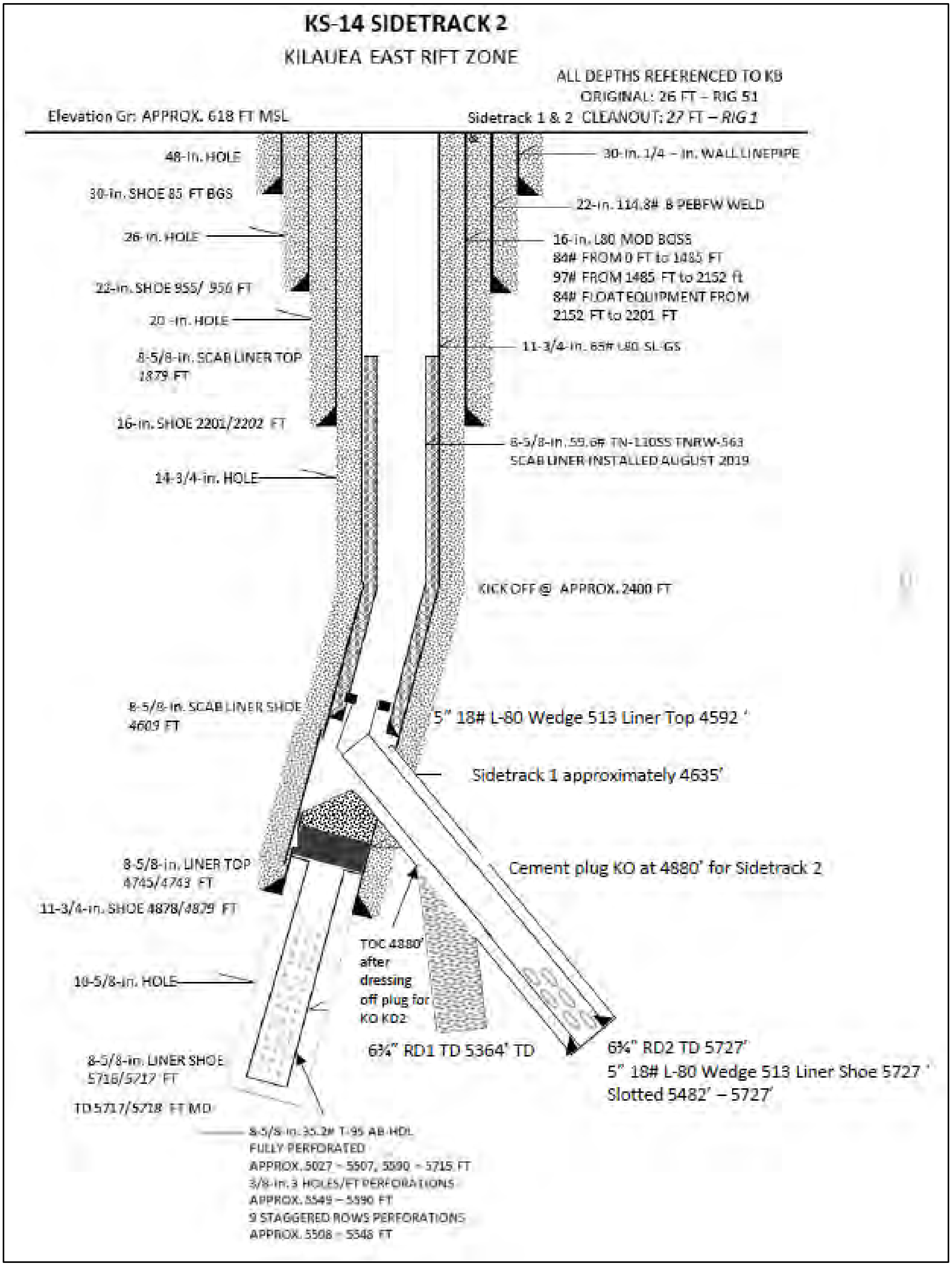

Figure 8. KS-14RD2 wellbore diagram including sidetrack no. 1 and original hole.

Acknowledgement

Thank you to Ormat personnel, crews, consultants, and service company hands who worked very hard in difficult conditions to plug and then to clean-out, repair and redrill this well. Thank you to C-FER, www.cfertech.com, for analysis of KS-14 camera and caliper surveys.

Date	Geothermal Well	Quenching Duration	Barrels Pumped	Gallons Pumped
5/15/2018	KS-14	6 hours 40 minutes	1,700	71,400
5/16/2018	KS-14	14 hours 10 minutes	2,125	89,250
5/16/2018	KS-16	2 hours 30 minutes	150	6,300
5/17/2018		No quenching due to high sulfer dioxide emissions		
5/18/2018	KS-14	11 hours 2 minutes	662	27,804
5/19/2018	KS-14	18 hours 20 minutes	1,115	46,830
5/19/2018	KS-9	3 hours 45 minutes	505	9,450
5/20/2018	KS-9	24 hours	2,460	103,320
5/21/2018	KS-9	9 hour 45 minutes	1,170	49,140
5/21/2018	KS-14	3 hours 17 minutes	810	34,020
5/22/2018		No quenching scheduled		
5/23/2018	KS-9	14 hours 30 minutes	5,220	219,240
5/24/2018	KS-9	12 hours	4,320	181,440
5/25/2018	KS-9	7 hours 10 minutes	2,580	108,360
5/26/2018	KS-9	15 hours 30 minutes	3,720	156,240
5/27/2018	KS-9	8 hours 55 minutes	5,010	210,420
5/27/2018	KS-10	1 hour 55 minutes	690	28,980
Totals	**All Wells**		**32,237**	**1,342,194**
	Individual Wells			
	KS-14		6,412	269,304
	KS-16		150	6,300
	KS-9		24,985	1,037,610
	KS-10		690	28980
Totals	All Wells		32,237	1,342,194

3:14-cv-00325-RCJ-VPC

UNITED STATES DISTRICT COURT DISTRICT OF NEVADA

United States v. Ormat Indus., Ltd.

Decided Mar 30, 2016

3:14-cv-00325-RCJ-VPC

03-30-2016

UNITED STATES OF AMERICA ex rels. TINA CALILUNG, et al., Plaintiffs, v. ORMAT INDUSTRIES, LTD., et al., Defendants.

ROBERT C. JONES United States District Judge

ORDER

This *qui tam* action, brought under the False Claims Act ("FCA"), arises from Ormat's allegedly fraudulent actions whereby they received approximately $136,800,000 in grant money from the United States pursuant to Section 1603 of the American Recovery and Reinvestment Act of 2009 ("ARRA"). Pending before the Court are Defendants' Motion for Summary Judgment (ECF No. 180), two Motions to Seal (ECF Nos. 181, 200), and Relators' Motion for Leave to File Surreply (ECF No. 209).

I. BACKGROUND

Relators initially named seven defendants in this lawsuit. On December 19, 2014, the parties stipulated to a voluntary dismissal without prejudice of Defendants Ormat Industries, Ltd. ("OIL") and First Israel Mezzanine Investors, Ltd. (ECF Nos. 105, 106). The remaining Defendants are Ormat Technologies, Inc. ("OTI"), Ormat Nevada, Inc. ("ONI"), ORNI 18, LLC *2 ("ORNI"), Puna Geothermal Venture II, LP, and Puna Geothermal Venture, GP ("PGV") (collectively "Ormat").

Relators allege the following. OTI is a wholly-owned subsidiary of OIL and is a Delaware corporation with its principal place of business located in Reno, Nevada. (Am. Compl. ¶ 38, ECF No. 27). OTI owns and operates geothermal power plants around the globe, including plants in California, Nevada, and Hawaii. (*Id.* ¶ 39). ONI is a wholly-owned subsidiary of OTI and is a Delaware corporation also with its principal place of business in Reno, Nevada. (*Id.* ¶ 40). ONI constructs and operates geothermal power plants in the United States and internationally. (*Id.*). ONI constructed and operates the North Brawley Geothermal Power Plant in Imperial County, California ("the Brawley Plant"), and it also operates the Puna Geothermal Power Plant in Hawaii ("the Puna Complex"). (*Id.*). PGV is another wholly-owned subsidiary of OTI and is a Hawaii general partnership that assists in the management and operation of the Puna Complex. (*Id.* ¶¶ 43-44). Relators allege that ONI pays all costs related to the Puna power plant through PGV since ONI is not licensed to do business in Hawaii. (*Id.* ¶ 40). As with the other Ormat Defendants, ORNI is a wholly-owned subsidiary of OTI with its principal place of business in Reno, Nevada. Relators claim that ORNI was responsible for financing the Brawley Plant. (*Id.* ¶ 46).

Relators are former employees of OTI. Tina Calilung served as OTI's Asset Manager from November 2007 until June 2012. Her primary function was to manage the long-term power purchase agreements ("PPAs") for Ormat's operations within the United States. (*Id.* ¶ 23). Calilung also provided due diligence on project financing, developed and managed investor relations, and testified on Ormat's behalf before the Nevada Public Utilities Commission. (*Id.*). Calilung claims to have left OTI of "her own 3 volition" in 2012, "in part due to the business *3 practices which she felt were morally and ethically repugnant." (*Id.* ¶ 24). She claims to have voiced her opinions multiple times prior to leaving and alleges that she signed a waiver of employment-related claims and severance in July 2012. (*Id.*).

Jamie Kell was the Administrator for OTI's Business Development Department from January 2008 until September 2012. (*Id.* ¶ 27). In this role, she personally assisted the directors in charge of business development including OTI's Vice-President of Business Development and OTI's Manager of Public Policy. (*Id.*). Kell assisted her department with reviewing new geothermal projects, which involved contract negotiations with outside parties, pricing, PPA negotiations, and negotiations with public utility commissions. (*Id.* ¶ 28). Kell terminated her employment with OTI in September 2012. (*Id.* ¶ 29).

Both Calilung and Kell claim to have "direct, independent, and personal knowledge" of Ormat's alleged scheme to defraud the United States by submitting false information to the Secretary of the Treasury in order to obtain grants under Section 1603 of the ARRA. (*Id.* ¶ 57).

A. Section 1603 of the ARRA

The ARRA was signed into law on February 17, 2009 for the purpose of preserving and creating jobs, as well as to "spur[] technological advances in science and health" and to "invest in . . . environmental protection, and other infrastructure that will provide long-term economic benefits." ARRA § 3(a), PL 111-5, 123 Stat. 115, 116. It sought to lay the groundwork for new green energy economies that would double the amount of renewable energy produced between 2009 and 2013. 2009 U.S.C.C.A.N. S6, 2009 WL 395189. To accomplish this goal, the ARRA temporarily provided for grants to be paid to persons engaged in developing renewable energy. *See* ARRA § 1603. The grants provided under Section 1603 of the ARRA were intended to replace the tax credits that would usually be offered to qualifying entities 4 under Section 48 of the *4 Internal Revenue Code of 1986 ("IRC"). *See 26* U.S.C. § 48(d)(1) (stating that "[n]o credit shall be determined under this section . . . for the taxable year in which such grant [pursuant to Section 1603 of the ARRA] is made"). It was expected that the Section 1603 program would "fill the gap created by the diminished investor demand for tax credits."[1] Indeed, Section 1603 is titled "Grants for Specified Energy Property in Lieu of Tax Credits." ARRA § 1603. Entities that receive a grant for renewable energy cannot also seek an energy tax credit under the IRC. 26 U.S.C. § 48(d). The Secretary of the Department of the Treasury ("the Secretary") was tasked with administrating the Section 1603 program. ARRA § 1603(f).

[1] U.S. Dep't of the Treasury, *Payments for Specified Energy Property in Lieu of Tax Credits under the American Recovery and Reinvestment Act of 2009 Program Guidance* 2 (Apr. 2011), *available at* http://www.treasury.gov/initiatives/recovery/Documents/GUIDANCE.pdf [hereinafter *Program Guidance*].

To qualify for receiving grant money under Section 1603, certain conditions must be met. First, the individual or entity applying for the grant must be eligible. *See* ARRA § 1603(g). Second, the property must be a "specified energy property." *Id.* § 1603(a). Under Section 1603, a specified energy property "consists of two broad categories of property—certain property that is part of a facility described in IRC [S]ection 45 (Qualified Facility Property) and certain other property described in IRC [S]ection 48."[2] Section 45 of the IRC includes a geothermal energy facility as a "qualified facility" if it uses geothermal energy to produce electricity. 26 U.S.C. § 45(d)(4). "Specified energy property," as used in Section 1603, further includes "geothermal property," as described in Section 48(a)(3)(A) of the IRC, and "geothermal heat pump property," as described in Section 48(a)(3)(A) of the IRC. The Secretary has explained that these encompass "[e]quipment used to produce, distribute, or use energy derived from a geothermal *5 deposit . . . ."[3] Third, the qualified property must be "placed in service" in 2009, 2010, or 2011 (or construction must begin during one of those years). ARRA § 1603(a).[4]

2 *Program Guidance* at 12.

3 *Id*. at 15.

4 The Section 1603 program was temporary and was set to terminate in October 2011. ARRA § 1603(j). However, that date was extended to October 2012 by the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010. PL 111-312, 124 Stat. 3296, 3312.

If these three requirements are met, then the ARRA provides a reimbursement of 30 percent of the basis of the property. *Id*. § 1603(b)(2)(A).

> The basis of property is determined in accordance with the general rules for determining the basis of property for federal income tax purposes. Thus, the basis of property generally is its cost (IRC [S]ection 1012), unreduced by any other adjustment to basis, such as that for deprecation, and includes all items properly included by the taxpayer in the depreciable basis of the property, such as installation costs and the cost for freight incurred in the construction of the specified energy property.[5]

5 *Program Guidance* at 16.

Section 1603 instructs that "the Secretary of the Treasury shall provide for the recapture of the appropriate percentage of the grant amount in such manner as the Secretary of the Treasury determines appropriate if the property is disposed of or otherwise ceases to be a specified energy property." *Id*. § 1603(f). Applicants under the Section 1603 program are also required to provide reports as the Secretary mandates.[6]

6 *Id*. at 21.

B. Ormat's Brawley Plant

Relators allege that Ormat received $130 million in Section 1603 grant money for the Brawley Plant that was obtained using false information. (Am. Compl. ¶¶ 150-51). Construction on the Brawley Plant began in February 2007, and the plant was expected to be operating by the end of 2008. (*Id*. ¶¶ 162-63). Based on these projections, ORNI entered into a PPA with Southern California Edison based on the representation that the plant would produce 50 MW of energy. (*Id*. ¶¶ 159-61). Relators claim that by December 2008, the Brawley Plant was *6 operational and began generating revenue, and Ormat began to depreciate the plant for tax purposes as early as 2009. (*Id*. ¶¶ 164-67).

In June 2010, Relators claim that Ormat filed, through ORNI, its first application for a Section 1603 grant with the Treasury. (*Id*. ¶ 168). On August 17, 2010, the Treasury awarded ORNI a grant of $108,285,626. (*Id*. ¶ 169). Relators allege that Ormat secured this grant by misrepresenting two key pieces of information to the Secretary. Relators believe that Ormat "falsely concocted a placed-in-service date for [the Brawley Plant] of January 15, 2010." (*Id*. ¶ 172). Relators allege that this date is inaccurate given that the Brawley Plant had been running since the end of 2008 and had generated approximately $2.5 million in revenue. (*Id*.). Relators further allege that the proper placed-in-service date is sometime in December 2008, which would disqualify the Brawley Plant from receiving grants under the ARRA's Section 1603 program. *See* ARRA § 1603(a) (requiring the placed-in-service date to be in 2009, 2010, or 2011). Relators claim that January 15, 2010 marked no special significance as to the energy output since at that time it was producing around 17 MW, "a level at which it had been for several months and would remain for many months more." (*Id*. ¶ 177). Relators also allege that Ormat artificially inflated and misrepresented the eligible basis of the Brawley Plant in order to qualify for a larger grant by purposefully delaying its Section 1603 application while incurring additional costs. (*Id*. ¶ 180).

Sometime in 2012, Relators claim that Ormat applied for a second Section 1603 grant based on an expansion of the Brawley Plant, which the Treasury granted in June 2013 in the amount of $14.67 million. (*Id*. ¶ 189-90). Relators allege that the grant must have been based on false information since OIL itself only valued the expansion at $23 million and the Brawley Plant was operating at less than 27 MW, which fails to 7 demonstrate that production had *7 appreciably increased. (*Id*. ¶ 191). Relators also claim that Ormat has failed to update, amend,[7] or notify the Treasury, as required by the Terms and Conditions of the Section 1603 program, of the change in the Brawley Plant's value based on its inability to reach the projected energy outputs. (*Id*. ¶ 212). Despite the Brawley Plant's alleged steady depreciation, Relators claim that Ormat is delaying the write downs so it can avoid terminating the failing project in order to escape the five-year grant recapture period provided by the Secretary.[8] (*Id*. ¶ 242).

7 U.S. Dep't of the Treasury, *Payments for Specified Energy Property in Lieu of Tax Credits under the American Recovery and Reinvestment Act of 2009: Terms and Conditions* 2, *available at* http://www.treasury.gov/initiatives/recovery/Documents/energy-terms-and-conditions.pdf [hereinafter *Terms and Conditions*]. To receive a Section 1603 grant, the applicant must agree to and sign the Terms and Conditions established by the Secretary. *See Program Guidance* at 3.

8 *Terms and Conditions* at 2.

C. Ormat's Puna Complex

Relators also allege that Ormat improperly sought and received Section 1603 grant money for an expansion to its plant in Puna, Hawaii. There are two energy producing geothermal plants at the Puna Complex. The first power plant ("the 30-MW plant") was placed in service by its original owner in 1993. (*Id*. ¶ 252). Ormat acquired the 30-MW plant in 2004 after which it sold the 30-WM plant to a third party who then leased the plant back to Ormat. (*Id*. ¶ 253). Relators note that the 30-MW plant is clearly unqualified for any Section 1603 grants as it was placed in service well before 2009. (*Id*. ¶ 254). Although the 30-MW plant was advertised as generating 30 MW of electricity, Relators claim that it actually produced no more than 17 MW and that this inhibited production was causing Ormat's revenues to decline by $1 million per month. Due to this loss, Relators allege that Ormat planned to drill a new production well, known as "KS-14," in order to boost the plant's productivity. (*Id*. ¶¶ 257-59). However, under the leaseback agreement that governed the Puna Complex, Ormat was required 8 to receive *8 investor approval prior to drilling KS-14. KS-14 successfully added about 14 MW of net capacity. (*Id*. ¶ 264).

Ormat added an 8 MW expansion ("the Expansion") to the Puna plant in late 2011. (*Id*. ¶ 265). The Expansion was substantially completed by December 2010, but Ormat was still waiting on the Hawaii Public Utilities Commission to approve a PPA at that time. (*Id*. ¶ 271). Relators allege that in an effort to qualify for a Section 1603 grant, Ormat began producing energy for free so that it could claim December 2011 as the placed-in-service date for the Expansion. (*Id*. ¶ 272). In November 2011, Cathy Tsaniff, Ormat's Tax Manager, began drafting PGV's application for a Section 1603 grant for the Expansion project. (*Id*. ¶ 273). In that application, Tsaniff cited December 2011 as the placed-in-service date so that the Expansion would fall within the Section 1603 program's requirements. (*Id*. ¶ 274).

Relator Calilung participated in drafting the Section 1603 grant application for the Expansion. As part of that process she spoke with a Paul Spielman, Ormat's Manager of Operations Support for Resources, who confirmed that the Expansion was designed to generate electricity by utilizing the 30-MW plant's byproduct and that the Expansion depended upon the original plant's byproduct to operate. (*Id*. ¶ 276-77). Relators allege that Ormat misrepresented the Expansion's true status in its Section 1603 application because it claimed that the Expansion was a stand-alone new Geothermal Property. (*Id*. ¶ 278).

Relators further allege that Ormat knowingly misrepresented the eligible basis for the Expansion in order to obtain additional Section 1603 funds. (*Id*. ¶ 279). Relators claim that Tsaniff initially allocated the cost of the KS-14 well pro rata between the 30-MW plant and the Expansion, but that she was later instructed to allocate the full cost of KS-14 to the Expansion in order to increase the cost basis. (*Id*. ¶ 280). Relator Kell
9 claims that she and Tsaniff discussed the *9 legality of submitting a Section 1603 application that intentionally excluded relevant facts and included material false information. (*Id*. ¶ 281). Relator Kell alleges that Tsaniff acknowledged the information was incorrect, but told Kell that OTI's CEO, Dita Bronicki, made the changes herself. (*Id*.). On April 14, 2012, PGV was awarded a Section 1603 cash grant of $13,821,143, which corresponded to Ormat's stated eligible basis of $46,070,477. This reported eligible basis, Relators allege, includes the full amount of drilling and connecting the KS-14 well, which Relators allege cost Ormat approximately $12.5 million. (*Id*. ¶ 283).

D. Ormat's Alleged Violation of the FCA

Relators claim that these facts demonstrate Ormat violated the FCA by reporting false or misleading information or by omitting material information in its various Section 1603 grant applications to the Treasury. Specifically, Relators contend that Ormat (1) misrepresented the put-in-service date for the Brawley Plant; (2) inflated the eligible basis of the Brawley Plant by intentionally driving up costs; (3) misrepresented the viability of the Brawley Plant in order to qualify for additional Section 1603 funds; (4) falsely represented the Puna Expansion as a stand-alone facility; and (5) fraudulently allocated the full cost of the KS-14 production well to the Expansion rather than representing that an ineligible property was the real beneficiary of the expense. Relators also allege that Ormat violated the Terms and Conditions of the Section 1603 program by submitting false or fraudulent annual reports for the Brawley Plant in order to prevent the recapture or disallowance of the Section 1603 funds already obtained. (*Id*. ¶ 316).

Relators argue that these misrepresentations and omissions were made to the Treasury in violation of the FCA. The FCA, 31 U.S.C. § 3729(a), imposes liability on all those who submit false or fraudulent claims for payment to the United States Government. *Campbell v. Redding Med. Ctr.*, 421 F.3d 817, 820 (9th Cir. 2005). The *qui tam*
10 provisions of the FCA allow private *10 parties aware of fraud against the Government to sue on behalf of the Government with the incentive that such parties may share in up to 30 percent of the recovery. 31 U.S.C. §§ 3730(b)(1), 3730(d)(2); *Campbell*, 421 F.3d at 820. The private party, referred to as the "relator," files the complaint alleging a violation of the FCA under seal. 31 U.S.C. § 3730(b)(2). The complaint remains under seal for at least sixty days and is served on the defendant only after the court so orders. *Id*. During this time, the Government elects whether to intervene or not, and notifies the court accordingly. *Id*. If the Government does not choose to intervene, then the private party who initiated the lawsuit has the right to conduct the action. *Id*. § 3730(c)(3); *Wang v. FMC Corp.*, 975 F.2d 1412, 1415 (9th Cir. 1992).

Relators include five counts of FCA violations arising from Ormat's alleged conducted. The first count alleges that Ormat and its agents knowingly presented false records or statements material to their fraudulent claims for Section 1603 funds in violation of 31 U.S.C. § 3729(a)(1)(A). The second count alleges that Ormat knowingly made and used a false record to perpetuate the fraud in violation of 31 U.S.C. § 3729(a)(1)(B). The third count alleges that Ormat is in possession of Section 1603 funds that should rightfully be returned to the Treasury, a violation of 31 U.S.C. § 3729(a)(1)(D). The fourth count alleges that Ormat has knowingly made false records or statements to the Treasury in order to avoid its obligation to transmit improperly received Section 1603 funds back to the Government, a violation of 31 U.S.C. Section 3729(a)(1)(G). Finally, the fifth count alleges that Ormat and its agents have conspired to defraud the Government by falsely obtaining $136,791,964 in Section 1603 grant money.

This case was originally filed under seal in the Southern District of California. The case remained under seal while the Government decided whether to intervene. Once the Government elected not to intervene (*see* ECF No. 11), the relevant
11 documents were unsealed and service was *11 completed. Ormat moved to transfer the case to this District, which the court granted. Prior to transfer, however, Relators submitted the Amended Complaint. In a motion to dismiss, Ormat asked the Court to dismiss all of Relators' claims based on several grounds. The Court granted the motion in part and denied it in part. (*See* ECF No. 122). Following the Court's order, these allegations remain: (1) Ormat misrepresented the put-in-service date for the Brawley Plant; (2) Ormat falsely represented the Puna Expansion as a stand-alone facility; and (3) Ormat fraudulently allocated the full cost of the KS-14 production well to the Expansion rather than representing that an ineligible property was the real beneficiary of the expense. Ormat now moves for summary judgment on the remaining allegations.

II. LEGAL STANDARDS

A court must grant summary judgment when "the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(a). Material facts are those which may affect the outcome of the case. *See Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 248 (1986). A dispute as to a material fact is genuine if there is sufficient evidence for a reasonable jury to return a verdict for the nonmoving party. *See id.*

III. DISCUSSION

A. Motion for Leave to File Surreply

As an initial matter, the Court must address whether Relators should be granted leave to file a surreply. Local Rule 7-2 allows for litigants to file a motion, a response, and a reply. *See* LR 7-2(a)-(c). It does not provide for a surreply. However, the Court may grant leave to a party to file a surreply if new matters are raised for the first time in the reply to which a party would otherwise be unable to respond. *See Spartalian v. Citibank, N.A.*, No. 2:12-cv-00742-MMD-PAL, 2013 WL 593350, at *2 (D. Nev. Feb. 13, 2013). Relators
12 ask the Court to grant them *12 leave to file a surreply because "Ormat raises new arguments not previously raised," "has erroneously argued for applications of law and precedent," and has "mischaracterized much of the law" in its reply to Relators' response. (Mot. 2-3). The Court disagrees. Relators do not identify any specific argument in Ormat's reply that is "new," requires an additional response, or which it could not have addressed in its response. Further, an alleged misapplication or mischaracterization of the law alone surely cannot be a sufficient basis for a surreply; otherwise, litigants would constantly seek to have the last word in brief filing by claiming the other side presented the law in an unfavorable manner. The Court denies the motion.

B. Motion for Summary Judgment

Ormat moves the Court to grant summary judgment in its favor on Relators' Brawley placed-in-service claim, arguing the FCA's public disclosure provision bars it. Ormat also argues that the Court should enforce settlement agreements in which Relators released all their FCA claims.

1. Public Disclosure Bar: Brawley Placed-in-Service Claim

The FCA includes bars to certain actions brought by *qui tam* relators, one of which is the public disclosure bar. 31 U.S.C. § 3730(e)(4)(A). The bar is designed to preclude "qui *tam* suits when the relevant information has already entered the public domain through certain channels." *Graham Cnty. Soil & Water Conservation Dist. v. U.S. ex rel. Wilson*, 559 U.S. 280, 285 (2010). The bar is set forth as follows:

> The court shall dismiss an action or claim under [the FCA], unless opposed by the Government, if substantially the same allegations or transactions as alleged in the action or claim were publicly disclosed [1] in a Federal criminal, civil, or administrative hearing in which the Government or its agent is a party; [2] in a congressional, Government Accountability Office, or other Federal report, hearing, audit, or investigation; or [3] from the news media, unless the action is brought by the Attorney General or the person brining the action is an original source of the information.

13 *13 31 U.S.C. § 3730(e)(4)(A). Thus, the public disclosure bar requires a two-step inquiry. First, the court determines whether there has been a prior public disclosure of the allegations or transactions underlying the *qui tam* suit through one of the sources enumerated in the statute. *U.S. ex rel. Meyer v. Horizon Health Corp.*, 565 F.3d 1195, 1199 (9th Cir. 2009); *see also Malhotra v. Steinberg*, 770 F.3d 853, 858 (9th Cir. 2014). If there has been a public disclosure, the court must then inquire whether the relator is an "original source" within the meaning of Section 3730(e)(4)(B). *Meyer*, 565 F.3d at 1199. The statute defines "original source" as:

> [A]n individual who either [1] prior to a public disclosure under subsection (e)(4)(a), has voluntarily disclosed to the Government the information on which allegations or transactions in a claim are based, or (2) who has knowledge that is independent of and materially adds to the publicly disclosed allegations or transactions, and who has voluntarily provided the information to the Government before filing an action under this section.

31 U.S.C. § 3730(e)(4)(B).

Ormat argues that Relators' Brawley placed-in-service claim is barred because the information relevant to Relators' claim was publicly available before Relators filed their initial complaint in February 2013. According to Ormat, Relators' claim is based on a number of SEC filings and reports published by the U.S. Energy Information Administration ("EIA"). In a prior order, the Court held that the SEC filings qualify as public disclosures under the FCA. (*See* Order, 28, ECF No. 122). The Court also held, however, that the information disclosed in the SEC filings is not substantially similar to Relators' allegations regarding the Brawley plant's placed-in-service date. (*Id*. at 29). As the Court stated:

> Regardless of the date that Ormat reported to the Secretary and that appears in the SEC filings, Relators claim that the January 15, 2010 date is false and misleading. Thus, the fact that the 2007 and 2009 Form 10-Ks make it clear that Ormat considered the Brawley plant substantially complete in December 2008 and that it was producing energy from that point on does not mean that Relators claims are barred. That information would not necessarily lead the Government to the
>
> 14 *14
>
> conclusion that this placed-in-service date was chosen with the intent to defraud the United States. The additional information available to the public likewise does not indicate that January 15, 2010 was not the actual date the Brawley plant was placed in service.

(*Id.*). Although the Court could have stopped at the first step, it also discussed whether Relators are an original source within the meaning of the FCA to "further clarif[y] the Court's position on the issue." (*Id.* at 33). The Court concluded that Relators allege two pieces of information that do not appear in the publicly disclosed documents: (1) that the Brawley Plant was synced into the power grid before January 15, 2010; and (2) that the plant began selling electricity as early as December 2008 and earned $2.5 million in revenues over the year prior to the January 2010 date. (*Id.*).

In Ormat's motion for summary judgment, it presents evidence showing these two pieces of information were publicly available in reports by the EIA. They argue that because this information was publicly available before Relators' claim, the claim is barred. To begin, the Court finds that the EIA reports are federal reports that qualify as public disclosures under the statute. Ormat submitted to the EIA two forms—Form EIA-860 and Form EIA-923—which show the Brawley Plant was synced into the power grid in December 2008, (Interconnection Report 2009, 2, ECF No. 180-12), and that the plant sold 595 MW of electricity in 2008, (Non-Utility Report 2008, 2, ECF No. 180-14), and 31,529 MW in 2009, (Non-Utility Report 2009, 2, ECF No. 180-15). Although this data is not as easy to access as the SEC filings, it is accessible and readily available to the

15 *15

public.[9] EIA representatives have confirmed that the data was published by 2010. (Correspondence, ECF No. 180-16).[10]

> 9 The Court was able to locate the reports on the EIA website within five minutes of beginning a search.

> 10 An EIA representative confirmed that the EIA-860 data for 2008 and 2009 were published in 2010. He also confirmed that the EIA-923 data for 2009 was published in December 2010 and said it "seems reasonable" that the 2008 data was published in March 2010. (*Id.*). Although the representative did not know for certain when the 2008 data was published, it does seem "reasonable" that if the 2009 data was published in December 2010, then the 2008 data was published before that time based on the Agency's publishing practices. Relators have not produced any evidence to cause the Court to question this conclusion. --------

Even though the EIA reports qualify as public disclosures, Ormat mistakenly focuses on the Court's analysis of whether Relators are an original source. Although Ormat has shown that the two pieces of information involved in the Court's original source analysis are available in public reports, they have presented no evidence to show that Relators' allegation that Ormat knowingly defrauded the United States was publicly available. "The public disclosure of 'mere information' relating to the claims is insufficient to trigger a jurisdictional bar to a False Claims suit; the 'material elements of the allegedly fraudulent transaction' must be disclosed." *U.S. ex rel. Bly-*

Magee v. Premo, 470 F.3d 914, 919 (9th Cir. 2006) (internal quotations omitted) (quoting *A-1 Ambulance Serv., Inc. v. California*, 202 F.3d 1238, 1243 (9th Cir. 2000)).

One material element of a claim under the FCA is that a person "*knowingly* presents . . . a false or fraudulent claim for payment or approval." 31 U.S.C. § 3729(a)(1)(A) (emphasis added). As the Court pointed out in its prior order, the information provided at that time "would not necessarily lead the Government to the conclusion that this placed-in-service date was chosen with the intent to defraud the United States." (Order, 29, ECF No. 122). Although the information
16 Ormat has now *16 established as publicly available might allow one to infer that Ormat falsely reported the placed-in-service date, Relators allege that "Ormat has admitted that it deliberately delayed submitting its § 1603 application and intentionally post-dated its placed-in-service date." (Am. Compl. ¶ 179). They also claim that due to their employment with Ormat they have personal knowledge that Ormat executives knowingly and intentionally inserted false information into its § 1603 applications. (*See* Am. Compl. ¶¶ 25, 30-31; First Decl. of Tina G. Calilung, ¶¶ 9-12, 29, ECF No. 199-5; Decl. of Jamie D. Kell, ¶ 3, ECF No. 199-6). Ormat has presented no evidence to show that these allegations, or the facts underlying them, are publicly available. By proving their allegations regarding Ormat's knowledge, Relators can establish a material element of their claim; without that element, however, the public pieces of information scattered among various federal websites prove only the existence of certain facts, not that Ormat knowingly made a false claim.

Moreover, Relators make other allegations related to the placed-in-service claim that Ormat has not shown are publicly available. Relators allege that the Brawley Plant was in daily operation by December 2008, (Am. Compl. ¶ 177; Second Decl. of Tina G. Calilung, ¶ 30, ECF No. 199-5), and that "Ormat has been depreciating the North Brawley Plant for tax purposes since at least 2009," (Am. Compl. ¶ 178). They also claim that Ormat's process for determining the in-service date of the plant contradicts the process Ormat has used in other § 1603 grant applications. (First. Decl. of Tina G. Calilung, ¶ 37). Ormat also has not presented evidence to show that these allegations, or the facts underlying them, were available to the public. As a result, the Court still finds that the publicly disclosed information is not
17 substantially similar to Relators' allegations *17 regarding the Brawley Plant's placed-in-service date, and, thus, the public disclosure bar does not apply. Finally, Relators ask the Court in the alternative to defer its decision under Federal Rule of Civil Procedure 56(D). Their request is moot.

2. Release of Claims

Ormat argues Relators each entered a settlement agreement by which they agreed to release Ormat of Relators' FCA claims. Relators each signed settlement agreements containing language that waives all legal claims against Defendants. Section 4.1 of Calilung's settlement agreement contains the following language:

> Employee hereby generally waives, releases and forever discharges the Company, its parent company, and any or all divisions, subsidiaries, and their officers, directors, agents, employees, affiliates and successors and insurers (hereinafter collectively "the Releasees"), of and from any and all claims, causes of action, damages or costs of any type Employee may have, prior to the date Employee signs this Agreement, against the Releasees arising out of or relating to Employee's employment with Company, or Employee's separation of employment . . .

(Settlement Agreement, 3, ECF No. 180-24). Although this clause addresses only claims arising out of employment, Section 4.3 states the following:

> Employee further understands and agrees that the waiver and release set forth in Section 4.1 and 4.2 applies to any and all claims, liabilities and causes of action, or every nature, kind and description, whether known or unknown, in law, equity or otherwise, which have arisen, or occurred or existed at any time prior to Employee's signing of this Agreement, including, without limitation, any and all claims, liabilities and causes of action arising out of or relating to Employee's employment with the Company or the cessation of that employment.

(*Id*. at 4). This section clearly bars any type of legal claim, not just claims arising out of Calilung's employment, by including but not limiting the section to claims arising out of her employment. The agreement also covers the remaining claims in this case because the events giving rise to the claims occurred from 2008 to 2011, before Calilung signed the settlement
18 agreement in July 2012. *18

Section 2.1 of Relator Kell's settlement agreement contains similar language:

> Employee . . . agrees to fully release . . . Company and all of its affiliates . . . from all known or unknown, revealed and concealed, contingent and non-contingent claims, actions, causes of action, and suits for damages at law or in equity, of any and every kind, nature, and character whatsoever, that Employee has now, has ever had, or may have in the future against the Releasees, filed or otherwise, including, but not limited to [list of causes of action] or any other claim Employee may now or hereafter acquire by reason of any loss or damage suffered by Employee as a result of any fact or facts in any way related to the Charge, Employee's previous employment relationship with Company, the resignation or termination of Employee's employment relationship with Company, or any other matter or event arising prior to the execution of this Agreement by Employee.

(Settlement Agreement, 5-6, ECF No. 180-25). Section 2.2 adds the following:

> Employee promises and agrees on behalf of herself and her heirs and representatives that she will never file, initiate, or cause to be filed or initiated, at any time after the execution of this Agreement, any claim, charge, suit, complaint, action, or cause of action, in any state or federal court or before any state or federal administrative agency, against Company or the Releasees identified in Section 2.1. Further, Employee shall not participate, assist, or cooperate in any suit, action, or proceeding against or regarding the Releasees, or any of them, unless compelled to do so by law.

(*Id*. at 6-7). These sections also clearly bar any type of legal claim Kell might bring against Ormat.

Relators argue that even if the settlement agreements preclude them from bringing FCA claims, two cases—*United States ex rel. Green v. Northrop Corp.*, 59 F.3d 953 (9th Cir. 1995) and *U.S. ex rel. Hall v. Teledyne Wah Chang Albany*, 104 F.3d 230 (9th Cir. 1997)—allow their claims to proceed. In *Green*, the Ninth Circuit held that "prefiling releases of *qui tam* claims, when entered into without the United States' knowledge or consent, cannot be enforced to bar a subsequent *qui tam* claim." *Green*, 59 F.3d at 969. In holding that the release was not enforceable to bar a *qui tam* claim, the court noted, "It is critical to observe . . . that the government only learned of the allegations of fraud and conducted its investigation *because of the filing of the qui tam*
19 *complaint*." *Id*. at 966. The *19 court based its reasoning on the "central purpose of the *qui tam* provisions of the FCA [which] is to set up incentives to supplement government enforcement of the Act by encouraging insiders privy to a fraud on the government to blow the whistle on the crime." *Id*. at 963 (internal quotations and citations omitted).

In *Hall*, the Ninth Circuit chose not to apply *Green* in enforcing a release because "[t]he federal government was aware of Hall's allegations regarding false certifications," *Hall*, 104 F.3d at 233, after Hall had filed a complaint with the Nuclear Regulatory Commission and a state court action alleging fraud against his employer. *Id*. at 231-32. The court held that the federal concerns implicated in *Green* did not apply in *Hall* because "[t]he federal government was aware of Hall's allegations regarding false certifications" and "because the federal government had already investigated the allegations prior to the settlement." *Id*. at 233. Ormat argues that according to *Hall* settlement agreements releasing FCA claims should be enforced simply "when the government is on notice of the facts underlying the fraud allegations before the FCA claims are released." (Mot., 10). Ormat suggests that public disclosure of the facts through documents submitted to the Government is sufficient to put the Government on notice. Relators argue *Hall* requires more than just notice of the facts involved. The Court agrees with Relators.

Nothing in *Green* or *Hall* suggests that mere public disclosure of the facts underlying allegations of fraud is sufficient to make a release of FCA claims enforceable. Indeed, *Green* and *Hall* refer repeatedly to the federal government's awareness of a relator's *allegations* of fraud, *see Green* 59 F.3d at 965-67; *Hall*, 104 F.3d at 233, not to awareness of *facts* from which the Government might possibly infer fraud. In *Green*,
20 the *20 critical factor was that the Government knew nothing about the fraud allegations until the relator filed a *qui tam* complaint, whereas in *Hall* the relator's filing of two separate complaints alerted the Government to his allegations. The primary question is whether the Government was aware of the relator's *allegations* before the relator signed a release; otherwise, an insider privy to fraud would be discouraged from blowing the whistle when some, or all, of the facts underlying the fraud are publicly available, even though the Government might not connect the facts or have any suspicion that fraud has occurred. Such a result would contravene the central purpose of the *qui tam* provisions of the FCA to encourage insiders to blow the whistle. *See Green*, 59 F.3d at 963.

On the other hand, Relators' argument goes too far in the other direction. They argue that the Government must actually investigate the fraud. This interpretation of *Hall* is misplaced. *Hall* does not require the Government to actively investigate the allegations of fraud; it must only be aware of allegations that could give it cause to initiate an investigation. Of course, the Government's actual investigation based on allegations of fraud, or based on a set of facts that gives rise to an inference of fraud which the Government has pieced together on its own, is strong evidence that a release of FCA claims should be enforced.

Here, Defendants ask the Court to enforce the releases primarily because the Government was aware of the facts underlying the allegations through public disclosure. They point to the reports and grant applications Ormat filed with federal agencies. The information in these reports might cause the Government to suspect fraudulent activity if it pieced together the facts from various reports filed among various federal agencies over a period of several years. But Ormat presents no
21 evidence to show the Government *21 suspected fraud or initiated an investigation after piecing together the facts. Ormat also does not show the Government was aware of Relators' specific allegations of fraud against Ormat.

Ormat points the Court to a response Ormat provided to the Treasury after the Treasury requested "a detailed discussion on production vs. nameplate capacity and the basis for verifying that the property has been placed in service." (Letter to Treasury, 4, ECF No. 180-21). In Ormat's response, it reviewed the process and timeline for placing the Brawley Plant in service, explained why the plant was not producing at 50 MW capacity, and reiterated that it was placed in service on January 15, 2010. (*See id*. at 4-6). It also informed the Treasury that the plant's turbines were synchronized to the grid in December 2008, and that the plant began initial operation on October 1, 2009. (*Id*. at 4). The Treasury's letter does not show the Government was aware of Relators' allegations, and Ormat's response to it would not necessarily cause the Government to suspect fraud. Indeed, the letter also represents that Ormat "treat[ed] the Project as in service for both tax and book purposes as of January 2010" and that by that date it was "operating on a continuous daily basis." (Letter to Treasury, 6). This assertion contradicts Relators' allegations that Ormat had been depreciating the plant for tax purposes since at least 2009 and that it was operating the plant on a daily basis and generating revenues before 2010. (Am. Compl., ¶¶ 172-174). Furthermore, even with the letter, the information available to the Government in public reports did not include many of the facts underlying Relators' allegations, as detailed above. Thus, the information available would not likely have
22 alerted the Government to fraudulent activity. *22

No evidence shows the Government was aware of Relators' allegations of fraud. Enforcing the settlements in this case would contravene the central purpose of the FCA's *qui tam* provision by preventing Relators from pursuing allegations of which the Government was likely not aware before Relators signed the releases. Hence, although Relators agreed not to bring any legal claims against Ormat, the FCA compels the Court to permit Relators' remaining claims to proceed.

Because neither the FCA's public disclosure provision nor Relators' settlement agreements bar Relators' claims against Ormat, the Court denies Ormat's motion for summary judgment.

C. Motions to Seal

Both Relators' and Defendants ask the Court for leave to file under seal documents containing provisions of Relators' settlement agreements (ECF Nos. 181, 200). The Court grants the motion.

CONCLUSION

IT IS HEREBY ORDERED that Ormat's Motion for Summary Judgment (ECF No. 180) is DENIED.

IT IS FURTHER ORDERED that the Motions to Seal (ECF Nos. 181, 200) are GRANTED.

IT IS FURTHER ORDERED that Relators' Motion for Leave to File a Surreply (ECF No. 209) is DENIED.

23 IT IS SO ORDERED. /// /// /// *23 DATED: March 30, 2016.

/s/__________

ROBERT C. JONES

United States District Judge

Lava Eruption Disrupts the Puna Geothermal Venture - The Background

by Michael Mathioudakis, Molly Johnson, Katie Huang, Jon Golla, and Theo Renaud
GRC Student Committee

The Kīlauea volcano has been continuously featured in international headlines since it began erupting in May, due to its adverse effects on both local residents and on the only geothermal power plant in Hawai'i. The lava flow has surrounded the Ormat Puna Geothermal Venture power plant, forcing a shutdown of activities, and the evacuation of thousands from nearby neighborhoods.

Lava Surrounds Geothermal Power Plant

As of the time of publication, Kīlauea Volcano, located on the Island of Hawai'i ("Big Island"), is still erupting from the summit caldera and from the Lower East Rift Zone (LERZ) in the Leilana Estates and Lanipuna areas. As magma steadily moves from the reservoir to the East Rift Zone and on to the ocean, the area around the caldera continues to experience small explosions, fissure eruptions, and earthquakes.

Remarkably, this is the first time that lava flow has affected operations of a geothermal power plant. The volcanic activity has caused the shutdown of the Puna Geothermal Venture (PGV), a 38 MW installed capacity plant operated by Ormat Technologies Inc. The lava flows surrounding PGV have blocked road access and have prompted officials to shut down the plant and take precautionary measures to prevent lava from reaching the wells. Despite best efforts, three wells have been covered in lava.

Kīlauea Volcano

Kīlauea is a relatively young, basaltic shield volcano east of Mauna Loa Volcano on the Island of Hawai'i (red deposits in **Figure 1**). Erupting 34 times since 1952, it is one of the most active volcanoes in the world [1].

The plumbing system of Kīlauea Volcano extends up to 60 km depth and feeds only the volcano[1]. Research by Lin et al. (2014) suggests the presence of a deeper crustal magma reservoir that may supply magma to the deep East Rift Zone [3]. Pietruzka et al. (2016) support this theory, and further suggest that magma intrusion from the summit reservoir into the LERZ is rare and accounts for major volcanic events [4].

The complicated plumbing system at Kīlauea may result in periodic shifts in magma composition. For example, a shift to a more Mg-O enriched magma composition in 1983 suggests a mixing of rift zone stored magma with mantle-derived magma. Furthermore, an eruption hiatus lasting only a few days may cause crystal fractionation and thus change the eruption magma composition [5].

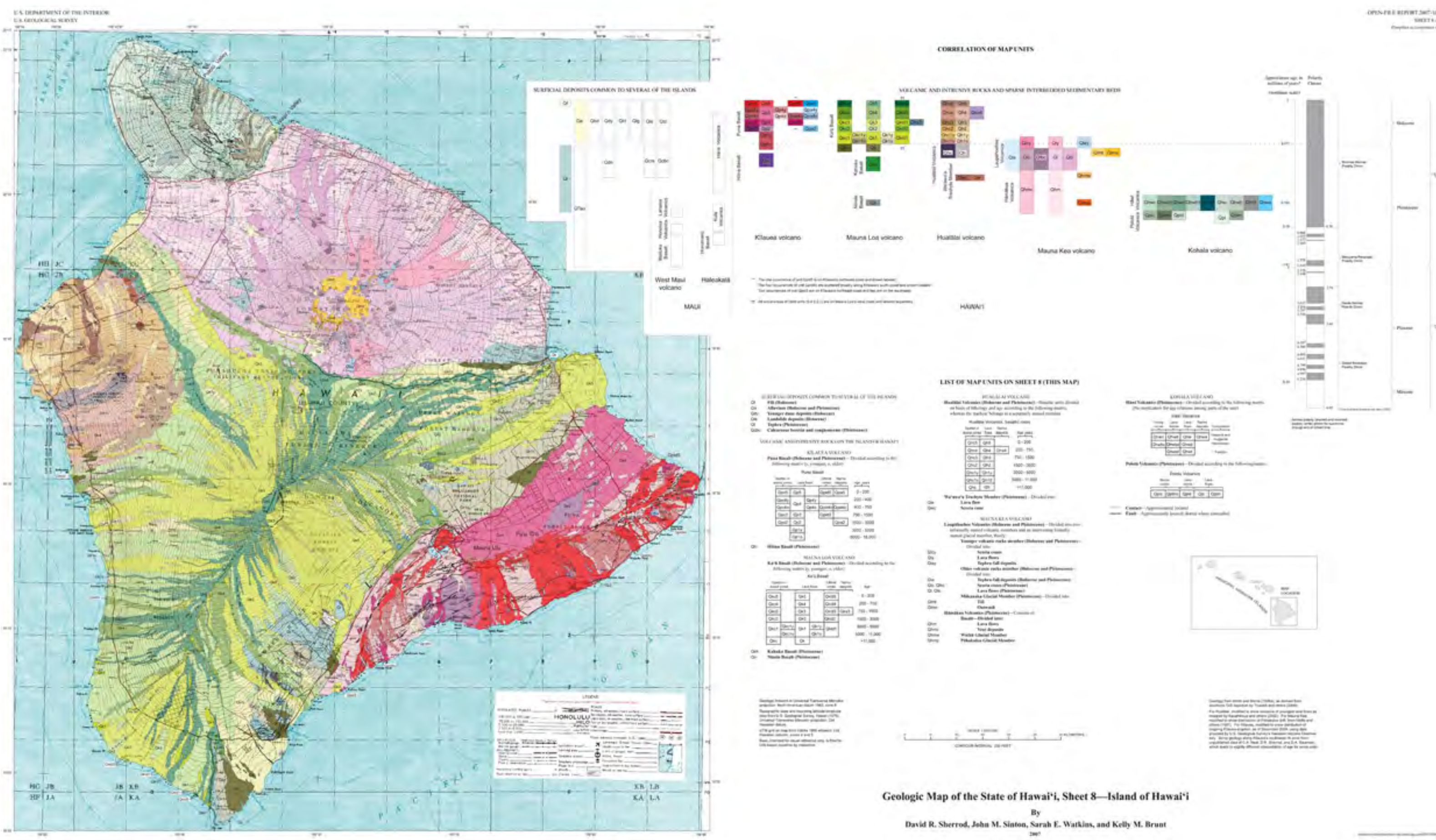

Figure 1: Geologic map of the Island of Hawaiʻi showing deposits from the five volcanoes on the island. Kīlauea is the easternmost volcano[2].

The active lava pond and gas plume of Kīlauea's summit caldera contribute to the eruption patterns of the volcano. The summit lava lake is directly connected to the summit magma reservoir, controlling the eruptive style (**Figure 2**)[6]. Initially, an abundant magma supply allows the summit caldera to fill and may eventually produce large lava flows from the summit and from rift zone vents at the caldera floor. However, in the current situation, a low magma supply has caused the caldera to collapse down to the water table, resulting in large steam explosions. As the magma supply re-entered the system, the lava has flowed into the rift zone vents causing effusive eruptions along the rift zone to the east.

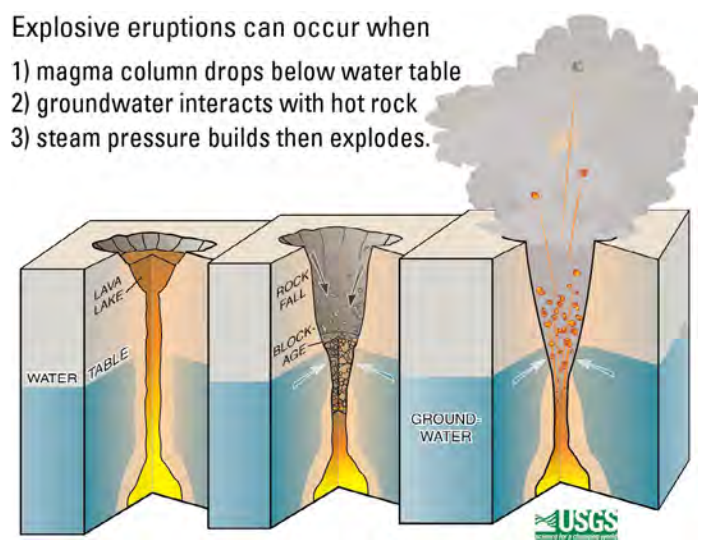

Figure 2: Kīlauea has three eruptive styles, depending on the magma supply. This graphic shows the process of steam explosions when magma supply drops, causing a caldera collapse and magma interaction with groundwater [6].

The 2018 Eruption

Indications of an impending eruption were noticed as early as April 17 2018 when the United States Geological Survey (USGS) noted pressurization of the magma system beneath Puʻu ʻŌʻō, a volcanic cone within the Eastern Rift Zone of Kīlauea. On April 26, lava overflowed onto the Halemaʻumaʻu crater (a pit crater within Kīlauea) floor at the summit of the volcano [7]. Four days later, the Puʻu ʻŌʻō crater collapsed, inducing seismicity and deformation down the rift of the vent, and increasing the risk of a Lower East Rift Zone (LERZ) eruption. The increased pressure beneath Puʻu ʻŌʻō formed a magma pathway from Puʻu ʻŌʻō crater to the LERZ, and, just two days later, small ground cracks began to open in the Leilani Estates area and the summit lava lake started to drop [8]. Finally, on May 3, a 5.0 magnitude earthquake caused Puʻu ʻŌʻō to collapse and release an ash plume; a few hours later, an eruption began on the LERZ with a 150m long vent opening and releasing molten lava to the surface[8]. In the following week, LERZ fissures steadily opened up and the summit lake continued to drop; by May 9, there were 15 new fissures and cracks opening.

As magma continues to move from the reservoir to the ERZ, the reservoir pressure continues to decrease and the Kīlauea Caldera floor has subsided further [9]. This subsidence stresses the faults in and around the caldera, causing continuous pulses of seismic activity [9]. A 6.9 magnitude earthquake, the strongest seismic event in Hawaiʻi since 1975, was recorded on May 11 -- eight days after the start of the eruption.

Puna Geothermal Venture

The Puna Geothermal Venture (PGV) is a geothermal power plant operated by Ormat Technologies Inc. and located approximately one mile east of Leilani Estates (Figure 3). Opened in 1992, the power plant manages 11 active wells that reach depths of 6,000 to 8,000 feet. The steam extracted is directed to turbine generators and also used to vaporize a working fluid for a second turbine. The condensed steam is then re-injected into the geothermal reservoir together with the unused brine [10]. With an installed capacity of 38 MW, PGV supplies 25% of Big Island's electricity, and represents 4.5% of Ormat's total generating capacity [11, 12].

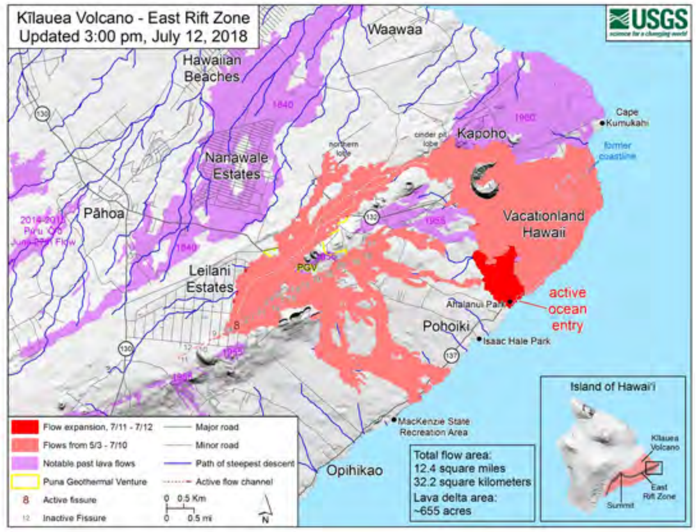

Figure 3: Flow expansion map since the beginning of the eruption on May 3 2018. The Puna Geothermal venture (PGV) is surrounded from the west by the lava flows. (Modified from USGS [1])

Protecting the Infrastructure

Due to the proximity of the lava flows, officials decided to shut down PGV on May 3, 2018. Over the next few days and weeks, Ormat personnel worked to shut down all wells, remove flammable materials, and install physical barriers to protect the plant's infrastructure from lava intrusion [12].

Experts from the geothermal energy community, including personal from the USGS, University of Hawaiʻi at Hilo, Ormat geologists and engineers, a wireline company and equipment suppliers, were brought in to help with the effort. Ormat also deployed a "mudman" who advised on the well quenching process. Charlene L. Wardlow, who oversees the Northern District of the California Division of Oil, Gas, and Geothermal Resources (DOGGR),

Charlene Wardlow *at the Puna Geothermal Venture* (Courtesy Charlene Wardlow).

was recruited by the Hawai'i Emergency Management Agency to join their Geothermal Task Force to secure PGV wells from potential lava intrusion. Wardlow described the process in an interview on June 20 2018: "Usually a geothermal well can be quenched by pumping cold water; however, the intrusion of the 2000+°F magma nearby and on the surface changed the wells' behavior and [the water] didn't work well at first on some of the wells." According to Wardlow, the operators of PGV were able to collect downhole temperature and pressure measurements before the lava had entered the facility. One of the wells had measured temperatures of 100°F greater than normal, even at 2500 ft depth. In addition to salt water, this well had to be quenched with a mud-barite mixture, which is intended to generate a ceramic seal upon exposure to high temperature conditions.

Figure 4: Aerial image of Puna Geothermal Venture (PGV) and the surrounding lava flows. PGV was built on high ground in order to mitigate risks from potential eruptions, and this strategic placement has mostly saved the plant from destruction. (USGS Facebook page)

The team also encountered problems due to delays in equipment delivery (especially bridge plugs) to the islands. "Overnight mail doesn't exist [on Hawaii]." noted Wardlow. As soon as the bridge plugs arrived, they were installed in the wells to isolate the lower part of the wellbore. "Ultimately, the wells were quenched and bridge plugs were run into the production wells using a wireline unit." This quenching operation, which involves injecting water so that the hydrostatic pressure exceeds the pressure of the volcanic stream below, is essential for ensuring the mechanical integrity of the wells. By May 21, all the wells were quenched and sealed with metal caps.

Meteorological conditions were monitored throughout this process, as the eruptions were emitting large amounts of sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) gas. To date, three wells, an equipment warehouse, and switchyard and access roads have been covered with lava [13]. "It is an island in between the active lava flows." said Wardlow. PGV was built on high ground in order to mitigate risks from potential eruptions, and this strategic placement has mostly saved the plant from destruction **(Figure 4).** Dr. Nicole Lautze, Director of the Groundwater & Geothermal Resources Center at the University of Hawaii, hopes that people will appreciate the success of Ormat's mitigation measures: "This eruption has shown that infrastructure on topographically high locations along Kilauea's East Rift Zone can survive eruptions along the rift, and [that] the mitigation measures initiated by PGV/Ormat worked. More broadly, the eruption demonstrates that there will be value in finding geothermal across the state, including in locations less prone to natural hazards."

Geothermal Power Plants and Other Natural Disasters

The future of PGV is difficult to assess as the eruption continues. Although most commercially producing geothermal power plants are built near or around volcanic centers, this is the first time geothermal operations have been interrupted by volcanic activity, so there are no case histories from which to draw comparisons or adopt compatible countermeasures. However, this is not the first instance when a geothermal power plant has had to endure threat from and damage by natural disasters: nearby geothermal plants survived the disastrous earthquake and tsunami during the 2011 Fukushima Daiichi nuclear disaster; Typhoon Haiyan led to the decommissioning of three geothermal power plants in Tacloban City, Philippines in 2013; cooling towers at a geothermal power plant in The Geysers in Northern California were damaged by wildfires in 2015 [14].

Hawaii's Energy Future

The State of Hawai'i has recently vowed full reliance on low-carbon power in the near future, after Governor David Ige signed and passed a bill (H.B. No. 623) in 2015 to set a 100% renewable portfolio standard by 31 December 2045 [15, 16]. Hawai'i is the most fossil-fuel-dependent state in the United States of America largely due to geographic isolation, but it is also one of seven states with utility-scale geothermal production[15]. The PGV plant, the lone geothermal energy source of the state, has been a steady contributor of renewable energy since the early-to-mid '90s. As mentioned previously, geothermal energy has most recently accounted for about a quarter of total electricity supply for Big Island. Coincident with improvement of solar and wind energy implementations, dependence on petroleum has decreased by ~12% from 2005 through 2016 [15]. In order to meet the renewable standard by the 2045 deadline, Dr. Lautze believes that more test wells are needed on other Hawaiian islands to determine viable locations for development: "Geothermal is the only viable baseload renewable energy source. There is a lot of talk about solar and storage here, but the fact is that issues with long-term storage remain. To me, geothermal is key."

Conclusion

Despite general uncertainty and upcoming challenges involving PGV, there is optimism amidst the concern: the wells could be re-opened and operations begun again within two to three years. This phenomenon is a 'first' for the geothermal industry. Mass communication of ensuing events and underlying science have signified the integral role of geothermal energy to local parties and have alerted geothermalists worldwide to adapt from such a situation, should this ever happen again. Although this eruption has caused a hiatus in energy production at PGV, the media coverage it received has revealed the need for careful and elaborate emergency response for geothermal plants in active volcano zones. The minimal damage to the facility proves that with clever design (built on high ground) and quick action to threats, geothermal energy may and will continue to be a stable source of baseload energy. Increasing geothermal baseload capacity throughout the Hawaiian Islands will reduce the negative effects of temporary shutdowns, which must be expected when facilities are built next to and depend on such powerful natural systems like Hawaii's Kilauea volcano.

[1] *https://volcanoes.usgs.gov/volcanoes/kilauea/*

[2] *https://pubs.usgs.gov/of/2007/1089/HawIsland_zone5_2007.pdf*

[3] *https://pubs.geoscienceworld.org/gsa/geology/article-abstract/42/3/187/131485*

[4] *http://adsabs.harvard.edu/abs/2016AGUFM.V53A3078P*

[5] *http://adsabs.harvard.edu/abs/2016AGUFM.V12A..03G*

[6] *https://volcanoes.usgs.gov/volcanoes/kilauea/geo_hist_summary.html*

[7] *https://volcanoes.usgs.gov/vsc/file_mngr/file-182/HVO%20Earthquakes%20FAQ%20FINAL.pdf*

[8] *https://volcanoes.usgs.gov/vsc/file_mngr/file179/Chronology%20of%20events%202018.pdf*

[9] *https://volcanoes.usgs.gov/vsc/file_mngr/file-181/kilauea_summit_earthquakes.pdf*

[10] *https://www.hawaiianelectric.com/clean-energy-hawaii/clean-energy-facts/renewable-energy-sources/geothermal/puna-geothermal-venture-(pgv)*

[11] *http://www.dailymail.co.uk/news/article-5778481/Lava-covers-potentially-explosive-Hawaii-geothermal-plant.html*

[12] *http://investor.ormat.com/file/Index?KeyFile=393508375*

[13] *http://investor.ormat.com/file/Index?KeyFile=393711325*

[14] *Garthwaite, J. "Geothermal at the foot of Kilauea". Stanford Earth: School of Earth, Energy, & Environmental Sciences, 5/25/2018. Accessed 6/30/2018 https://earth.stanford.edu/news/geothermal-foot-kilauea*

[15] *https://www.eia.gov/state/?sid-HI* ■

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Geothermal Induced Seismicity National Environmental Policy Act Review

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Keywords

Induced seismicity, geothermal, environmental review, mitigation

ABSTRACT

In 2016, the U.S. Bureau of Land Management (BLM) contracted with the National Renewable Energy Laboratory (NREL) to assist the BLM in developing and building upon tools to better understand and evaluate induced seismicity caused by geothermal projects. This review of NEPA documents for four geothermal injection or EGS projects reveals the variety of approaches to analyzing and mitigating induced seismicity. With the exception of the Geysers, where induced seismicity has been observed and monitored for an extended period of time due to large volumes of water being piped in to recharge the hydrothermal reservoir, induced seismicity caused by geothermal projects is a relative new area of study. As this review highlights, determining the level of mitigation required for induced seismic events has varied based on project location, when the review took place, whether the project utilized the International Energy Agency or DOE IS protocols, and the federal agency conducting the review. While the NEPA reviews were relatively consistent for seismic monitoring and historical evaluation of seismic events near the project location, the requirements for public outreach and mitigation for induced seismic events once stimulation has begun varied considerably between the four projects. Not all of the projects were required to notify specific community groups or local government entities before beginning the project, and only one of the reviews specifically stated the project proponent would hold meetings with the public to answer questions or address concerns.

1. Introduction

In 2016, the U.S. Bureau of Land Management (BLM) contracted with the National Renewable Energy Laboratory (NREL) to assist the BLM in developing and building upon tools to better understand and evaluate induced seismicity caused by geothermal projects. In the geothermal context, induced seismicity refers to small earthquakes (typically between a magnitude of 1.0 and 3.5 on the Richter scale) that may occur as a result of human activity (i.e. stimulating the geothermal reservoir or injecting fluid to replenish the geothermal reservoir).

The most infamous hydraulic stimulation event for creating an enhanced geothermal system (EGS) reservoir is likely the 2006 Basel 1 project in Switzerland. The project site was located in downtown Basel with known historic seismicity and presence of nearby active faults. An estimated M 6.0 to 6.9 earthquake in 1356 destroyed downtown Basel and is considered the most significant seismological event to have occurred in Central Europe in recorded history (RMS, 2012). In December 2006, a 21-day hydraulic stimulation job was planned for the Basel 1 well. Increased seismic activity (with a maximum event of M_L 3.4) resulted in structural damage of nearby buildings and 2,700 damage claims by local residents, triggered halting of fluid injection prematurely (within 6 days of start of injection), and eventually terminated the entire project (GPB, 2007; Häring et al. 2008).

The seismic event at the Basel 1 EGS project resulted in the development of the "Induced Seismicity protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems" by the U.S. Department of Energy (DOE) in 2008 (Majer et al., 2008) and an updated protocol in 2012 (Majer et al., 2012). This IS protocol was developed to guide geothermal developers for managing induced seismicity and applying EGS technology safely. It consists of seven steps an operator must follow when given permission to perform activities that may cause induced seismicity.

In this paper, we analyze existing National Environmental Policy Act of 1969 (NEPA) environmental review documents and summarize a selection of geothermal projects that had induced seismicity concerns. This paper focuses on:

- The NEPA process and how it relates to geothermal resource development;
- The DOE's Geothermal Induced Seismicity Protocol; and
- NREL's findings as they relate to how previous EGS and geothermal injection projects have analyzed and mitigated concerns around human-induced seismic events.

2. Background

This section provides a brief overview of NEPA and its relation to the BLM and/or DOE geothermal funding or permitting process, the DOE Geothermal Induced Seismicity Protocol, and the geothermal projects reviewed for this analysis.

2.1 NEPA and Geothermal Funding and Permitting on Federal Land

NEPA requires federal agencies or departments to consider the environmental impacts of all major federal actions significantly affecting the quality of the human environment ("major federal action") (NEPA, Sec. 102). The NEPA review is a procedural tool used to consider the environmental impacts of the proposed action as well as alternatives to the proposed action before a federal agency approves or rejects it.

A geothermal project on BLM-managed federal land must complete an environmental review under NEPA for any project that includes a major federal action, such as activities that require permit approval from the BLM, including a Notice of Intent to Conduct Geothermal Resource Exploration (where the project includes new surface disturbance or extraordinary circumstances), a Geothermal Drilling Permit (GDP), and a Site License and Facility Construction Permit (43 CFR 3200 et seq.). Often the environmental review under NEPA is in the form of an Environmental Assessment (EA), but a more comprehensive review termed an Environmental Impact Statement (EIS) may be required for projects with significant environmental impacts

(NEPA, Sec. 201 (C)). In many instances, the BLM may require mitigation measures in the EA for the project to reduce the environmental impact caused by the project. For this analysis we reviewed BLM geothermal NEPA documents that addressed induced seismicity to better understand these concerns, how these concerns are evaluated, and how the BLM has previously addressed these concerns through mitigation measures.

In addition, geothermal activities funded by the DOE also constitute a major federal action and require NEPA review. We have included a DOE NEPA environmental review for a DOE-funded EGS project that occurred on private land for additional comparison.

2.2 DOE Induced Seismicity Protocol

Due to concerns surrounding the potential for seismic events caused by EGS projects and to gain public acceptance for EGS projects, the DOE commissioned experts in induced seismicity, geothermal power development, and risk assessment to revise and write a "Protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems" ("DOE IS Protocol") building upon the 2009 International Energy Agency (IEA) protocol. *(See* Majer et al. 2012). The objective of the DOE IS Protocol is to promote safety and help gain acceptance for geothermal activities, particularly EGS projects (Majer et al. 2012). The Protocol provides a set of guidelines detailing steps to evaluate and manage the effects of induced seismicity related to EGS projects and is commonly used and/or referred to in DOE and BLM NEPA documents.

The DOE IS Protocol consists of seven steps for addressing induced seismicity issues:

1. Perform a preliminary screening evaluation.
2. Implement an outreach and communication program.
3. Review and select criteria for ground vibration and noise.
4. Establish seismic monitoring.
5. Quantify the hazard from natural and induced seismic events.
6. Characterize the risk of the induced seismic events.
7. Develop risk-based mitigation plan.

2.3 Geothermal NEPA Documents Analyzed

For this memorandum, NREL staff analyzed four NEPA documents presented in Table 1:

- Newberry Volcano EGS Demonstration Project EA
- Bottle Rock Power Steam Project Environmental Impact Report (EIR)/EA
- Brady Hot Springs Well 15-12 Hydro-Stimulation EA
- Calpine Enhanced Geothermal Systems Project EA.

Table 1: List of Projects Reviewed

Project	Location	Review Type	Lead Agency	Participating Agencies	Review Completion
Newberry Volcano EGS Demonstration Project	Deschutes National Forest Lands in Oregon	EA	BLM	USFS DOE	December 2011
Bottle Rock Power Steam Project	Lake County, CA	EA/EIR	BLM/Lake County	None	December 2010
Brady Hot Springs Well 15-12 Hydro-Stimulation	Churchill, NV	EA	BLM	DOE	January 2013
Calpine Enhanced Geothermal Systems Project	Sonoma County, CA	EA	DOE	None	June 2010

In the following section, we discuss the findings from environmental review documents for these four geothermal projects that included potential induced seismicity issues.

3. Induced Seismicity NEPA Review by Project

This section provides detailed findings for four geothermal projects that included induced seismicity concerns on a case-by-case basis. For each geothermal project we highlight:

- The lead and participating agencies
- The action triggering NEPA review
- Noted seismic concerns with the project
- The seismicity evaluation conducted for the project
- Utilization of the DOE IS Protocol
- The level and type of seismic monitoring
- Pre-stimulation mitigation measures and planning
- Stimulation and post-stimulation mitigation measures and planning
- Actual events measured during project.[1]

3.1 Newberry Volcano EGS Demonstration Project

Date of completed EA: December 2011

The Newberry Volcano EGS Demonstration Project is located on BLM leases in the Deschutes National Forest lands in Oregon and completed an EA under NEPA in 2011. The BLM acted as lead agency for the EA, with the U.S. Forest Service (USFS) and DOE signing onto the document as cooperating agencies. The Newberry project utilized a deep geothermal well on an

[1] Seismic data for this study were accessed through the Induced Seismicity Data Website (EGS Earthquake Maps) at the Lawrence Berkeley National Laboratory, which is supported by the U.S. DOE Office of Geothermal Technology.

existing well pad to stimulate the reservoir using hydroshearing.[2] During this operation, developers injected high-pressure water estimated in the range of 1,160 to 2,500 psig at depths of 6,500 to 10,000 feet. After creating the EGS reservoir, the proponent proposed to drill two additional deep production wells that would be directionally drilled from the same well pad to bring the heated water up to the surface.

Noted seismic concerns with the project included induced seismicity at the Newberry National Volcanic Monument, damage to structures and resorts, the potential for property damage, and avalanche risk.

3.1.1 Mitigation Plan

Based on induced-seismicity concerns, the project proponent completed an induced seismicity/seismic hazards and risk evaluation conducted by an independent third party. The evaluation considered the potential magnitude and seismic rate that could result due to hydroshearing. The evaluation stated that the probable upper bound of an induced seismic event at Newberry was estimated in the 3.5 to 4.0-magnitude range and that other seismic events of less than a magnitude of 2.0 are largely not of concern.

In completing the NEPA review, the BLM (and third party consultants) used the IEA protocol from 2008 and later incorporated components of the draft DOE IS protocol. The EA called for the installation of two additional seismic monitoring stations at Newberry and utilization of one existing seismic monitoring station. In addition, 20 seismic monitoring devices (10 borehole, 10 surface) were to be installed at wells, boreholes, and surface stations to constantly monitor seismic activity. The continuous monitoring of microseismic events through these devices results in a daily seismic reports.

The EA stated that before the project begins, the developers must:

- Provide notice in local newspapers, which includes contact information for citizens to request additional information or report concerns
- Hold monthly public meetings
- Install rock fall hazard ahead signs that include information on reporting damage
- Install new avalanche warning signs
- Purchase general and umbrella liability insurance with an aggregate limit of $2,000,000 and $1,000,000 per occurrence
- Conduct structural engineering analysis to determine the vulnerability of 52 key assets near the site
- Install crack monitors on a bridge and monitor cracking at a nearby dam.

[2] Hydroshearing is a process in which pressurized (often cold, clean) water opens up natural fractures in the rock and causes them to slip and create underground storage units. This differs from the hydrofracking done in the oil and gas industry, which uses a mixture of chemicals and significantly higher pressures to actually shatter the rock and create new fractures.

Once stimulation (hydroshearing) of the reservoir begins, the EA requires a series of mitigation measures based on the level of seismic event that occurs. Table 2 highlights the required mitigation based on magnitude of seismic event or ground shaking.

Table 2: Newberry EGS Project Seismic Event Mitigation Measures

Seismic Event within 3 KM *(in Magnitude)*	Required Mitigation
Less than M2.0	Only a concern if a seismic event greater than M1.0 is detected by at least 6 monitors located shallower than 6,000 feet. This would trigger a diversion mitigation strategy, resulting in the use of a diverter to shift stimulation to another zone. No increase in flow rate would be allowed until after the diverter is applied.
M2.0 to M2.7	Triggers diversion mitigation strategy (see *less than M2.0*). No increases in flow rate until after the diverter is applied.
M2.7 to M3.5 **Or** **Peak Ground Acceleration (PGA) greater than 0.014 g on the SMS**	Reduction of flow rate. Injection rate decreased so that downhole pressure is reduced by 250 psi. Additional pressure reduction by 250 psi if M2.0 or greater continue to occur. May gradually increase flow rate back to normal if no M2.0 or greater occurs for 24 hours. Project website will be updated after such events to provide instructions for how to report damage. Written trigger reports and phone calls will be made to inform key personnel. Notification to park visitors and owners of nearby homes.
Greater than M3.5 **Or** **PGA greater than 0.028 g on the SMS**	Halt all injection. Flow well to surface test equipment to relieve reservoir pressure. Do not resume stimulation until after consultation and agreement between developer, DOE, BLM, and USFS. Project website will be updated after such events to provide instructions for how to report damage. Written trigger reports and phone calls will be made to inform key personnel. Notification to park visitors and owners of nearby homes.

3.1.2 Seismic Results Associated with Well Stimulation

The Newberry Volcano EGS Demonstration project began the first phase of stimulation (hydroshearing) using an existing well in October 2012 and completed this phase in December 2012 (Cladouhos et al., 2013). Seismicity occurred throughout the two-month stimulation period, with seismic monitors recording a total of 174 seismic events, 114 of which occurred during the stimulation period of 10/29/12 to 12/7/12 (Cladouhos et al., 2013). The largest magnitude event to occur during the first phase of stimulation registered M2.39 and a total of three events greater than M2.0 occurred. The M2.39 event triggered a mitigation action per the mitigation plan to wait 24 hours before increasing well head pressure or flow rate, however the event occurred on the last day of planned stimulation and the well was shut-in later that day (Cladouhos et al., 2013). No PGA greater than 0.014 occurred during the first phase of stimulation (Cladouhos et al., 2013).

The second phase of stimulation (hydroshearing) began at an existing well in September 2014 and was completed in November of 2014 (Cladouhus et al., 2016). The stimulation occurred from September to October 2014 and again in November 2014. Seismicity occurred throughout the stimulation periods, with the rate of seismicity being the highest in early October 2014 when wellhead pressure exceeded 2800 psi. In total, 398 seismic events occurred, however only two of those events were larger than M2.0 (a M2.1 in early October 2014 and a M2.3 during the November stimulation period) (Cladouhus et al., 2016). A timeline of seismic events for both phases of stimulation was developed (see Figure 1) using discrete event data pulled from Lawrence Berkeley National Laboratory's (LBNL) EGS earthquake maps (LBNL, 2017).

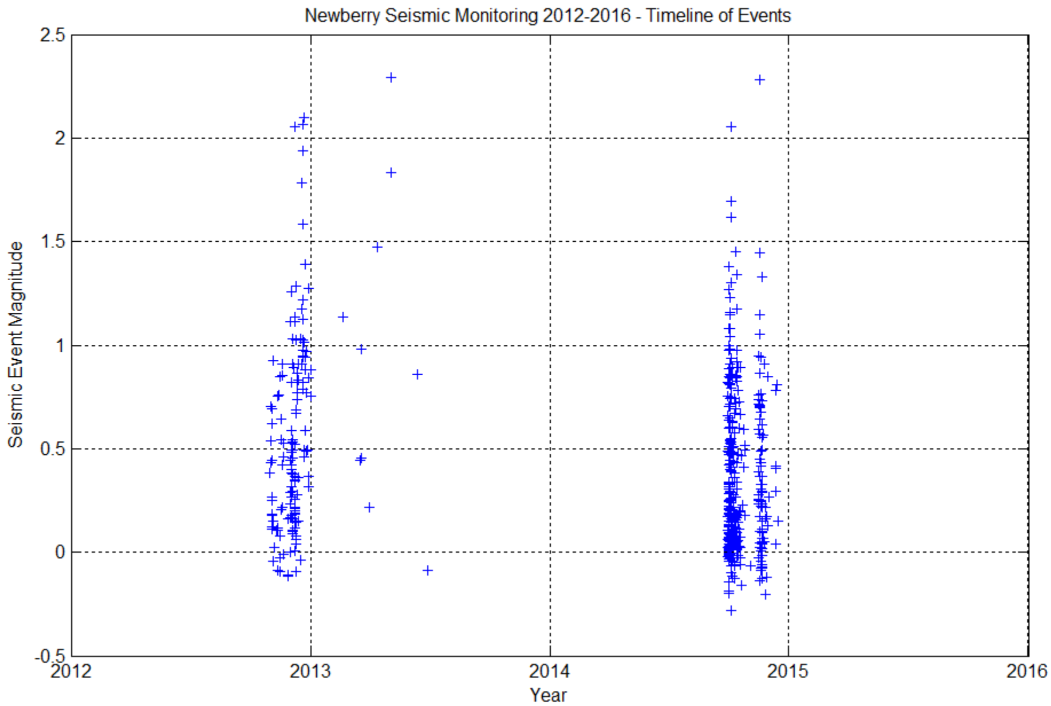

Figure 1. Newberry Volcano EGS Demonstration Project Seismic Monitoring Data from LBNL's EGS Earthquake Maps

3.2 Bottle Rock Power Steam Project EIR/EA

Date of completed EA: December 2010

The Bottle Rock Power (BRP) Steam Project is located on BLM leases near the Geysers in Northern California. The BLM served as the lead agency under NEPA for completion of an EA, while Lake County served as the lead agency under the California Environmental Quality Act (CEQA) for completion of an EIR in 2010. GeothermEx evaluated geothermal resource data under contract to AECOM, which was hired by BRP as the environmental consultant. This NEPA review was related to BRP GeoResource LLC's (BRP) application for a GDP and Commercial Use Permit to support expanded electricity production at the existing BRP Plant. The proposal was termed the "BRP Steam Project" and included two new well pads with a total of 22 geothermal production wells. Initially 12 to 14 production wells would be drilled, while the remaining 8 to 10 wells would serve as replacements over the life of the project. BRP proposed constructing two additional injection wells (one on each pad) to return condensate from the power plant to the geothermal reservoir. BRP planned to construct about 4 miles of steam and injection pipelines to transport the geothermal resource to and from the power plant. The construction of the well pads along with the access roads would disturb 22.51 acres.

Geothermal activities and injection in particular, have been associated with increased seismicity at the nearby Geysers geothermal operations. This induced seismicity has been felt by residents in communities such as Cobb and Anderson Springs. Residents have been concerned with these impacts, and the aforementioned two injection wells included in the BRP Steam Project could cause additional seismic activity. Thus, the BLM and Lake County (hereinafter referred to as BLM) analyzed the potential impacts of induced seismicity from the BRP Steam Project. The BLM did not leverage the IEA protocol in their study of induced seismicity (the DOE IS Protocol did not exist at the time).

GeothermEx analyzed the existing faults where natural earthquakes could occur and identified no active faults in or near the project site. As a result, the BLM concluded that geothermal operations were not likely to trigger earthquakes at existing faults. However, the site could be impacted by earthquakes at regional faults (i.e. the San Andreas Fault system located 37 miles west) that could result in injury and damage at the site. The BLM included a range of mitigation efforts to address natural earthquake risks including constructing project components in compliance with the applicable International Building Code.

3.2.1 Induced Seismicity Associated with Historical Geothermal Operations in the Area

To evaluate the potential effects of geothermal operations on induced seismicity, GeothermEx evaluated historical geothermal injection data at the Francisco Geothermal Lease (nearby to the proposed project) and potential correlation with seismicity. Over the spatial-temporal distribution study period from 1970 – 2009, GeothermEx identified that fluid injection at the Francisco Lease was associated with increased seismic activity typically below M2.0. GeothermEx identified approximately six seismic events per month below M2.0, which can be felt as far as eight kilometers from the epicenter. Seismic events of $2.0 \leq M \leq 3.0$, were limited to one event every seven months and GeothermEx determined that seismicity at smaller M levels ($M < 3.0$) may be associated with reservoir operations, while those at higher magnitudes ($M > 3.0$) may be associated with another cause such as natural earthquake activity. GeothermEx could not effectively evaluate ground peak acceleration because of the ground shaking effects of local operations causing these measurements to significantly vary across the Geysers.

GeothermEx identified that seismic activity was not consistently correlated with injection at the wells stating "seismicity rates are unrelated to injection periods and volume at some locations and correlated to the same properties at other locations." As a result, GeothermEx could not make a prediction relating to potential seismic rates at the BRP Steam Project. Nevertheless, GeothermEx assumed that the close proximity of the Francisco Lease to that of the BRP Steam Project provided a useful case study for the expected results of the project. On this basis, Geothermex concluded that the project might expect between one to four events per month of $M > 2.0$ and one to two events per month at $M > 2.5$. Given induced seismicity would likely not correlate with large-magnitude earthquakes that can be felt on the surface ($M > 3.0$), the BLM concluded that potential induced seismicity from the BRP Steam Project was a less than significant impact that did not require mitigation.

3.2.2 Mitigation Plan

Despite this finding, the BLM did require BRP to install a seismometer at a location deemed appropriate by the BLM and Lake County[3] to monitor seismic activity. Once installed, all the collected seismic activity would be submitted to the BLM, Lake County, and the Lake County Seismic Monitoring Advisory Committee.

Prior to stimulation, the BLM required the developer to submit a complete operations plan including a production and injection plan along with the locations of the wells for review. With the plan, the BLM would determine whether the BRP Steam Project operations would be similar to those in the Francisco Geothermal Lease or require additional mitigation measures.

During stimulation, if the seismic activity correlated with injection varied substantially from the conclusions presented in the EA (generally $M < 3.0$), BRP would be required to take corrective actions such as adjusting injection volumes and location of injection wells among other measures. These corrective actions would be developed via consultation between the developer, the BLM, and Lake County.

3.2.3 Seismic Results Associated with Well Stimulation

The Bottle Rock Steam Project stimulation initially began in March 2011 with a series of stimulation activities occurring through April 2011. The Geysers geothermal area has extensive seismicity, making it difficult to identify the total number of seismic events associated with stimulation based on LBNL's EGS Earthquake Maps (LBNL, 2017).[4] The project operator (and hired consultant) could not find any conclusive evidence in the maps or the consultant's earthquake processing system for an increase in earthquake activity as a result of the stimulation (Foulger Consulting, 2011). The operator's consultant identified five seismic events in a cluster near one of the stimulated wells that may have resulted from the stimulation, but results were not conclusive (Foulger Consulting, 2011).

A second phase of stimulation occurred in April 2014. The frequency of seismic events increased during the stimulation, but a 2014 stimulation analysis concluded there was "little evidence" to support this was a direct result of the stimulation activities (AltaRock, 2014).

3.3 Brady Hot Springs Well 15-12 Hydro-Stimulation EA

Date of completed EA: January 2013

The Brady Hot Springs Well 15-12 Hydro-Stimulation Project is located on BLM leases at an existing geothermal well pad at the Brady Hot Springs Federal Lease located nearest to Fernley, Nevada. The BLM was designated as the lead agency for the NEPA process, while DOE agreed

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[3] Administered by the Lake County Special Districts department, the Lake County Seismic Monitoring Advisory Committee was formed in 1998 and meets bi-annually to provide the local community with regular updates and information on seismicity issues within the Geysers. For more information *see* http://www.geysers.com/smac.aspx.

[4] Additionally, the LBNL EGS Earthquake Database Map website appears to be missing data during the 2011-2013

to be a cooperating agency due to project funding provided through a 2008 DOE Funding Opportunity Announcement (FOA).

In 2013, the BLM completed the EA in response to Ormat's application to allow the developer to test EGS technologies at Well 15-12 to increase geothermal reservoir production at the field. The well was originally constructed as a production well, but it was unsuccessful because it did not have "sufficient hydraulic connections with the geothermal reservoir." The developer proposed to inject relatively cool geothermal water (90 – 140 °F) into Well 15-12 at wellhead pressures less than 1,400 psi at depths between 4,245 and 5,096 feet below the surface to hydroshear the reservoir (i.e., stimulate or further open existing fissures or connections within the geothermal reservoir). The developer would stimulate the reservoir at varying pressures over a period of three weeks and add tracer compounds to the injected water to assess geothermal fluid movement and increased steam pressure at other production wells. The expectation was that the injection of cool geothermal water would allow for increased production from the reservoir thereby increasing power generation at the nearby Brady Power Plant.

Because injecting the cool geothermal water into the reservoir could cause induced seismicity, there was a concern that these events might have adverse impacts above and below ground. Before the development of the EA, Ormat (in cooperation with DOE) began evaluating these impacts with the aid of the IEA protocol and (once finalized) the DOE IS Protocol. BLM leveraged the results of this analysis in completing their NEPA review.

3.3.1 Induced Seismicity Associated with Historical Geothermal Operations in the Area

Ormat identified that historical geothermal operations at the Brady Hot Springs field are associated with microseismic events (M>2.0), while at the same time, noting there has been some natural earthquake activity in the area (M<4.0). To quantify potential seismic hazards, Ormat leveraged the results of a nearby geothermal project that employed well stimulation that showed low seismicity between M0.11 – M0.77. Based upon these results and geological and geophysical surveys, Ormat concluded that there was a low probability that an induced seismic event over M2.0 would occur within 500 meters of Well 15-12. Outside of this area, the probability of such an event was significantly lower to nonexistent.

3.3.2 Mitigation Plan

Given these results, in completing the NEPA review, the BLM required the project to install 15 microseismic monitoring stations to detect and map induced seismic events. Six of the microseismometers would be installed a few feet below ground, while nine would be installed at existing boreholes up to 300 feet below ground. The stations would be installed in an array around the stimulation well to increase monitoring effectiveness. Once installed, the developer must publish this real-time seismicity data for public consumption via an online website during injection.

Prior to stimulation, the developer must also notify the Churchill County Local Emergency Planning Committee of its intention and install a ground motion sensor in Fernley, Nevada, the only community within 30 miles of the well.

During well stimulation, the developer must submit daily project reports that outline on-site activities, seismic events, and other information to the BLM and DOE. Table 3 highlights the required mitigation based on magnitude of seismic event or ground shaking.

Table 3: Brady Hot Springs Seismic Event Mitigation Measures

Seismic Event within 3 KM *(in Magnitude)*	**Required Mitigation**
M2.5 or greater	Project must halt injection. Developer must submit a Trigger report to the BLM and DOE and notify key personnel at the BLM, DOE, and Churchill County immediately.
Single reading over 0.02 g or more than 10 readings per day over 0.002 g peak ground acceleration measured at the Fernley ground motion sensor	Project must halt injection. Developer must submit a Trigger report to the BLM and DOE and notify key personnel at the BLM, DOE, and Churchill County immediately.

3.3.3 Seismic Results Associated with Well Stimulation

The Brady Hot Springs Well 15-12 stimulation initially began in late 2010 with a series of stimulation activities occurring through March 2015. Seismic monitors recorded a total of 403 seismic events, none of which reached M2.5 or greater (the required mitigation threshold) and only one event reached a magnitude of M2.0. A timeline of seismic events for both phases of stimulation based on LBNL's EGS Earthquake Maps (LBNL, 2017) is provided below in Figure 2.

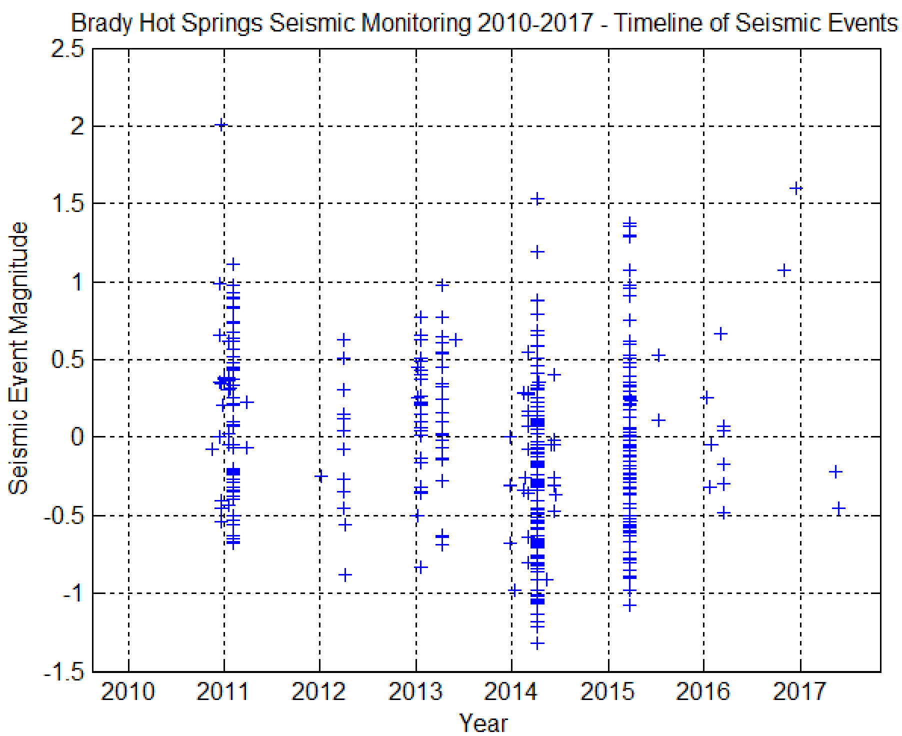

Figure 2. Brady Hot Springs Seismic Monitoring Data from LBNL's Earthquake Maps

3.4 Calpine Enhanced Geothermal Systems Project

Date of completed EA: June 2010

The Calpine Enhanced Geothermal Systems Project is located on private land within the Northwest Geysers in Sonoma County, California. DOE was the lead agency on the project as a result of providing the project funding through a 2008 FOA. The Calpine project sought to develop an EGS demonstration project to inject water ranging from 50 to 80 °F at increasing rates (100, 200, 400, and 800 gpm, depending on the ability of the fracture to accept the fluid) into abandoned exploratory wells converted to deep injection wells to enhance permeability of an existing high-temperature hydrothermal reservoir. The project utilized water obtained from other wells on site, with injection rates declining at those wells. The project, as proposed, consisted of three phases:

1. Pre-stimulation activities, including construction of a pipeline to deliver water for injection, preparation of the well pad and access roads, and re-opening/modification of two wells.
2. Stimulation activities, including implementation of the stimulation plan and monitoring the EGS system.
3. Long-term injection and monitoring the sustainability of the EGS project.

Noted seismic concerns included re-opening the formation, which may impact nearby communities and structures, as well as 25 historical (probable) Geysers-induced earthquakes of M4.0 and greater since 1972. Based on these induced seismicity concerns, the project conducted pre-stimulation modeling of the selected EGS wells, analyzed the historical induced seismicity in the Geysers, and conducted injectivity tests. The evaluation stated that seismic events were expected to be lower than M3.0, with a maximum predicted (but unlikely) event of M4.5 (based on events of this magnitude occurring over the last 40 years).

<u>3.4.1 Mitigation Plan</u>

In completing the NEPA review, DOE utilized and required adherence to the IEA protocol from 2008 based on a DOE decision to follow international protocols to address and mitigate potential impacts resulting from induced seismicity. (This environmental review was completed prior to the development of the DOE IS protocol.) The project planned to add four seismic monitoring stations to an existing network of twenty-nine seismic monitoring stations operated by the U.S. Geological Survey and LBNL. Additionally, two accelerograph stations are located in nearby communities that are used to determine the relationship between drilling and effects felt in the communities.

In addition to monitoring improvements, pre-stimulation efforts included informing community groups, seismological experts, regulatory agencies, and local government officials through the Seismic Monitoring Advisory Committee for the Geysers, which meets biannually to inform attendees of upcoming EGS projects. Further, software improvements were made to enable routine automated locating and mapping of nearby epicenters.

Mitigation during stimulation included analyzing well data to determine which wells are more susceptible to induced seismicity and a reduction of injection pressure at wells that produce higher levels of felt seismicity. During stimulation the success of the redistribution of water and any other modifications to reduce felt seismicity will be continually evaluated.

3.4.2 Seismic Results Associated with Well Stimulation

The Calpine Enhanced Geothermal Systems project initially began stimulation in October 2011 with a series of stimulation activities predominately occurring through March 2013 (Figure 3). The Geysers geothermal area has extensive seismicity, making it difficult to identify the total number of seismic events associated with stimulation based on LBNL's EGS Earthquake Maps (LBNL, 2017). However, Calpine used the LBNL seismic monitoring stations to identify a total of eight seismic events greater than M2.5 associated with stimulation (Garcia et al., 2016). The largest of these seismic events were an M3.74 in January of 2014 and an M2.87 in May of 2012 (Garcia et al., 2016). The timing of the events greater than M2.5 did not show a strong correlation with injection rate or injection rate variability (Garcia et al., 2016).

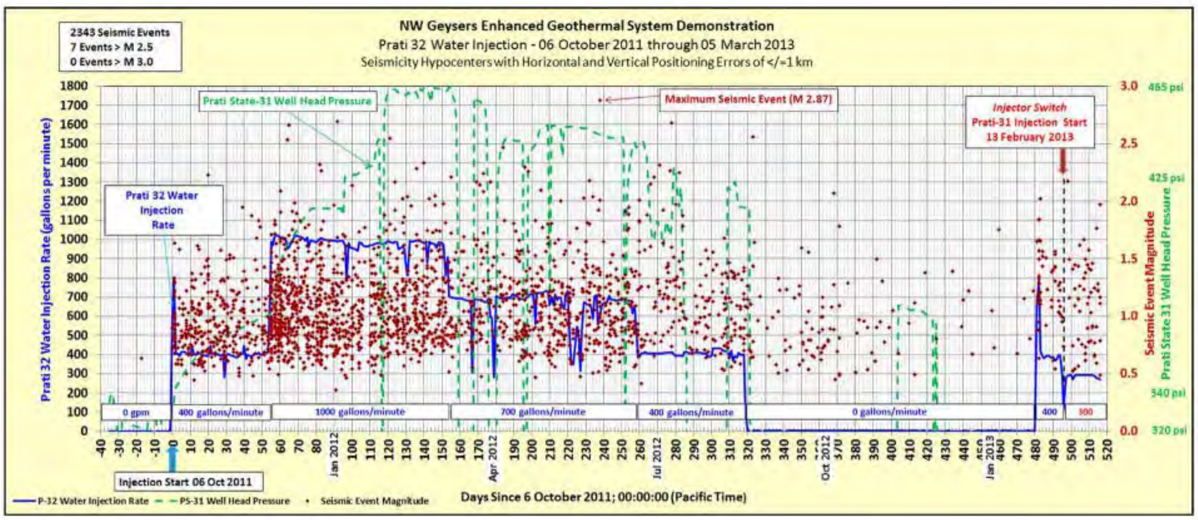

Figure 3. Calpine EGS Demonstration Project. Timelines shows fluid injection pressures (green curve), flow rates (blue curve) and seismic event magnitudes (red dots) highlighting maximum seismic event of M2.87 (Garcia et al., 2016).

4. Induced Seismicity NEPA Review Summary

This section summarizes the varying methods used to evaluate induced seismicity impacts across the projects and documents the key differences and similarities in the pre-stimulation, stimulation, and post-stimulation mitigation requirements.

4.1 Seismic Evaluations

To structure NEPA-related studies of seismic activity, three of the four projects (excluding BRP) used either the IEA protocol or iterations of the DOE IS Protocol. Calpine leveraged the IEA protocol, Newberry started with the IEA protocol and then incorporated components of the DOE IS protocol, and Brady Hot Springs used only the DOE IS Protocol. The use of the IEA protocol can likely be attributed to the environmental reviews taking place prior to the development of the DOE IS protocol.

All four projects conducted an evaluation of historical seismicity. These data were generated from existing seismometers and associated networks located near each project. From these data, an upper bound of plausible seismic events related to induced seismicity was established for each project and ranged from M3.0 $\leq$ M $\leq$ 4.5. BRP anticipated the lowest induced seismicity impact of M3.0. In comparison, Calpine anticipated the highest probable magnitude of 4.5.

In addition to this historical analysis, each project modeled the likely induced seismicity associated with stimulation activities. Here, each project took somewhat different approaches. In the Newberry case, the developer contracted with a third party to conduct an induced seismicity/seismic hazards and risk evaluation. In the Calpine case, the developer conducted pre-stimulation modeling of the selected EGS wells and evaluated the historical seismicity at the Geysers (where the project was located) and the results of injection tests. In the Brady Hot Springs case, the developer analyzed the induced-seismicity effects of a nearby project that employed well stimulation, along with geological and geophysical surveys of the area. Finally, in the BRP case, the BLM estimated the potential impacts of induced seismicity by evaluating the historical seismicity correlated with re-injection of geothermal fluid at a nearby project.

Despite this varied methodology, each document predicted that the induced seismic events of magnitudes less than 3.0 were the most probable. In the case of Brady Hot Springs and Newberry the expectation was that normal operations (re-injection) would result in induced seismic events of magnitude typically less than 2.0. Calpine and BRP expected 1-2 events per month (during normal operations) between 2.0 $\leq$ M $\leq$ 3.0.

4.2 Pre-stimulation Monitoring and Communication Activities

A range of pre-stimulation activities were required for each project, based in part upon the predicted induced seismicity effects. First, each project was required to conduct seismic monitoring during operations through the installation of 1-20 seismometers above and below ground. The BRP and Calpine projects represent the low end of the range with requirements to install one and four seismometers, respectively. In comparison, the Newberry project was required to install the most seismometers at 20, followed by Brady Hot Springs with 15. These seismometers were necessary to provide more accurate data linking stimulation activities with seismicity. Though Calpine only added four seismometers, they would be added to a much larger network of 29 seismometers already located at the Geysers. Though the BRP project was located near the Geysers, the EA does not specify that the larger network of seismometers would be used to monitor activities at the project site.

These seismometers offer continuous data of seismic activities, and each project was required to submit daily reports during stimulation to specified agencies such as the BLM, DOE, and local government entities. In the case of Brady Hot Springs, the developer was required to publish this seismicity data for public consumption via an online website. Calpine was required to update software to more effectively identify and map epicenters of seismic activity.

Three of the four projects were also required to install new, or monitor existing, ground acceleration detectors in certain populated areas, generally within 30 miles of the project. Brady

Hot Springs was required to install a detector in the nearby (20 miles away) populated area of Fernley, Nevada. Similarly, Calpine was required to monitor existing detectors at two nearby communities (Cobb and Anderson Springs), and Newberry was required to monitor activity at the Paulina Lake Visitors Center.

Prior to conducting stimulation activities, three of the four (excluding BRP) projects were required to notify certain community groups, agencies, and/or local governments such as advisory or emergency planning committees. In the case of Newberry, developers were also required to provide notice in local newspapers and hold monthly public meetings to allow citizens the ability to seek additional information or report concerns.

With Newberry's proximity to nearby structures, infrastructure, and geography it was required to adopt several other unique measures. The developer was required to install crack monitors on a nearby bridge, monitor cracking at a dam, evaluate the vulnerability of 52 assets around the project, purchase liability insurance, and install rock and avalanche hazard signs on specified roadways near the project.

Though BRP was not required to adopt many of these mitigation measures, the lead agency in the NEPA process, the BLM, did request that the developer submit a complete operation plan prior to construction to ensure that the project did not require further monitoring than the aforementioned seismometer.

4.3 Stimulation and post-stimulation mitigation activities

The level of mitigation required once stimulation of the wells begins varied significantly between the four projects reviewed as a part of this memorandum. The projects varied from specifying no specific mitigation measures for seismic events under M3.0 (BRP) to using diverters to shift stimulation to another zone if 6 monitors shallower than 6,000 feet measured an event greater than M1.0 (Newberry). The lack of consensus on stimulation mitigation activities was most significant for the *threshold* at which the project was required to halt injection completely. The Newberry EGS project required halting all injection into the well when stimulation produced an event greater than M3.5, or where ground shaking readings were at least 0.028 g PGA, while the Brady Hot Springs project required a halt to all injection for any event greater than M2.5 or where ground shaking readings were at least 0.02 g or 10 readings of 0.002 g. By comparison, BRP and Calpine did not require halting injection at all, with both projects' mitigation measures only discussing adjusting the volume of pressure or location for events that were M3.0 or greater (BRP) or where wells were determined more susceptible to induced seismicity through analyzing well data (Calpine). Further, neither the BRP nor Calpine projects included any mitigation measures based on PGA readings from ground shaking.

In addition, likely due to Newberry's proximity to Newberry National Volcanic Monument, this was the only project that specifically called for stimulation requirements to include a website for how to report damage as well as notification to nearby visitors and home owners after induced seismic events occur.

5. Conclusion

This review of NEPA documents for four geothermal injection or EGS projects (Table 4) reveals the variety of approaches to analyzing and mitigating induced seismicity. With the exception of the Geysers, where induced seismicity has been observed and monitored for an extended period of time due to large volumes of water being piped in to recharge the hydrothermal reservoir, induced seismicity caused by geothermal projects is a relative new area of study.

As this review highlights, determining the level of mitigation required for induced seismic events has varied based on project location, when the review took place, whether the project utilized the IEA or DOE IS protocols, and the federal agency conducting the review. While the NEPA reviews were relatively consistent for seismic monitoring and historical evaluation of seismic events near the project location, the requirements for public outreach and mitigation for induced seismic events once stimulation has begun varied considerably between the four projects. Not all of the projects were required to notify specific community groups or local government entities before beginning the project and only one of the reviews specifically stated the project proponent would hold meetings with the public to answer questions or address concerns.

Table 4: Project Summaries

Project	Action	Use of IS Protocol	Monitoring	Mitigation Trigger	Seismic Results
Newberry Volcano EGS Demonstration Project EA;	EGS test project using hydroshearing to stimulate the reservoir with injection pressure of 1,160 to 2,500 psig at 6,500 to 10,000 feet	IEA IS Protocol and components of the Draft DOE IS Protocol	Two new seismic monitoring stations; 20 pre-existing seismic monitoring devices installed at wells, boreholes, and surface stations	M1.0 shallower than 6,000 feet detected by at least 6 monitors or any seismic event greater than or equal to M2.0	174 total seismic events; Largest seismic event M2.39
Bottle Rock Power Steam Project EIR/EA	Drill new wells to expand existing hydrothermal power plant from 18 MW to 55 MW	No	Installation of new seismometer and utilization of existing system of seismometers	None stated. BLM and Lake County can re-evaluate if seismic events greater than M3.0 occur.	No conclusive evidence of increased seismicity
Brady Hot Springs Well 15-12 Hydro-Stimulation EA	EGS test project at existing production well and well pad; Hydraulic stimulation at 1,400 psig at 4,000 to 5,000 feet	DOE IS Protocol	Fifteen new microseismic monitoring stations (6 on surface, 9 in boreholes at depths up to 300 ft); Use of existing ground motion detector in nearest town	M2.5 or a single reading of 0.002g PGA ; 10 readings per day over 0.0002g PGA	403 total seismic events; No seismic event M2.5 or greater
Calpine Enhanced Geothermal Systems Project EA.	Injection of cool water at 100-800 gpm to enhance permeability of an existing high temperature reservoir through alteration of existing exploratory wells	IEA Protocol	Four new seismic monitoring stations; Use of 29 existing seismic monitoring station Use of two accelerograph stations in nearby communities	Analyze well data to see which wells are more susceptible to induced seismicity and decrease injection rate at wells with higher levels of felt seismicity	8 seismic events greater than M2.5; Largest seismic event M3.74

During the stimulation phase, while all of the projects required active monitoring and reporting of seismic events, multiple projects did not include specific requirements to halt injection if specific magnitude or groundshaking thresholds are met. In addition, these same projects failed to specify the exact mitigation measures that would be required for seismic events above a certain magnitude.

Moving forward, this NEPA review in combination with other activities completed under the induced seismicity task, including an induced seismicity check-list and associated guidance document, will enable the BLM to draft technical guidance on how to implement the DOE IS protocol within the BLM NEPA process to address concerns associated with geothermal induced seismicity.

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BLUE OCEAN PRESERVATION SOCIETY, a Hawaii non-profit corporation; Sierra Club, a California non-profit corporation; and Greenpeace Foundation, a Hawaii non-profit corporation, Plaintiffs, v. James D. WATKINS, Secretary Department of Energy, et al., Defendants.

Civ. No. 90–00407 DAE.
|
Jan. 8, 1991.

Synopsis

Environmental groups brought action to compel federal government to prepare environmental impact statement (EIS) covering development of geothermal energy on Hawaii before proceeding further with that development. Defendant federal departments and agencies moved for summary judgment and environmental groups cross moved for partial summary judgment. The District Court, David A. Ezra, J., held that: (1) even if the four phases of project for development of geothermal energy on Hawaii were considered separate actions triggering separate National Environmental Policy Act (NEPA) obligations, the four phases were sufficiently connected to require that they all be evaluated in single EIS; (2) where agency is arguing that it has no obligation to do anything under the NEPA, court cannot presume that agency is at the same time carrying out environmental assessments required by NEPA; (3) genuine issues of material fact remained regarding the government's commitment to implementation of phase three of Hawaii project designed as Hawaii geothermal resource verification and characterization program and as to Department of Energy's (DOE's) role with respect to $5 million federal appropriation for project, so as to preclude summary judgment on whether action to compel compliance with the NEPA was ripe; and (4) Hawaii project constituted “major federal action” for purposes of the NEPA, although government described involvement of salaried federal officials as tangential.

Environmental groups' motion granted.

West Headnotes (13)

[1] **Federal Civil Procedure** Presumptions

In ruling on motion for summary judgment, federal district court views facts and inferences in light most favorable to nonmoving party.

1 Cases that cite this headnote

[2] **Federal Civil Procedure** Burden of proof

If party moving for summary judgment meets its burden of identifying those portions of materials that party believes demonstrate absence of any genuine issue of material fact, then opposing party may not defeat motion for summary judgment in absence of any significant probative evidence tending to support his legal theory; opposing party cannot stand on its pleadings, nor can it simply assert that it will be able to discredit movant's evidence at trial.

47 Cases that cite this headnote

[3] **Federal Civil Procedure** Absence of genuine issue of fact in general

No genuine issue of fact precluding summary judgment exists if party opposing summary judgment fails to offer evidence sufficient to establish existence of element essential to that party's case.

49 Cases that cite this headnote

[4] **Federal Civil Procedure** Absence of genuine issue of fact in general

Genuine issue of material fact precluding summary judgment does not exist if on record as a whole rational trier of fact could not find in favor of nonmoving party.

7 Cases that cite this headnote

[5] **Environmental Law** Particular Projects

Even if the four phases of project for development of geothermal energy on Hawaii were considered separate actions triggering separate National Environmental Policy Act (NEPA) obligations, the four phases were sufficiently connected to require that they all be evaluated in single environmental impact statement (EIS); phases included Hawaii geothermal resource assessment program, Hawaii deep water cable program, Hawaii geothermal resource verification and characterization program, and construction of commercial Hawaii geothermal project, and the first three phases did not possess any real independent utility, so the four phases qualified as "connected actions." National Environmental Policy Act of 1969, § 2 et seq., 42 U.S.C.A. § 4321 et seq.

1 Cases that cite this headnote

[6] **Environmental Law** Scope of project; multiple projects

Regulation governing scope of environmental impact statements (EIS) that defines connected actions through three subdivisions would be construed to read subdivisions in the disjunctive, rather than in the conjunctive.

1 Cases that cite this headnote

[7] **Environmental Law** Mootness

Any attempt to have considered in comprehensive environmental impact statement (EIS) geothermal energy project development phases which had already been completed was moot, although the completed phases were actions connected with uncompleted phases that should be the subject of a single EIS.

[8] **Environmental Law** Mootness

Where decision has already been made and carried out and action taken cannot be undone, environmental impact statement (EIS) has no function or role and any suit to compel EIS at that point is moot.

[9] **Environmental Law** Particular Projects

Proposal sufficient to trigger environmental impact statement (EIS) with respect to phase three of Hawaii geothermal energy development program designed as Hawaii geothermal verification and characterization program existed;

decision to commit $5 million of federal funds to phase three of project had already been made, agency had goal of implementing phase three with ultimate goal of seeing phase four designed as construction of commercial Hawaii geothermal project through, and $5 million congressional appropriation would be considered made to fund already proposed federal action characterized as phase three.

[10] **Environmental Law** Assessments and impact statements

Where agency is arguing that it has no obligation to do anything under the National Environmental Policy Act (NEPA), court cannot presume that agency is at the same time carrying out environmental assessments required by NEPA. National Environmental Policy Act of 1969, § 2 et seq., 42 U.S.C.A. § 4321 et seq.

[11] **Environmental Law** Ripeness

Any presumption of regularity that might apply in determining whether suit to compel environmental impact statement (EIS) was ripe was waived or vitiated by Government's claim that it had no duty under the National Environmental Policy Act (NEPA) with respect to Hawaii geothermal energy development project. National Environmental Policy Act of 1969, § 2 et seq., 42 U.S.C.A. § 4321 et seq.

1 Cases that cite this headnote

[12] **Federal Civil Procedure** Environmental law, cases involving

Genuine issues of material fact remained regarding the government's commitment to implementation of phase three of Hawaii geothermal energy development project designed as Hawaii geothermal resource verification and characterization program and as to Department of Energy's (DOE's) role with respect to $5 million federal appropriation for project, so as to preclude summary judgment on whether action to compel compliance with the National Environmental Policy Act (NEPA) was ripe. National Environmental Policy Act of 1969, § 2 et seq., 42 U.S.C.A. § 4321 et seq.

1 Cases that cite this headnote

[13] **Environmental Law** Particular Projects

Hawaii geothermal energy development project constituted "major federal action" for purposes of the National Environmental Policy Act (NEPA), although government described involvement of salaried federal officials as tangential; the first three of four phases received $10.7 million, $24 million, and $5 million with two additional installments of $5 million from federal funds, and federal Government would be heavily involved in permitting role in fourth phase of project. National Environmental Policy Act of 1969, § 2 et seq., 42 U.S.C.A. § 4321 et seq.

1 Cases that cite this headnote

Attorneys and Law Firms

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Daniel A. Bent, U.S. Atty., Linda J. Joachim, Asst. U.S. Atty., Honolulu, Hawaii, and Gary B. Randall, Atty., U.S. Dept. of Justice, Washington, D.C., for defendants.

ORDER DENYING DEFENDANT UNITED STATES' MOTION FOR SUMMARY JUDGMENT AND GRANTING PLAINTIFFS' MOTION FOR PARTIAL SUMMARY JUDGMENT

DAVID A. EZRA, District Judge.

I. Introduction

This is an action brought by three environmental groups ("Plaintiffs") seeking to compel the federal government to prepare an Environmental Impact Statement ("EIS") covering the development of geothermal energy on the Island of Hawaii (the "Big Island") before proceeding further with that development. Defendant federal departments and agencies (collectively the "Government") have moved for summary judgment on the grounds that Plaintiffs' claim is not ripe, and that this court therefore lacks subject matter jurisdiction. Plaintiffs have filed a cross-motion for partial summary judgment on the issue of whether the geothermal project constitutes "major federal action" within the meaning of 42 U.S.C. § 4332(2)(C). This motion presents a major question for resolution in this action.

II. Factual Background

A. The 4–Phase Hawaii Geothermal Project

In 1978, in order to encourage the commercial development of geothermal energy, the State of Hawaii, with the cooperation of Congress and the Department of Energy, began the Hawaii Geothermal Project (the "Project"). It was envisioned that the ***1453** Project would be carried out in four stages: (1) the Hawaii Geothermal Resource Assessment Program ("Phase I"), (2) the Hawaii Deep Water Cable Program ("Phase II"), (3) the Hawaii Geothermal Resource Verification and Characterization Program ("Phase III"), and (4) Construction of the Commercial Hawaii Geothermal Project ("Phase IV"). The Project was intended to provide large quantities of electric power,[1] generated by geothermal energy plants on the side of the Big Island's Kilauea volcano, and transported to the islands of Maui and Oahu via underwater and overland cable. The early phases were to be carried out primarily with public funds to remove the uncertainty and risk, and thereby encourage private investors to undertake the ultimate Project development (Phase IV).

Phase I was jointly funded by the State of Hawaii and the U.S. Department of Energy ("DOE"), with the federal government contributing $10.7 million, 80% of the total funding. It resulted in the drilling of one geothermal well and the establishment of a small 2.5 megawatt demonstration plant (recently closed down) in the Puna district on the Big Island. Phase I provided important data on the geothermal resource base and has now been completed.

Phase II, the Deep Water Cable Program, was a study of the feasibility of transmitting electricity via a submarine cable system from the Big Island to Maui and Oahu. The federal government provided over $24 million (83% of total cost) for the research, design, construction and routing of an undersea cable. This included not only generic cable development research, but also site-specific route surveys between the islands as well as actual test-laying of cable on site. At-sea tests have been finished and this phase is essentially completed.

In conjunction with these first two phases of the Project, the Hawaii legislature has enacted a series of laws designed to further the Project, which it terms a "federal/state partnership effort." *See* the 1988 Act, discussed *infra* at Section II.B. These include laws granting favorable excise tax treatment to sellers of geothermal energy (1978–Act No. 135), designating geothermal subzones for development purposes (1983–Act No. 296), and granting agency authority to set geothermal royalty rates (1985–Act No. 138).

Phase III has now begun, with Congress having already appropriated $5 million of federal funds toward it. It involves the drilling of 25 commercial scale exploration wells throughout the Kilauea East Rift Zone to "verify" the geothermal resource. As a preliminary matter in this phase, two slim-bore scientific observation holes have, at state (not federal) expense, already been drilled. Completion of Phase III will clear the way and set forces in motion for the private construction of the full-scale 500 megawatt project, which is Phase IV.[2]

B. The Geothermal and Cable System Development Permitting Act of 1988

In 1988, to further accelerate and facilitate the Project, the Hawaii legislature enacted the "Geothermal and Cable System Development Permitting Act" (the "1988 Act"), codified at H.R.S. §§ 196D–1, *et seq.* The 1988 Act is designed primarily to streamline the approval and permit process.

The 1988 Act defined the Project in terms of its ultimate goal (Phase IV), and ***1454** specifically recognized the interdependence of its two fundamental components:

> (7) The *fundamental interrelationship between the development of geothermal resources and a cable system* and the magnitude of the cost to undertake each of these developments clearly indicate that *neither will be undertaken without the firm assurance that the other also will be undertaken in a synchronized and coordinated manner* to enable both developments in substance to be completed concurrently....

H.R.S. § 196D–2 (emphasis added).

In addition, the 1988 Act established the Interagency Group, a body with representatives from each agency deemed to have jurisdiction or permitting authority over some aspect of the Project. Under the statute, eight state agencies were represented and eight federal agencies (all of whom are named defendants) were invited to join the group. All eight accepted the invitation, and seven sent representatives to some or all of the meetings of the Interagency Group.[3]

The Interagency Group's mission is to consolidate and streamline the permitting process for the Project. The purpose is to overcome the daunting array of federal, state and local permits and processes that have discouraged potential commercial developers. The Group has compiled a master list of necessary permits, and it is expected that it will be involved in establishing a timetable for regulatory review, conducting necessary hearings, and consolidating governmental activities.

C. The Extent of Federal Involvement in the Project

In addition to the contribution of federal funds, and the arguably significant role various federal agencies and officials have played as part of the Interagency Group, the federal government has been involved in the Project in a number of other ways.

As early as 1978, DOE contracted with a private consultant for a "Direct Use Overview for Hawaii and Total Use Scenario for Puna (HI)."[4] The purpose of the resulting report is stated in its Summary:

> As a means of accelerating the environmentally acceptable use of geothermal resources in the State of Hawaii, this report presents an overview of the potential for direct utilization (non-electric) in the state and a scenario for development to the year 2020 of the most promising prospect—Puna, on the Big Island of Hawaii.

This document, commissioned by DOE, sets forth a series of recommendations for the development of geothermal energy in the Puna district. It has provided groundwork and guidance for much of the Project.

DOE has provided planning and financial assistance in a number of actions aimed at driving commercial geothermal development forward, independent of its participation in the phases of the Project itself. Plaintiffs have submitted a list of 21 DOE-sponsored reports, funded by DOE contracts, that deal specifically with geothermal energy development *in Hawaii.* In addition, when the state passed legislation for the designation of resource subzones, DOE provided most of the funding for the necessary geothermal resource assessment and impact analysis.

More recently, Patricia Port, Regional Environmental Officer for the U.S. Department of Interior conducted two meetings in October 1989 and June 1990 with state officers and the National Park Service, the Fish and Wildlife Service, and the U.S. Geological Survey. These meetings monitored progress on the Hawaii Geothermal ***1455** Project Master Plan, and were designed to share information on agency concerns so the Master Plan could be adjusted to mitigate such concerns and facilitate expeditious implementation. A third such meeting was scheduled for December 1990.

Additionally, it appears that every federal agency named as a defendant in this action will have some role in permitting the Project when it reaches Phase IV.

The Government's role in the Project has not gone unacknowledged. As already noted, in the 1988 Act, the Hawaii legislature described the Project as a "federal/state partnership." This "partnership" characterization of the Project has been echoed a number of times in various contexts.

The 1990 Proposal to Congress for funding for Phase III utilized the heading: "HAWAII GEOTHERMAL PROJECT: A Federal–State–Private Partnership Leading Toward Commercialization." That Proposal explained that "[a] government-private-partnership is ... necessary to prove the resource and allow private commercial development to go forward."

In May 1990 U.S. Senator Daniel Inouye sent a letter to one of his colleagues regarding the 1990 Proposal in which he stated that the total funding of Phase III would "be divided equally between the private sector and a *State and Federal government partnership.*" (Emphasis added.)

In January 1990, DOE held a hearing in Honolulu on "National Energy Strategies." At this meeting, the Director of Hawaii's Department of Business and Economic Development ("DBED") confirmed its request to DOE of $15 million (spread over three years in $5 million increments) for Phase III. The Director stated: "This is an excellent example of government money, *state and federal,* being used in a good way: as seed money to prepare the way for the private sector to do the project with reduced risk." At this hearing, the state made a specific plea for DOE's continued support of and participation in the Project.

This "continuation" theme is also reflected in the record. Governor Waihee, in letters to the House and Senate Appropriation Committees, requested "continuation of the federal assistance for the Hawaii geothermal research and development project through the funding of [Phase III]." Similarly, the 1989 and 1990 Proposals ask that "the Federal government continue its support of the Hawaii Geothermal Project by joining the State and private developers in financing [Phase III]."

III. Summary Judgment Standards

[1] Summary judgment is proper when there is no genuine issue of material fact and the moving party is entitled to judgment as a matter of law. Fed.R.Civ.P. 56(c); *Retail Clerks Union, Local 648 v. Hub Pharmacy, Inc.,* 707 F.2d 1030 (9th Cir.1983). In ruling on a motion for summary judgment, this court views the facts and inferences in the light most favorable to the non-moving party. *Id.*

[2] The moving party has the initial burden of "identifying for the court those portions of the materials on file in the case that it believes demonstrate the absence of any genuine issue of material fact." *T.W. Elec. Serv., Inc. v. Pacific Elec. Contractors Ass'n,* 809 F.2d 626, 630 (9th Cir.1987) (citing *Celotex Corp. v. Catrett,* 477 U.S. 317, 323, 106 S.Ct. 2548, 2552, 91 L.Ed.2d 265 (1986)). If the moving party meets its burden, then the opposing party may not defeat a motion for summary judgment in the absence of any significant probative evidence tending to support his legal theory. *Commodity Futures Trading Comm'n v. Savage,* 611 F.2d 270, 282 (9th Cir.1979). The opposing party cannot stand on its pleadings, nor can it simply assert that it will be able to discredit the movant's evidence at trial. *See T.W. Elec.,* 809 F.2d at 630.

[3] **[4]** There is no genuine issue of fact if the opposing party fails to offer evidence sufficient to establish the existence of an element essential to that party's case. *Celotex,* 477 U.S. at 322, 106 S.Ct. at 2552. There is also no issue of fact if on the record as a whole, a rational trier of fact could not find in favor of the non-moving ***1456** party. *Taylor v. List,* 880 F.2d 1040, 1045 (9th Cir.1989).

IV. Statutory Background—The National Environmental Policy Act ("NEPA")

Section 102(2)(C) of NEPA requires federal agencies to prepare and file an EIS before undertaking "major federal action significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C). In *Baltimore Gas & Electric v. Natural Resources Defense Council,* 462 U.S. 87, 97, 103 S.Ct. 2246, 2252, 76 L.Ed.2d 437 (1982) the U.S. Supreme Court identified the twin aims of NEPA: (1) it obligates the agency " 'to consider every significant aspect of the environmental impact of a proposed action;' and (2) it ensures that the agency will inform the public that it has considered such environmental concerns in its decisionmaking process." (quoting *Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc.,* 435 U.S. 519, 553, 98 S.Ct. 1197, 1216, 55 L.Ed.2d 460 (1978)). NEPA does not indicate the weight that should be given such environmental concerns. It requires "only that the agency take a 'hard look' at the environmental consequences before taking a major action." *Baltimore Gas,* 462 U.S. at 97, 103 S.Ct. at 2252.

This case raises issues concerning what prompts or triggers NEPA obligations, what is the proper scope of the EIS, and, most importantly at this stage in the proceedings, *when* an EIS is required and *when* can it be compelled by legal action.

V. The Government's Summary Judgment Motion

The Government has moved for summary judgment on the grounds that the court lacks subject matter jurisdiction. Specifically, the Government contends that the suit to compel an EIS is moot with respect to Phases I and II since those are completed actions, and that it is unripe with respect to Phases III and IV because no specific proposal has been advanced for either of them.

[5] A fundamental issue on the Government's ripeness argument is whether the Project can and/or should be treated as a single project for NEPA purposes. The Government's ripeness arguments presuppose that the Project is nothing but four separate, independent projects, each subject to a separate NEPA analysis. Plaintiffs' entire lawsuit, in contrast, presupposes that the several phases of the Project should be aggregated and that an EIS should issue for the Project as a whole.

The characterization of the Project is critical to this court's inquiry because the Government's contention that Plaintiffs' suit for an EIS is moot with respect to Phases I and II and unripe with respect to Phases III and IV makes sense only if the four phases are properly treated as separate actions under NEPA. If, as Plaintiffs contend, they are merely components of one "major federal action," Plaintiffs' suit to compel an EIS for that action is neither moot nor unripe. It would not be moot since so much of the Project remains to be done, and it would not be unripe since the Project has already been partially implemented.[5]

The court finds that there is insufficient evidence in the record to support a finding, at summary judgment, that the Project is and always was a single, integrated, action with a solitary purpose: the construction of a 500 megawatt geothermal plant in Puna. It is difficult to glean from the evidence presented just how clearly and specifically the latter phases were defined at the time Phase I was proposed and implemented in 1978. Accordingly, there remain issues of fact as to whether the Project was and is, in actuality, a single project with a single goal, or whether it began as mere background research projects that did not ripen into a proposal for a full-scale geothermal energy plant until sometime later. This issue cannot, therefore, be resolved by summary judgment.

Even accepting the Government's contention that the four separate phases of the Project are distinct actions, however, the court nonetheless finds that the Government ***1457** is not entitled to summary judgment. The reasoning is set forth below.

A. The Four Phases As "Connected Actions"

Even if the four phases of the Project are considered separate actions triggering separate NEPA obligations, those four actions (or phases) are sufficiently "connected" to require that they all be evaluated in a single EIS.

[6] The regulation that governs the scope of EISs specifically provides for the consideration of:

> (1) Connected actions, which means that they are closely related and therefore should be discussed in the same impact statement. Actions are connected if they:
>
> (i) Automatically trigger other actions which may require environmental impact statements.
>
> (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.
>
> (iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

40 CFR § 1508.25(a).

Although the three subsections are connected by neither "and" nor "or," it appears that they should be read in the disjunctive rather than the conjunctive. They are separated by periods, suggesting that each or any of the three criteria should be sufficient, standing alone, to make the actions "connected." The case law interpretations of the regulation have been consistent with this, having treated the separate subsections as sufficient conditions, not necessary conditions. *Hudson River Sloop Clearwater v. Dept. of Navy,* 836 F.2d 760, 763 (2d Cir.1988) (noting that "[o]nly subdivisions (ii) and (iii) are at issue here," and then proceeding to analyze the applicability of those subdivisions); *Town of Huntington v. Marsh,* 859 F.2d 1134, 1142 (2d Cir.1988) (finding the actions to be connected based solely on the satisfaction of subdivision (iii)) (citing *Save the Yaak Committee v. Block,* 840 F.2d 714, 719 (9th Cir.1988)).

In this case, subsection (i) clearly does not apply, subsection (ii)'s applicability is arguable, and subsection (iii) appears to contemplate these facts precisely. The latter two provisions will be discussed in turn.

1. *Connected Actions Under Subsection (ii)*

> *Actions are connected if they:*
>
> ....
>
> *(ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.*
>
> *40 CFR § 1508.25(a)(1).*

Under subsection (ii), it seems clear that Phase IV could never proceed unless Phases I–III were undertaken previously. Thus, subsection (ii) arguably applies. The Second Circuit has suggested, however, that the proper inquiry under (ii) is not whether the more remote action can proceed absent the more immediate action, but rather whether the more immediate action can proceed absent the remote action.[6]

In *Hudson River Sloop Clearwater v. Dept. of Navy,* 836 F.2d 760 (2d Cir.1988), conservation groups sued to stop development of a Navy battleship homeport until the Navy filed an EIS that also considered the accompanying proposal for the construction of housing to serve the homeport. The court observed:

> With respect to subdivision (ii), the district court concluded that the actions in this case are connected because the "construction of the family housing will not proceed unless the operational aspects of the homeport are built." We deem the issue presented, however, to be whether the converse is true. In other words, will the operational aspects of the homeport proceed without the construction of family housing?

***1458** 836 F.2d at 763. Concluding that the homeport would proceed whether or not the housing project could be approved, the court ruled that, under subsection (ii), the two actions were not connected.[7]

Following the Second Circuit, the issue is not whether Phase IV could go forward without Phases I–III, but rather whether the earlier Phases could go forward without Phase IV ever being implemented. When characterized this way, it seems clear that the answer is yes. Indeed, Phases I and II have already been completed without any guarantee that Phase IV will ultimately be implemented. Moreover, the actual language of subsection (ii) suggests that it has *no* applicability when the more remote action *follows* the more immediate action:

> Actions are connected if they:
>
> ....
>
> (ii) Cannot or will not proceed unless other actions are taken *previously* or *simultaneously.*

40 CFR § 1508.25(a)(1) (emphasis added). Under this characterization, the various phases would not be "connected actions" under subsection (ii).

It is clear, however, that the two major components of the Project, the cable construction and the geothermal power plant construction, *are* necessary to each other. The 1988 Act stated:

> (7) The *fundamental interrelationship between the development of geothermal resources and a cable system* and the magnitude of the cost to undertake each of these developments clearly indicate that *neither will be undertaken without the firm assurance that the other also will be undertaken in a synchronized and coordinated manner* to enable both developments in substance to be completed concurrently....

H.R.S. § 196D–2 (emphasis added). In a sense, therefore, the work related to either of those components "will not proceed" unless there is development of the other component. This argument, somewhat strained under the language of subsection (ii), is more squarely advanced as an application of subsection (iii), *infra.*

2. *Connected Actions Under Subsection (iii)*

> *Actions are connected if they:*
>
> ....
>
> *(iii) Are interdependent parts of a larger action and depend on the larger action for their justification.*
>
> *40 CFR § 1508.25(a)(1).*

This provision describes the facts before the court accurately. Phases I–III appear to have been conceived for the sole purpose of bringing about Phase IV, and depend on Phase IV and each other for their justification.

Although the Ninth Circuit has never *explicitly* relied on subsection (iii) in finding actions to be connected for NEPA purposes, it has repeatedly applied a virtually identical standard. It has, for example, specifically defined the interdependence that must exist between the various phases of a larger project if they are to be deemed connected:

> The dependency is such that it would be irrational, or at least unwise, to undertake the first phase if subsequent phases were not also undertaken.

Save the Yaak Committee v. Block, 840 F.2d 714, 719–20 (9th Cir.1988) (quoting *Trout Unlimited v. Morton,* 509 F.2d 1276, 1285 (9th Cir.1974)). The standard has been alternatively stated (as applied to a highway project) as follows:

> [T]he environmental impacts of a single highway segment may be evaluated separately from those of the rest of the highway only if the segment has "independent utility."

Thomas v. Peterson, 753 F.2d 754, 759 (9th Cir.1985) (summarizing the holding of *Daly v. Volpe,* 514 F.2d 1106, 1110 (9th Cir.1975)); *see also Fritiofson v. Alexander,* 772 F.2d 1225, 1242 (5th Cir.1985) (" 'Connected ***1459** actions' are defined in a manner consistent with the criteria recognized in the independent-utility cases.").[8]

The Ninth Circuit elaborated on the application of this "independent utility" test in *Thomas v. Peterson,* 753 F.2d at 759–60:

> In the light of *Trout Unlimited,* the phrase "independent utility" means utility such that the agency might reasonably consider constructing only the segment in question.

In *Thomas,* there were two proposals: one for timber harvesting and sales, and another for construction of a road into the area to be harvested. The Ninth Circuit ruled that because the harvesting could not be done without construction of the road, and because the road did not have any significant utility other than to facilitate the harvesting, NEPA required a single EIS covering both the road and the timber sales. *Id.; see also Morgan v. Walter,* 728 F.Supp. 1483, 1493 (D.Idaho 1989) (David A. Ezra, District Judge) (Proposed diversion of river and proposed fish propagation facility are "connected actions" because "the fish propagation facility could not exist absent a diversion" and because the diversion was proposed for the purpose of facilitating fish propagation.).

On the facts before this court, Phases I–III do not possess any real independent utility. If Phase IV were not a possibility, it would clearly be "irrational, or at least unwise" to proceed with Phases I–III. *Trout Unlimited,* 509 F.2d at 1285. The Government could not "reasonably consider" going ahead with the deep water cable research and construction if there were no geothermal energy development to utilize the cable. *Thomas,* 753 F.2d at 760. Neither would the geothermal energy be developed if there were no cable project to convey the power generated. *See* the 1988 Act, H.R.S. § 196D–2. The facts of *Thomas*—timber project and access road—are analogous. Most significantly, there is no "independent utility" to the drilling of 25 commercial size wells to "verify" a geothermal resource (Phase III); that action is "irrational" absent imminent construction of a geothermal power plant (Phase IV).

Accordingly, even if the Project is properly characterized as four separate phases, the court would hold that those four phases are "connected actions" under NEPA regulations, and should be the subject of a single EIS.[9]

B. Mootness

[7] Even though the actions are connected, Phases I and II have already been completed. Any attempt to have those actions considered in a comprehensive EIS is, therefore, moot.[10]

[8] As discussed above in Section IV, NEPA's function is to assure that adequate information is provided at the decision-making stage on a proposed action.

> [T]he basic function of an EIS is *to serve as a forward-looking instrument* to assist in evaluating "proposals" for major federal action....

***1460** *National Wildlife Fed. v. Appalachian Reg. Commission,* 677 F.2d 883, 889 (D.C.Cir.1981) (quoting *Aertsen v. Landrieu,* 637 F.2d 12, 19 (1st Cir.1980) (citing *Kleppe v. Sierra Club,* 427 U.S. 390, 410 n. 20, 96 S.Ct. 2718, 2730 n. 20, 49 L.Ed.2d 576 (1975))) (emphasis supplied by the *Appalachian* court).

Where the decision has already been made and carried out, and the action taken cannot be undone, there is absolutely no function or role for an EIS. Any suit to compel an EIS at that point is, perforce, moot. *Sierra Club v. Penfold,* 857 F.2d 1307, 1317–18 (9th Cir.1988) (suit challenging mining operations; the suit for an EIS is moot because "no adequate remedy exists.... [A] completed mining project cannot be moved," distinguishing *Columbia Basin Land Protection Assoc. v. Schlesinger,* 643 F.2d 585, 591 n. 1 (9th Cir.1981) (suit over placement of power lines is not moot since the court could order that the power line be moved)); *see also Friends of the Earth, Inc. v. Bergland,* 576 F.2d 1377, 1378–79 (9th Cir.1978) (claim is moot because the challenged mining project ended before the appeal was heard); *Ogunquit Village Corp. v. Davis,* 553 F.2d 243, 246–47 (1st Cir.1977) (courts cannot provide post-completion relief under NEPA).

Thus, whatever EIS might ultimately be ordered if Plaintiffs are successful in this suit can be directed only toward the remaining work to be done.

> [W]hen a NEPA challenge is leveled against some subsequent phase of a continuing federal action, the EIS obligation attaching at the latter point is realistically qualified by the elements of the program already in place. This limitation simply confines NEPA's mandatory decisionmaking input to programs posing options that may still freely be chosen.

Appalachian, 677 F.2d at 890. The actions taken in Phases I and II are complete and cannot be made the subject of any EIS; rather their effects should be incorporated into the background "data base" for assessment of the phases still at issue. *See Coalition on Sensible Transp., Inc. v. Dole,* 826 F.2d 60, 70 (D.C.Cir.1987).

C. Ripeness

As to the remaining phases, the Government contends that there is no proposal yet before it, and that the suit to compel an EIS is therefore unripe. Coupled with this contention is the Government's promise that the appropriate environmental assessment will be done for Phase III before that project is undertaken. These alternative, if somewhat inconsistent, arguments will be considered in turn.

1. *The Proposal Requirement—Triggering the NEPA Duty*

[9] It is now well settled that an EIS cannot be required unless and until a "proposal" is made. *Kleppe v. Sierra Club,* 427 U.S. 390, 96 S.Ct. 2718, 49 L.Ed.2d 576 (1975). In *Kleppe,* the Department of Interior was involved in leasing government property to be mined, and the Sierra Club sought to compel an EIS for the entire region then being leased. The Court of Appeals found that the Department "contemplated" a regionwide plan or program, even though its only activity had been the entering of individual leases, and ordered that an EIS be prepared. The Supreme Court reversed, saying that the statute does not require an EIS until an agency makes a report or recommendation on a *proposal.* Whether or not regionwide action was contemplated, there was no *proposal* for such regionwide action, and the EIS could not be compelled. *See also Aberdeen & Rockfish R. Co. v. SCRAP,* 422 U.S. 289, 320, 95 S.Ct. 2336, 2356, 45 L.Ed.2d 191 (1974) ("[T]he time at which the agency must prepare the final [environmental impact] 'statement' is the time at which it makes a recommendation or report on a *proposal* for federal action.") (emphasis in original); *B.R.S. Land Investors v. United States,* 596 F.2d 353, 355 (9th Cir.1979) (utility applied for federal approval for high-tower power lines over federal land; although there had been "preliminary discussions" on the application, there was no federal action sufficient to trigger NEPA).

Despite its attempt to establish a bright-line test, the *Kleppe* decision does not dictate ***1461** a clear conclusion in this case. One commentator has observed:

> The Supreme Court's decision in *Kleppe* leaves many questions unanswered. The Court stated that NEPA requires a "precise" decision on whether an agency has "proposed" an action, but it did not define "proposal." ....

Mandelker, *NEPA Law & Lit.* § 8:13 (1990). Indeed this fact pattern does not seem to fit within the parameters contemplated by *Kleppe* or by any other reported decision.

In the more typical scenario, a federal agency considers a private proposal, then issues a report or recommendation on it before the proposed action is taken. *Kleppe* and its progeny clearly establish that the EIS must be completed at the time such report or recommendation is made. If Congressional action is required, the proposal, the report or recommendation, and the EIS all go to Congress for consideration.

In this case, however, the proposal was submitted directly to Congress, and DOE did not issue a report or recommendation on it. DOE's failure to issue such a report or recommendation has already frustrated to some degree NEPA's purposes in that Congress acted on the proposal without being advised or informed of its potential environmental impact. The Government now argues that it may use the appropriated funds to contract for the work comprising Phase III before it can be compelled to look at the environmental consequences of that action.

This approach appears to be in conflict with NEPA's clear intent, as interpreted by the accompanying regulations:

> The [environmental impact] statement shall be prepared early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made.

40 CFR § 1502.5. The Ninth Circuit has joined in this refrain, stressing that "[t]he purpose of an EIS is to apprise decisionmakers of the disruptive environmental effects that may flow from their decisions *at a time when they 'retain[ ] a maximum range of options.'* " *Conner v. Burford,* 848 F.2d 1441, 1446 (9th Cir.1988) (quoting *Sierra Club v. Peterson,* 717 F.2d 1409, 1414 (D.C.Cir.1983)) (emphasis added), *cert. denied sub nom. Sun Exploration and Production Co. v. Lujan,* 489 U.S. 1012, 109 S.Ct. 1121, 103 L.Ed.2d 184 (1989). In any case, the statement "must be prepared before any irreversible and irretrievable commitment of resources." *Conner v. Burford,* 848 F.2d at 1446. The Ninth Circuit has further warned that "delay in preparing an EIS may make all parties less flexible. After major investment of both time and money, it is likely that more environmental harm will be tolerated." *Environmental Defense Fund v. Andrus,* 596 F.2d 848, 853 (9th Cir.1979).

The decision to commit $5 million of federal funds to Phase III of the Project has already been made. It may be, therefore, that some kind of NEPA compliance—an environmental assessment or EIS—may in fact already be due. Nonetheless, the U.S. Supreme Court requires a "proposal."

Although *Kleppe* fails to define "proposal", the regulations provide some assistance in this regard:

> "Proposal" exists at that stage in the development of an action when an agency subject to the Act has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal and the effects can be meaningfully evaluated.... A proposal may exist in fact as well as by agency declaration that one exists.

40 CFR § 1508.23. This definition is plainly geared toward a more general, functional interpretation of the term, not the literal interpretation urged by the Government.

In this case, the agency, DOE, clearly "has a goal" of implementing Phase III, and it is apparent that its ultimate goal is to see Phase IV through. There is evidence that the Department of Interior shares this goal. If DOE is, as it suggests, soliciting or drawing up contracts to perform the work, it "is actively preparing to make a decision on one or more means of accomplishing that goal." The fact that ***1462** DOE has not set forth any written "proposal" is immaterial because "a proposal may exist in fact as well as by agency declaration." *Id.*

The fact that Congress has already appropriated $5 million for Phase III clearly establishes that some kind of proposal has been made. In *National Wildlife Fed. v. Coston,* 773 F.2d 1513 (9th Cir.1985), the Ninth Circuit addressed the significance of appropriations in triggering NEPA obligations. The court held that while the appropriations themselves are not major federal action, *Id.* at 1518, they are the "fund[ing of] actions *already proposed.*" *Id.* at 1518 (quoting *Andrus v. Sierra Club,* 442 U.S. 347, 362, 99 S.Ct. 2335, 2343, 60 L.Ed.2d 943 (1979)) (emphasis added). Because NEPA already applies to, and an EIS duty has already arisen for, the proposed action for which the appropriation is made, any EIS requirement for the appropriation itself would be redundant. *Id.*

Based on this analysis, the $5 million appropriation was made to fund the "already proposed" federal action herein characterized as Phase III. Because a proposal must be deemed to have been made to secure the appropriation, the suit to compel an EIS appears to be, under this approach, clearly ripe. Moreover, because the money has been appropriated, the Government is clearly in the decision-making mode—that in which an EIS is required—deciding precisely how the money will be disbursed and/or how the action will be carried out. There is no risk that the EIS will ultimately prove unnecessary. *See Kleppe,* 427 U.S. at

406, 96 S.Ct. at 2728 (because many "contemplated" projects do not ever ripen into "proposals," EISs for such contemplated projects would be unnecessary wastes of resources). This is a case in which a proposal "exist[s] in fact," whether or not it has ever been formally advanced as such. 40 CFR § 1508.23.

Further, there are additional grounds for finding a "proposal" here. Congress was not acting in a vacuum. It appropriated the money for Phase III in response to an extensive and detailed "Proposal to Establish the Hawaii Geothermal Resource Verification and Characterization Program," prepared by the Hawaii Department of Business and Economic Development, and submitted to Congress by the State of Hawaii in March 1990 (the "Hawaii Proposal"). In light of DOE's significant role in the greater Project, this is clearly a "proposal" sufficient to trigger NEPA obligations.

The Government cannot argue that this was simply a private proposal which it may yet dismiss without any need for an EIS. *See Daingerfield Island Protective Society, Inc. v. Andrus,* 458 F.Supp. 961, 963 (D.D.C.1978) (rejecting plaintiff's contention that "the Government, *prior* to accepting or rejecting a private proposal submitted to it, must have prepared an EIS."). Under the "state/federal partnership" characterization the Project has received, the state's proposal might even be deemed DOE's proposal as well. And even if the Hawaii Proposal could be properly termed a "private proposal," the proposal *has been accepted* by act of Congress, and has now been served into DOE's court with that formal federal imprimatur.

Now that the proposal is before DOE, NEPA requires that work begin on the prescribed environmental assessments. Under the regulations, such work must begin immediately:

> An agency shall commence preparation of an environmental impact statement as close as possible to the time the agency is developing or is presented with a proposal.

40 CFR § 1502.5

To rule that a proposal on which Congress has already acted is not ripe for NEPA purposes, *i.e.,* does not trigger NEPA obligations, would elevate form over substance. A proposal exists since "an agency subject to the Act has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal." 40 CFR § 1508.23. Moreover that proposal has been given Congressional blessing. The time appears to be ripe for preparation of an EIS.

***1463** A separate question remains, however, of whether the time is ripe for an action *to compel* an EIS.

2. *Ripeness of an Action to* Compel *NEPA Compliance*

At the hearing, the Government stressed that federal agencies are entitled to a presumption of regularity, and promised that DOE would take steps to comply with NEPA. Government counsel cited the Declaration of John E. Mock, Director of DOE's Geothermal Division:

> DOE is currently preparing a statement of work for a contract to implement the congressional language cited above. As yet, DOE has not contracted with the State for the verification or characterization work to be performed by the State. Prior to any verification or characterization work being undertaken with these funds, DOE will prepare or have prepared for its evaluation under NEPA the appropriate environmental analysis.

Mock Declaration, ¶ 7.

There is a certain inconsistency in the Government's position, however. In its briefs, and as discussed *supra,* the Government has argued that no proposal has been submitted to DOE, and that no duty to perform an Environmental Assessment accrues until there is both a proposal submitted and a report or recommendation from the agency on that proposal. Government counsel promised that if and when some "triggering" event occurs (*e.g.,* a permit application), the applicable agency will not take action (approve the permit) without first jumping through the necessary NEPA hoops.

Aside from the issue of when NEPA obligations are first triggered is the issue of when an agency's compliance (or noncompliance) with NEPA may be challenged and/or enjoined. By arguing that DOE should be given a chance to comply with NEPA and that the agency is already "in the process" of such review, the Government implicitly admits that NEPA obligations have been triggered. The Government's argument then focuses on the contention that its compliance cannot be challenged or enjoined until the time has come for that compliance to be complete. The Government's position is apparently that no injunction can be sought or issued until the money is transferred or contracts are entered. Until that time, the Government asserts that it is entitled to a "presumption of regularity."

Plaintiffs contend, on the other hand, that there is nothing left for DOE to do in this situation except hand the money over to Hawaii's DBED, and even this transfer is not in DOE's discretion. They argue that because no further federal approvals are necessary before the $5 million is used to commence work on Phase III, there is no date certain by which NEPA compliance must be complete and at which review of such compliance would be any riper than it already is.

a. *The Presumption of Regularity*

The best articulation of the relevant law on an agency's "presumption of regularity" comes from *Conner v. Burford,* 848 F.2d 1441 (9th Cir.1988). *Conner* was a challenge to the sale of oil/gas leases in vast areas of national forest. The suit was based on the government's failure to prepare an EIS as required by NEPA before selling the leases. The court found that the leases contained "no surface occupancy" ("NSO") stipulations prohibiting any surface-disturbing activity, and therefore did not have significant environmental consequences. It concluded that an EIS for such leases could be required only upon the

> [m]odification or removal of an NSO stipulation ..., which ... would constitute an irretrievable commitment of resources requiring the preparation of an EIS.

Conner, 848 F.2d at 1447–48. The court refused to anticipate such alteration of NSO stipulations:

> We cannot assume that government agencies will not comply with their NEPA obligations in later stages of development. *Cf. Citizens to Preserve Overton Park v. Volpe,* 401 U.S. 402, 415, [91 S.Ct. 814, 823, 28 L.Ed.2d 136] (1971) (agency action entitled to presumption of regularity).

***1464** *Id.* at 1448.[11]

Conner relied on *Sierra Club v. FERC,* 754 F.2d 1506 (9th Cir.1985), in which a "preliminary permit" for a hydroelectric project had been issued without conducting an EIS. The court in *Sierra Club* ruled that because the preliminary permit did not authorize any activity on federal land, but functioned simply to maintain the applicant's priority of application for a license, no EIS could be required. *Id.* at 1509. The court observed that "[p]etitioners can only enter federal land and conduct ground-breaking activities after obtaining Forest Service and BLM special use permits." *Id.* Because the court found that action affecting the environment *could not take place* until the permits were issued, the requirements of NEPA could be fully met by conducting the EIS at that later stage.

b. *Where the Agency Denies Any Duty*

In this case, however, the Government has argued that there is/was no proposal before DOE, and there is/was, therefore, nothing for DOE to act on. As discussed above, Government counsel suggested that NEPA obligations would be triggered if a permit were applied for, but refused to speculate as to what, if any, permits might be necessary before work on Phase III begins.

[10] **[11]** Where the agency is arguing that it has no obligation to do anything under NEPA, the court cannot presume that the agency is, at the same time, carrying out the environmental assessments that NEPA requires. Any such "presumption of regularity" is waived or at least vitiated by the Government's contention that it has no NEPA duty whatsoever.

The inquiry does not end here, however, because the Government does not rely solely on its denial of duty argument.

c. *The Point at Which NEPA Compliance May Be Reviewed, Challenged, or Compelled*

[12] The Government has also argued that "DOE is currently preparing a statement of work for a contract to implement the congressional language" and that "the appropriate environmental analysis" will be done before any work on Phase III is undertaken with federal funds. Mock Declaration, ¶ 7. As noted earlier, this argument essentially concedes that NEPA obligations have been triggered, and the issue shifts to the question of when the obligation which presently exists can be compelled.

The "presumption of regularity" suggests that this court should assume that DOE will fully comply with its NEPA obligations, and should not interfere until the time has come for such compliance to be complete. At that point, the court can evaluate the adequacy of the compliance, and compel any actions required by law that have been overlooked. The Government suggests that such a time will not be reached in this case until contracts are entered for the performance of the work contemplated by Phase III.

Even if DOE has a role in contracting for the work in Phase III, however, this suit will not necessarily be unripe. The Ninth Circuit has held that when the agency is committed to implementing a project, a suit to compel NEPA compliance need not be delayed until the contracting stage. In *Environmental Defense Fund v. Andrus,* 596 F.2d 848 (9th Cir.1979), the Department of Interior announced a program for marketing reservoir water for industrial uses. The court ruled that the Plaintiffs need not await the entering of actual contracts:

> Here the Secretary of Interior has no intention of abandoning plans for marketing industrial water and is prepared ***1465** to execute water option contracts. NEPA does not permit delay in assessing the environmental impact of the marketing plan.

Id. at 852.[12] Here, given the $5 million appropriation already made for Phase III, as well as the previous undertaking and completion of Phases I and II, the evidence may show that the Secretary of Energy similarly "has no intention of abandoning plans" to implement that Phase. In such a scenario, under *Andrus,* NEPA will not permit further delay, regardless of whether DOE will later be entering into contracts. *See also Lathan v. Volve,* 455 F.2d 1111, 1121 (9th Cir.1971) ("If defendants' contention were accepted—that no environmental impact statement is required until the final approval stage—then it could well be too late to adjust the formulated plans so as to minimize adverse environmental effects.")

There is some question, however, as to the role DOE will play in contracting for the Phase III work. The Congressional action does not authorize DOE to "contract" for that work. It simply provides the $5 million to the State DBED:

> The Committee recommendation also includes $5,000,000 for the State of Hawaii through its [D]epartment of [B]usiness and [E]conomic [D]evelopment to continue the Hawaii geothermal resource verification and characterization projects to help reduce the State's dependency on fossil fuels. The State of Hawaii has assured the Committee that this cost-shared assessment will be conducted consistent with the State's outstanding effort to protect and preserve its unique natural resources.

Conference Report 101–889, Oct. 16, 1990 to accompany HR 5019. This language suggests, and Plaintiffs argue, that Congress did not envision a contracting role for DOE. Rather, it provided the money to DBED based on assurances *from the state* about how the money would be used, apparently leaving the contracting in the state's hands and discretion.

If this is the case, these facts are distinguishable from *Conner* and *Sierra Club,* both of which anticipated a specific future event, a future federal decision whether to permit the environment-threatening project to go forward. The action already taken in this case, Congressional appropriation of $5 million for the express purpose of implementing the "already proposed" Phase III, may actually be sufficient for work to begin. Neither party has identified any kind of further approval that will be needed before the work on Phase III may commence.[13]

If there is no further federal approval required, if there is no substantial and significant decision-making role left for DOE before committing itself to implementing Phase III, the suit to compel NEPA compliance is as ripe as it will ever be. *Conner* and *Sierra Club* do not control to defeat ripeness unless there is a future point, clearly identified, at which NEPA compliance must be complete and can be reviewed, challenged or compelled. *Andrus* controls to establish ripeness if that future point is the mere implementation of a project or program already embraced and adopted.

This gives rise to a material issue of fact. The court needs more information on DOE's level of commitment to the implementation of Phase III, as well as the precise role that DOE expects to play, will play, and/or must play in the disbursement of the $5 million. If, as the conference report language suggests, DOE has little or no discretion, but must transfer the money directly to DBED, then the time is ripe to consider the adequacy of DOE's NEPA compliance. If, on the other hand, ***1466** the disbursement of the funds is subject to DOE contracting, and DOE will have to prepare proposed contracts on which it will make recommendations, exercising a discretionary, decision-making role, an action to compel an EIS may be ripe only at that later time.

The presence of these material issues of fact preclude summary judgment as requested by the Government at this stage. Resolution of the issue presented will require further factual findings at trial.

VI. Major Federal Action—Plaintiffs' Motion for Partial Summary Judgment

The issue is raised in Plaintiffs' Cross–Motion whether the participation of the Government in the Project, as outlined above, constitutes "major federal action" as a matter of law. Plaintiffs have moved for summary judgment on this issue, reserving the remaining two issues for trial.[14]

A. The Regulations

[13] The applicable regulations define "major federal action" to include, *inter alia,* "new and continuous activities, including projects or programs entirely or partly financed, assisted, conducted, regulated, or approved by federal agencies...." 40 CFR § 1508.18(a).

The Government has attempted to de-emphasize the participation of the various defendant agencies in the Project (stressing that the more significant involvement of such agencies will not come until Phase IV), and both parties have argued the significance, or insignificance, of the Interagency Group. The Government relies on *Almond Hill School v. U.S. Dept. of Agriculture,* 768 F.2d 1030 (9th Cir.1985) to argue that such limited participation of federal employees has not been sufficient to turn this local project into major federal action. In *Almond Hill,* California undertook a beetle eradication project, and put three federal government officials on the project's eight-member board of advisors. Although their salaries were paid with federal funds, these officials did not have a decision-making role. The Ninth Circuit found that the payment of salaries was not a significant enough commitment of federal funds to make the eradication project a "major federal action." 768 F.2d at 1039.

The Government argues that the tangential involvement of salaried federal officials in this case is similarly insufficient to make the Project a federal action. The Government is straining at a gnat but swallowing a camel.[15] In addressing the issue of the role of federal officials in the Project, the Government overlooks the near $40 million in federal funds *directly* contributed to the Project. *Almond Hill* is easily distinguished because in that case, as the court emphasized, "no federal funds [were] sought by the state or spent on the state's beetle eradication project." *Id.*

There is no dispute as to the degree of the Government's financial participation in the Project. The use of federal funds, especially in such amounts and to such a degree (over 80% of total funding) is enough standing alone to render the Project "major federal action." *See, e.g., State of Alaska v. Andrus,* 591 F.2d 537, 540 (9th Cir.1979) ("Most courts agree that significant federal funding turns what would otherwise be a local project into a major federal action."); *Homeowners Emergency Life Prot. Committee v. Lynn,* 541 F.2d 814 (9th Cir.1976) ("Inasmuch as the grant of federal funds unquestionably moves the activity in issue to the point of a federal-city partnership, the project is now a major federal action.").

No matter whether the Project is considered as a single multi-faceted program or segmented into four separate and independent projects, there can be little question that it is major federal activity. Indeed, each of the first three phases independently has received sufficient federal financial funding to qualify as a major federal action: Phase I received $10.7 million; ***1467** Phase II received $24 million; and Phase III has already received $5 million with two more installments of $5 million each likely to come. Although it is not apparent from the record how much, if any, federal money will be utilized in Phase IV, it is clear from the list compiled by the Interagency Group that the federal government will be heavily involved in a permitting role at that stage.[16] Therefore, even if federal financing at that stage is not significant, Phase IV will nonetheless qualify as major federal action because it is a "project[ ] [or] program[ ] entirely or partly ... regulated, or approved by federal agencies." 40 CFR § 1508.18(a).

The enormous commitment of federal resources to the Project easily establishes it as major federal action. These facts are not in dispute, and no facts are alleged which, if proven, could make it otherwise. Further, in addition to the substantial financial commitment to this Project, the court has outlined above the Government's additional substantial involvement and participation at every stage of the Project's history. *See* Section II.C. *supra.* Plaintiffs are entitled to partial summary judgment declaring the Government's involvement in the Project to be major federal action.

VII. Conclusion

Whereas material issues of fact remain regarding (1) the Government's, specifically DOE's, commitment to implementation of Phase III, and (2) DOE's role with respect to the $5 million appropriation, the Government's motion for summary judgment is DENIED. As the Government's involvement in the Project constitutes major federal action for purposes of NEPA, Plaintiffs' motion for partial summary judgment is GRANTED.

All Citations

754 F.Supp. 1450, 21 Envtl. L. Rep. 20,901

Footnotes

1 The Project clearly contemplates the provision of 500 megawatts of power (enough to meet half the power needs of the State of Hawaii). It is not clear from the record, however, whether this specific amount was projected from the beginning, or whether it was determined using the data gathered in Phase I.

2 Hawaii Governor John Waihee, in his formal request for federal funding for Phase III, characterized that phase as follows:

> Mr. Chairman, we are not asking for funding for just another study of renewable energy technology. Our proposal is for a resource verification program which will lead immediately to a full-scale private development of 500 megawatts of geothermal power.

Letter to J. Bennett Johnston, Chairman of Subcommittee on Energy and Water Development, June 19, 1989, p. 2.

3 The federal members of the Interagency Group are the U.S. Army Corps of Engineers, U.S. Pacific Fleet, U.S. Coast Guard, U.S. Geological Survey, U.S. Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, and Environmental Protection Agency ("EPA"). The EPA has been unable to provide a representative because of a staffing shortage in its Honolulu office. It has, nonetheless, requested to be kept on board in a non-attending capacity and to be kept apprised of matters of interest to the Interagency Group.

4 The report bearing this title was prepared for DOE by Science Application, Inc., La Jolla, California, under Contract ET–78–C–03–1529, on January 12, 1979.

5 *See* discussion of the "proposal" requirement *infra* at Section V.C.1.

6 In this case, the immediate action is Phase III, the action currently being proposed. The more remote action is Phase IV. It is a different question to ask whether implementation of Phase III is a necessary precondition for Phase IV than to ask whether implementation of Phase IV is a necessary precondition for Phase III.

7 *Hudson River Sloop* cites *Thomas v. Peterson,* 753 F.2d 754, 758–59 (9th Cir.1985) as an application of subsection (ii), observing that it found connectedness where *both* actions are necessary preconditions to the other. This court believes *Thomas* is better characterized as an application of subsection (iii), discussed *infra.*

8 The Second Circuit has affirmatively acknowledged that this "independent utility" test is merely an application of subsection (iii). *See e.g. Town of Huntington v. Marsh,* 859 F.2d 1134, 1141–42 (2d Cir.1988) ("The proper test to determine relatedness under 40 CFR § 1508.25(a)(1)(iii) is whether the project has independent utility."); *Hudson River Sloop Clearwater v. Dept. of Navy,* 836 F.2d 760, 764 (2d Cir.1988) ("[S]ubdivision (iii) has been determined to mirror a line of cases which hold that the proper test for interdependence is one of independent utility.").

9 Given the mootness of Phases I and II, *see infra* Section V.B., this finding of connectedness is effective only as to the remaining actions, Phases III and IV.

10 Phase I was the subject of an environmental assessment (EA) under NEPA, the adequacy of which was challenged in *Puna Speaks v. Edwards,* 554 F.Supp. 117 (D.Haw.1982) (finding the EA to comply with the statute, and refusing to compel an EIS). In order to compel an EIS considering all four phases, Plaintiffs should have challenged the adequacy of the EA for Phase I, arguing that the remaining three phases were "connected actions." Plaintiffs in this case were not parties to the *Puna Speaks* action, and it does not appear from the opinion that any "connected action" argument was raised at that time.

11 The *Overton Park* case was a challenge to the Secretary of Transportation's approval of a highway through a state park. In finding that the plaintiffs had submitted insufficient evidence that the Secretary had exceeded his authority in giving such approval, the U.S. Supreme Court observed:

> Certainly, the Secretary's decision is entitled to a presumption of regularity. But that presumption is not to shield his action from a thorough, probing, in-depth review.

401 U.S. at 415, 91 S.Ct. at 823 (citations omitted). The Court also noted that the Secretary's decision could be overturned if " 'arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law.' " *Id.* at 416, 91 S.Ct. at 823 (quoting 5 U.S.C. § 706(2)(A)).

12 It is noteworthy that the Ninth Circuit also recognized that each water option contract required a separate EIS. The court held that such "EIS[s] must be prepared *prior to* execution of an option contract." *Andrus,* 596 F.2d at 852 (emphasis added).

13 The Government has suggested that further permits *might* be required, and has argued that it is at such a juncture that an EIS could be compelled. But when Government counsel was asked by this court what permits will be required or applied for, he insisted, "I have no idea."

14 The issues which would remain for trial are (1) whether such action "significantly affect[s] the quality of the human environment," and (2) what is the appropriate remedy.

15 *See Matthew* 23:23–24 (KJV).

16 In fact, the Government defends Plaintiffs' Cross–Motion by arguing that most of the defendant federal agencies are not yet involved and will not become involved until the Project reaches the permitting stage in Phase IV. In so arguing, the Government acknowledges the important role numerous federal agencies will have in Phase IV.

End of Document

Blindsided with Advance Warning

By **Debra Fiakas CFA** - June 14, 2018

Spread the love

Holders of Ormat Technologies (ORA: NYSE) shares may feel somewhat blindsided by the cessation o
Puna geothermal power plant on the Hawaii Island. Lava flowing from neighboring Kilauea volcano has c
geothermal wells as well as a warehouse and an electricity substation.

Shareholders cannot claim they were not forewarned. Ormat's annual report for 2017 mentions the risk
seventeen times. However, since no geothermal power company has ever experienced an interruption in
volcanic eruption, investors most likely overlooked the real dangers of locating a business on top of geolo

Ormat is not the only geothermal power company with publicly traded common stock. Innergex Renewa
began its first foray in geothermal energy with the acquisition of Alterra Power in early 2018, and Calpine
private in 2017 by the private equity fund Energy capital Partners. The actions left two fewer public stoc
minority shareholders can take a stake geothermal power. Of the five remaining, geothermal power sou
significant portion of total power production for all except one. The Italian utility company Enel has a ve
renewable power production, but is just getting involved in geothermal.

Publicly Traded Geothermal Power Companies				
Company Name	SYMB	Mkt Cap	Price	Generating Capacity
Innergex Renewable Energy (Alterra)	INE.TO	$1.3 B	$10.46	1,647 MW
Enel Green Power (Enel SpA)	ENEL.MI	$56.1 B	$6.42	2.4 GW

Energy Development Corporation	EGDCY	$194.5 B	$10.38	1,458 MW
Ormat Technology	ORA	$2.6 B	$51.49	795 MW
Polaris Infrastructure	PIF.TO	$162.6 M	$10.37	72 MW
US Dollars; all stocks traded on US exchanges unless otherwise indicated				

Notably, initial news reports related to the volcano and the Puna Geothermal facility appeared print and c company remained silent on the topic until well after the initial volcanic eruptions before issuing updates service. Ormat has yet to submit an 8K filing with the SEC and waited until the week of this post to disp Puna Geothermal facility on the corporate website. Sluggish communications with shareholders appear t Ormat, a habit that has attracted a scrum of law firms investigating the company for breaches in fiduciar

The more diversified Enel has been given something of a pass by investors. The rest of the geothermal p punished by traders over the last few months. Ormat, with its high profile difficulties has seen its stock p over the last six months and reduced by 28.2% from the 52-week high sent in late January 2018. A goo was in initial reaction to the announcement of year-end financial 2017 results. The stock has been atten news of the Kilauea volcanic activity become more visible in the news.

Innergex Renewable Energy has also been given a thorough thrashing by traders, perhaps because of ne geothermal power generation through Alterra Power. The stock has lost over 20%% value over the last t Infrastructure (PIF.TO) is focused on developing geothermal power in both North and South America. Th stripped of 28.7% of its market value over the last three months. Yet it seems Polaris price trends appea to sales and earnings performance rather than growing awareness of the risks in geothermal power prod

Publicly Traded Geothermal Power Companies							
SYM	Mkt Cap	Price	52-wk Hi	52-wk Lo	Trailing PE	Forward PE	3 Re
INE.TO	$1.3 B	$10.46	$12.13	$10.03	61.59	35.66	-2
ENEL.MI	$56.1 B	$6.42	$6.52	$5.30	12.79	10.52	18
EGDCY	$194.5 M	$10.38	$13.20	$9.67	11.53	na	-5
ORA	$2.6 B	$51.49	$70.68	$51.14	15.89	20.68	-1
PIF.TO	$162.6 M	$10.37	$12.36	$9.23	82.90	12.90	-2
US Dollars; all stocks traded on US exchange unless otherwise indicated							

Average forward price/earnings ratio for the green and renewable energy sector is 38.96. The forward p the S&P 600 Index is near 24.0 times. It seems plausible that renewable energy earnings higher multipl

expectations for faster growth than most of the companies in S&P's index of small companies. The S&P
companies, against which Enel is best compared, merits an average price/earnings ratio of 16.5 times fo

Ormat's forward price/earnings ratio is higher than the rest of the group. However, this is to be expected
company's sales and earnings have been trimmed beginning in the current quarter with the loss Puna Ge
closure. It might even be too simplistic to assume ORA shares are trading only in reaction to difficulties

The valuation dynamic for Ormat is probably the same for each of the other geothermal power companie
of factors that influence valuation for stock. Yet, with the lava spouting out of Hawaii's Kilauea volcano it
forewarnings of the risk of volcanic activity will be taken more seriously than ever.

*Neither the author of the Small Cap Strategist web log, Crystal Equity Research nor its affiliates have a b
companies mentioned herein.*

Debra Fiakas CFA

http://crystalequityresearch.blogspot.com/

RESPONSES TO SCOPING COMMENTS

Puna Geothermal Venture Project
Early Consultation for the Environmental Impact Statement Preparation Notice
Comments and Responses

Letter ID Number	Comment Number	Comment	Response	Resource/ Section
Steve Sparks				
1	1	Where can I see the EIS for the PGV plant?	The Planning Department provided an email response on 07/29/2022, which stated, "The EIS for this Project is in the beginning stage, and only the EIS Public Notice (EISPN) has been released. A digital copy of the EISPN is available by selecting the July 23, 2022, edition of the state's *The Environmental Notice* at https://files.hawaii.gov/dbedt/erp/The_Environmental_Notice/2022-07-23-TEN.pdf. Once a Draft EIS is released, it will be available on the Office of Planning and Sustainable Development's Environmental Review Program website here: https://planning.hawaii.gov/erp/ea-and-eis-new-rules/."	EIS Process
ʻO Makuʻu Ke Kahua				
2	1	The we decline the proposal set forth. I could not find the information with the given information. If direct access links can be provided that would be greatly appreciated.	An email response was provided on 07/27/2022, which included the following link to the EISPN: https://files.hawaii.gov/dbedt/erp/Doc_Library/2022-07-23-HA-EISPN-Puna-Geothermal-Venture-Repower-Project.pdf.	General Opposition, EIS Process
DOH Clean Air Branch				
3	1	Thank you for the opportunity to provide comments on the subject project. Based on review of the Puna Geothermal Venture Repower Project, CAB has no further comments at this time. Please see our standard comments at: https://health.hawaii.gov/cab/files/2022/05/Standard-Comments-for-Land-Use-Reviews-Clean-Air-Branch-2022-1.pdf	Thank you for your participation in the EIS process; your comment has been noted.	Air Quality
3	2	<u>Requires an Air Pollution Control Permit</u> • You must obtain an air pollution control permit from the Clean Air Branch and comply with all applicable conditions and requirements. If you do not know if you need an air pollution control permit, please contact the Permitting Section of the Clean Air Branch. • Permit application forms can be found here: https://health.hawaii.gov/cab/permit-applicationforms/	As shown in Table 4-1 of the Draft EIS, PGV holds two DOH noncovered source permits (a state air pollution control permit) for its current operations: Noncovered Source Permit No. 0008-02-N and Noncovered Source Permit No. 0008-03-N. PGV understands that under its current permits, PGV may generate up to 38 MW. PGV acknowledges that it will need to request a modification to generate up to 46 MW under Phase 1 of the Proposed Action and that PGV will need to request either a modification or new permit under Phase 2 of the Proposed Action.	Air Quality
3	3	<u>Includes construction, demolition, or renovation activities that involve potential asbestos and lead containing materials</u>: • Asbestos may be present in any existing structure. Prior to demolition, you must contact the Indoor and Radiological Health Branch, Asbestos-Lead Section. Testing may be required to determine if building materials may contain asbestos, such as: drywall, vinyl floor tile, mastic, caulking, roofing materials, insulation, special coatings, etc. • Structures built prior to 1980 may also contain lead paint. Prior to demolition, contact the Indoor and Radiological Health Branch, Asbestos-Lead Section. Testing may need to be conducted to determine if building materials contain lead. • Some construction activities have the potential to create excessive noise and may require noise permits. For DOH Noise Permits and/or Variances and for more information on the Indoor and Radiological Health Branch, please visit: https://health.hawaii.gov/irhb/	Potential impacts from hazardous materials during demolition are analyzed in the Hazardous Materials and Solid Waste section of the Draft EIS. Please see Section 3.10 of the Draft EIS. Potential impacts from noise during Project construction are analyzed in the Noise section of the Draft EIS. Please see Section 3.4 of the Draft EIS.	Hazardous Waste, Noise
3	4	<u>Includes demolition of structures or land clearing</u> • Department of Health, Administrative Rule: Title 11, Chapter 26, Vector Control, Section 11-26-35, Rodents; Demolition of Structures and Clearing of Sites and Vacant Lots, requires that: o No person, firm or corporation shall demolish or clear any structure, site, or vacant lot without first ascertaining the presence or absence of rodents which may endanger the public health by dispersal from such premises. o Should such inspection reveal the presence of rodents, the person, firm, or corporation shall eradicate the rodents before demolishing or clearing the structure, site, or vacant lot. o The Department may conduct an independent inspection to monitor compliance, or request a written report. • The purpose of this rule is to prevent rodents from dispersing into adjacent areas from infested buildings or vacant lands during demolition or land clearing. • Contractors may either hire a pest control firm or do the job themselves with a qualified employee. Rodenticides must be inspected daily and replenished as necessary to provide a continuous supply for at least one week prior to the start of any work. • To submit notifications or for more information, contract the Vector Control Branch: https://health.hawaii.gov/vcb/	Section 2.2.10 of the Draft EIS clarifies that demolition associated with the proposed Project complies with HAR Title 11, Chapter 26.	Hazardous Material and Solid Waste, Biological Resources

Letter ID Number	Comment Number	Comment	Response	Resource/ Section
3	5	Has the potential to generate fugitive dust • You must reasonably control the generation of all airborne, visible fugitive dust. Note that construction activities that occur near to existing residences, businesses, public areas and major thoroughfares exacerbate potential dust concerns. It is recommended that a dust control management plan be developed which identifies and mitigates all activities that may generate airborne, visible fugitive dust. The plan, which does not require Department of Health approval, should help you recognize and minimize potential airborne, visible fugitive dust problems. • Construction activities must comply with the provisions of Hawaii Administrative Rules, §11-60.1-33 on Fugitive Dust. In addition, for cases involving mixed land use, we strongly recommend that buffer zones be established, wherever possible, in order to alleviate potential nuisance complaints. • You must provide reasonable measures to control airborne, visible fugitive dust from the road areas and during the various phases of construction. These measures include, but are not limited to, the following: o Planning the different phases of construction, focusing on minimizing the amount of airborne, visible fugitive dust-generating materials and activities, centralizing on-site vehicular traffic routes, and locating potential dust-generating equipment in areas of the least impact; o Providing an adequate water source at the site prior to start-up of construction activities; Landscaping and providing rapid covering of bare areas, including slopes, starting from the initial grading phase; o Minimizing airborne, visible fugitive dust from shoulders and access roads; o Providing reasonable dust control measures during weekends, after hours, and prior to daily start-up of construction activities; and o Controlling airborne, visible fugitive dust from debris being hauled away from the project site. • If you have questions about fugitive dust, please contact the Enforcement Section of the Clean Air Branch	Potential impacts from fugitive dust during Project construction are discussed in the air quality section of the Draft EIS (Sections 3.3 and 3.11 of the Draft EIS).	Air Quality
3	6	Increases the population and potential number of vehicles in an area: • The creation of apartment buildings, complexes, and residential communities may increase the overall population in an area. Increasing the population in an area may inadvertently lead to more air pollution via vehicle exhaust. Vehicle exhaust releases molecules in the air that negatively impact human health and air quality, as they are known lung irritants, carcinogens, and greenhouse gases. • Ensure that residents keep their vehicle idling time to three (3) minutes or less. • Provide bike racks and/or electric vehicle charging stations for residents. • Ensure that there are sufficient and safe pedestrian walkways and crosswalks throughout and around the development. • Conduct a traffic study to ensure that the new development does not significantly impact traffic in the area.	Potential impacts from the Project to air quality are discussed in Sections 3.3 and 3.11 and potential impacts to traffic are discussed in Section 3.12 of the Draft EIS.	Air Quality, Traffic
David Kisor				
4	1	What comes out of the ground is more than hydrogen sulfide. “The sampling and testing of the resource shall be performed once upon experiencing the first steam release, and at least once during abated well cleanout and flow testing operations. Gasses to be tested: ammonium (total), cadmium nitrates, arsenic carbonate, non-methane hydrocarbons, asbestos, fluorides (total), radionuclides, (a & b), benzene, hydrogen sulfide, radon, beryllium lead sulfates, bicarbonate, mercury (total), vinyl chloride, boron (total), methane” Lucky me, I have elevated levels of arsenic, mercury, lead and cadmium, which should be no more than a trace, as found on my hair tissue mineral analysis. During the storm, while in the eye, I used a handheld weather station and recorded a maximum wind velocity of 16mph, which was ideal for the distribution of gas To believe H2S is the only gas that can cause physiological problems and only travels one mile is pure and unadulterated fantasy. I knew someone who has since moved back to Oahu who lived in Tangerine Acres, by the intersection of HWYs 130 and 132 who was knocked down for 4 hours just after the lights went out, at approximately 2.5 miles past your magical one mile limit.	Thank you for your participation in the EIS process; potential impacts from the Project to water quality are discussed in Section 3.2 and potential impacts to air quality are discussed in Sections 3.3 and 3.11 of the Draft EIS. Additionally, Section 3.10 of the Draft EIS analyzes potential impacts from hazardous materials and solid wastes, and Table 4-1 in the Draft EIS identifies the current permits and permits that would be required for the Project.	Air Quality, Public Health and Safety
Captain Scott Amaral, Police Department				
5	1	Staff, upon reviewing the provided documents, does not anticipate any significant impact to traffic and/or public safety concerns and acknowledges support of the contingency plan. Thank you for allowing us the opportunity to comment. Should you have any additional concerns and/or wish to discuss this matter further, please contact our Puna District Commander, Captain Scott Amaral, at (808) 965-2716 or via email at Scott.Amaral@hawaiicounty.gov.	Thank you for your participation in the EIS process; your comment has been noted.	Traffic, Public Health and Safety
DOT, Highways Division				
6	1	Thank you for the opportunity to provide comments. Please elaborate on what changes to plans and operating conditions have been implemented since the 2018 lava flow. If there are any questions, please contact Mr. Harry Takiue, Hawaii District Engineer, Highways Division, Hawaii District Office, at (808) 933-8866 or by email at harry.h.takiue@hawaii.gov.	The Project description has been updated in Section 2.2 of the Draft EIS to reflect current operations at the facility.	Existing Operations
April Spencer				
7	1	My concerns is the effects of fracking on the environment, air quality, earthquakes, and volcanic eruptions. Every time I drive down the Hwy PGV is located off of, I develop a migraine. Something is not right there.	Thank you for your participation in the EIS process. Potential impacts from the Proposed Action and alternatives are discussed in air quality (Sections 3.3 and 3.11) and geologic hazards (Section 3.1) of the Draft EIS.	Geologic Hazards, Air Quality
Chuck Barker				

Letter ID Number	Comment Number	Comment	Response	Resource/ Section
8	1	The proposal to implement advanced technology equipment such as will allow an increase in generating capacity from the current 25-38 MW to 60 MW is to be applauded and encouraged. We are fortunate that Ormat is willing to make this investment in capital improvements, as their economic return will take quite a few years to recover. While there are certain (often quite vocal) dissenting persons who complain of "emissions," the actual statistics reveal that geothermal power plants emit 97% less acid rain-causing sulfur and 99% less CO2 than fossil power plants, per total MWh of electricity produced. And the dissenters go home, switch on their lights, open their refrigerators, and plug in their computers. Geothermal power generation is environmentally safe and economic.	Thank you for your comment. Impacts from the 13 MW increase in power production from geothermal sources, and the 13 MW of power being generated from other methods of power production (including oil combustion), are discussed in the Air Quality – No Action Alternative section of the Draft EIS (Section 3.3). Potential impacts from greenhouse gas analysis is included in Section 3.3 of the Draft EIS.	Air Quality
Kohana Nolan K Iopa				
9	1	I use to work at geo could you help the people that got or has medical bill from the gas an the people that live around the area I am a Native Hawaiian an respect our AINA the water that was down there is gone at times I smell it wen I was working at geo I got paid pretty good I maid 3,00 a week but one day I seen a little boy holding a Osman(?) pump in his hand I stop and ask him why are you holding it he point at geo where I work I got a hurt in my heart so I quite my job I have a lot more to say I wish you guys could help the people with some money for there medical bills an life we are hurting in a way because off the water air land an wish you guys could help us with some money for watt going ok P.S. Can we help each other an love one another	Thank you for your comment. Potential impacts from the Proposed Action and alternatives to water and air quality are discussed in water quality (Section 3.2) and air quality (Sections 3.3 and 3.11) of the Draft EIS. Potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS.	Hydrology, Air Quality, Public Health and Safety
Steve Sparks				
10	1	Why is the Planning Dept to only approving agent. Why not include the Health Dept and the Civil Defense?	Thank you for your comment. Section 1.1 of the EISPN explains how the County of Hawai'i Planning Department was selected as the approving authority for this Project. This explanation is also included in Section 1.1 of the Draft EIS. HRS § 343-5(f) authorizes the Office of Planning and Sustainable Development to designate the approving agency, and it has selected the County of Hawai'i Planning Department, consistent with HRS § 343-5(e), which provides that "[t]he planning department for the county in which the proposed action will occur shall be a permissible accepting authority for the final statement."	EIS Process
County of Hawai'i Department of Water Supply				
11	1	We have reviewed the subject Environmental Impact Statement Preparation Notice, and we have no comments at this time. Should there be any questions, please contact Mr. Ryan Quitoriano of our Water Resources and Planning Branch at (808) 961-8070, extension 256.	Thank you for your participation in the EIS process; your comment has been noted.	EIS Process
Lisa Roach				
12	1	I am a property owner within less than one mile from the proposed new well sites, I would like to submit my comments after reading the EIS preparation notice. I want to say, first of all, that I am very much an advocate of renewable, non-fossil fuel based energy sources. PGV has been a good neighbor and geothermal energy is a gift we should utilize.	Thank you for your participation in the EIS process; please see responses to your specific comments below.	General support
12	2	The concerns of many who testified at the input meeting on August 17th, however, need to be addressed. In-real-time air monitoring stations that can be accessed by the public is not too big of a request. Per the report: An Air Dispersion Modeling Report for PGV was prepared in April 2021 as an update to the analysis performed in 1991 for the 1992 ERP using AERMOD, which is currently approved by the EPA, and incorporating the USGS terrain files of the post-eruption terrain. The updated report concluded that the evacuation warning level for H2S would not be exceeded under any scenario. *AERMOD was not in the list of acronyms and I would like the updated report to be accessible.*	As described in Section 3.3 of the EISPN, "In addition to control systems, PGV also conducts monitoring and reporting as required by its DOH noncovered source permit (a state air pollution control permit) for its current operations. These reports are provided to the DOH, DLNR, and County of Hawai'i Planning Department. PGV publishes real-time data for H_2S and wind direction on its website: https://punageothermalproject.com/." Real-time results from monitoring are publicly available on PGV's website. AERMOD has been added to the list of acronyms in the Draft EIS.	Air Quality
12	3	Furthermore, This study (Adler 2013) did not conduct a separate air quality assessment but reviewed existing independent studies/health risk assessments for the area. Existing studies concluded that PGV plant operations are unlikely to pose a threat to the air quality in nearby residential areas. *I would like access to these independent studies/health risk assessments. Is there a link to this study? It would seem that, with past releases, you're going to have a hard time convincing opponents of PGV that this statement is true.*	Additional air analyses conducted for the Project are included as Appendix E in the Draft EIS. Impact analyses summarizing the results of these and other analyses are included in the air quality (Section 3.3) and public health and safety (Section 3.11) sections of the Draft EIS.	Air Quality
12	4	Recommendations were made to substantially improve the existing monitoring systems and protocols which were found to be inadequate. The recommendations called for the availability of real time and reliable gas, particulate and meteorological data for citizens to view and make informed decisions to protect themselves from fugitive emissions. *I agree.*	See response to comment 2 above regarding availability of real-time air quality and wind direction data. The air quality and public health and safety sections of the Draft EIS, Sections 3.3 and 3.11, respectively, include a detailed description of monitoring systems, protocols, and impact analyses for the proposed Project. The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	Air Quality

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12	5	The use of pentane was adequately explained. Thank you.	Comment noted.	General support
12	6	Scientists/geologists were able to address, post eruption, that PGV did not cause the 2018 eruption. Conspiracy theorists will likely never be convinced, but publishing an article or two related to this would help your cause and more rational thinkers would benefit.	Comment noted.	Geologic Hazards
12	7	I hope PGV is successful and that the new wells are incorporating the most modern technology available. If you had better PR, (I may be missing your PR statements, as I don't use technology much) you may be more successful in minimizing distrust.	Comment noted.	General support
12	8	Good luck! PS, and I don't mean to be mean, but... As to the Hawaiian cultural concerns, I have a question for them: Did they protect the religion of and include the Marquesans in the decision-making process? The Marquesans were the "host culture" upon the early Hawaiians' arrival.	Comment noted.	Out of scope
Peter Sternlicht				
13	1	As a resident and homeowner on the Big Island of Hawai'i, I want to voice my support for Puna Geothermal Ventures' (PGV) continued operations, execution of the pending Amended and Restated Power Purchase Agreement (Docket No. 2019-0333) and its planned capacity expansion to 60MW under its ongoing Repower Project.	Thank you for your participation in the EIS process; please see responses to your specific comments below.	General support
13	2	While I agree that PGV must be held to the highest standards of safety, the service that PGV provides to Hawai'i Island is invaluable to the residents, businesses, and our pursuit of mitigating the effects of climate change and resource depletion.	Comment noted; additionally, the reduction of greenhouse gas emissions associated with the Project is discussed in Section 3.3 of the Draft EIS.	General support, Air Quality
13	3	Furthermore, geothermal power production involves one of the two sustainable, renewable energy systems capable of producing firm, dispatchable, baseload power for our community. The other is hydroelectric power generation. The latter is limited in its capacity on Hawai'i Island due to the small scale of individual generation sites. All the remaining renewable, utility scale energy systems we're currently employing have limited lifecycles and require raw materials that are in high demand and experiencing stressed supplies. This means that they likely will not be economically replaced at the end of their useful lifespan. Geothermal systems use mostly base metals and can be maintained over many decades as has been witnessed in Iceland, New Zealand and the oldest continuously producing facilities in Larderello, Italy.	Comment noted.	General support
13	4	With the perfect storm of climate change, global resource depletion and a still growing population, leveraging a long-lasting source of power that does not require imported energy carrying feedstocks, I feel that it is essential that PGV continue to operate and that we consider developing additional geothermal power generation capabilities here on Hawai'i Island.	Comment noted.	General support
Christopher Biltoft				
14	1	The Environmental Notice of 23 July 2022 states that the PGV Repower Project EIS Preparation Notice includes a 30-day public review and comment period. Please note that I intend to follow this EIS process and request that I be included in all future notifications and opportunities for public comment. My comments on the PGVRP EIS Preparation Notice are as follows:	Thank you for your participation in the EIS process; please see responses to your specific comments below. Your name has been added to the distribution list.	EIS Process, EIS Contact List
14	2	1. 2.1.6 Existing Operations. Please note that the ESRF is used for upset conditions, but does no "prevent a release of unabated H2S to the atmosphere."The ESRF is essentially a pile of rocks into which steam containing high levels of H2S and other toxins are dumped during emergency conditions. Sodium hydroxide is sprayed over the ESRF in an attempt to neutralize the H2S, but is only marginally successful. PGV failed to shut down power production in a timely fashion during Hurricane Iselle and had to use the ESRF to dump its toxic steam after power lines went down. The result was the wind-borne dispersion of both H2S and caustic soda through the nearby community. No H2S measurements were available for this incident because the monitoring system went down when the power was shut off. PGV received a slight slap on the wrist for this incident.	Sections 3.10 and 3.11 of the Draft EIS include a description of the facility's procedures for identifying, reporting, and responding to any exceedances and how to respond in the case of natural disasters as required in permit requirements for public health and safety.	Hazardous Materials, Public Health and Safety
14	3	2. 3.3 Air Quality and Climate Change PGV continues to operate under an outdated non-covered source permit (NSP 0008-02-N) that expired in 2019, and the DoH has refused, for some unknown reason, to update this permit to include current wells (as shown in Table 2.1 of this notice) and other facilities. Compliance with existing laws and regulations pertaining to H2S is also missing in the draft DoH NSP. This Notice correctly states in Table 4.1 that the current NSP requires amendment for the Project.	Comment noted. PGV is currently working with the DOH to update the noncovered source permit. New permits will be applied for if and when necessary, as described in Sections 1.5.1, 3.10, and 3.11 of the EISPN and Draft EIS.	Air Quality
14	4	3. 3.3 Air Quality and Climate Change Existing studies, for example the 1992 ERP as well as the April 2021 updated ERP, do NOT conclude that PGV plant operations are "unlikely to post a threat to the air quality in nearby residential areas." The early dispersion modeling done for the PGV Emergency Response Plan (ERP) using ISCST and the recent ERP modeling done using AERMOD are consistent in showing that H2S disperses into public space in concentrations well in excess of acute exposure guideline level 1 (AEGL1), posing a hazard to both nearby residents and to the public traveling along roads past PGV. It is worth noting that these models are gaussian dispersion models which provide ensemble averages, not peak concentrations. Peak concentrations can be many times greater than the reported ensemble averages. Evacuation warning levels for H2S can be exceeded during toxic gas dispersion scenarios at PGV.	Potential impacts to air quality are analyzed in Sections 3.3 and 3.11 of the Draft EIS. Section 3.11 also includes a discussion of the ERP, which includes an updated air modeling analysis completed in 2021 and reporting thresholds. Additionally, the ERP identifies potential impacts to the facility as well as response actions for each hazard by incorporating warning systems, control options, steps for securing and shutting down the facility, personnel evacuation, and notification of appropriate state and county agencies.	Air Quality, Public Health and Safety

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14	5	4. 3.3 Air Quality and Climate Change It is true that PGV publishes "real time data" for H2S and wind direction" (along with wind speed and other variables) with 5-minute updates from three sites near the PGV perimeter. However, publishing the data and publishing correct and meaningful data are different things. Studies such as Meder (2013) have shown that data quality, particularly the H2S data quality, is poor, with missing data and negative concentrations (which are impossible) rendering the data unusable. Data from the Hilo Airport, not PGV data, were used for the latest AERMOD modeling of the PGV site, presumably due to poor quality and missing data at PGV. The Adler Report (2013) also notes that "existing monitoring systems and protocols" were found to be inadequate. PGV uses various sensors near flanges, seals, valves and other points to alert staff when significant H2S emissions occur, yet this is not included in the NSP even though laws clearly state that emissions should be measured at the source. The refusal of PGV to provide real emissions information, compounded by the refusal of the DoH to require adequate H2S measurements in their NSP, constitutes a serious threat to public health and safety. I hope that the comments presented above help inform the development of the PGV EIS. Please keep me "in the loop" as the EIS is developed.	Comment noted; an independent third party verifies the accuracy of the air data collected and reports the results to the DOH and County of Hawai'i in compliance with the requirements of PGV's air permit and GRP. The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements. Potential impacts to air quality are discussed in Sections 3.3 and 3.11 of the Draft EIS.	Air Quality, Public Health and Safety
Noel Morin				
15	1	I'm a resident of Hilo and a climate action advocate. I lead several organizations focused on sustainability, clean transportation, and clean energy. I am supportive of the PGV's operations and its RePower Project. The resulting reduced system complexity (the number of wells) while increasing power generation capacity to 60MW is a welcome development.	Thank you for your participation in the EIS process; your comment has been noted. Refer to Section 2.2 in the Draft EIS for the Project description including how production and injection wells are used to produce geothermal energy and the number of wells already approved for the Project.	General support
15	2	Of course, relevant community concerns must be addressed, and attention to environmental consequence mitigation must be maintained. Hawaii Island must aggressively decarbonize its economy, and geothermal plays an important role in this goal. Intermittents are providing value and are critical for our decarbonization efforts. However, for a truly sustainable and resilient energy ecosystem, we need diverse solutions, including geothermal. With its relatively small physical footprint, high potential for abundant renewable energy access, and lower reliance on minerals and metals, geothermal offers Hawaii an opportunity to deliver firm, clean, and sustainable energy for future generations.	Comment noted.	General support
15	3	There are geothermal plants across the globe, including in geologically active locations, e.g., New Zealand, Philippines, Indonesia, Italy, and California. Some have been in operation for many, many decades. One of Italy's plants has delivered benefits for over a century. There is precedence.	Comment noted.	General support
15	4	Importantly, geothermal energy production requires much less resource-dependent inputs (minerals, metals, and fossil fuels) than other clean energy solutions.	Comment noted.	General support
15	5	For a truly resilient Hawaii Island, we have many types of energy solutions. Geothermal has been an important part of this diversity. The planned changes will make it a bigger contributor to energy capacity with fewer wells deployed. This will be a boon for an economy that has an ever-increasing need for clean energy.	Comment noted, and potential impacts to socioeconomics from the Project Area are included in Section 3.6 of the Draft EIS.	Socioeconomics
Robert Petricci, Puna Pono Alliance				
16	1	Puna Pono Alliance, a Hawai`i non-profit association, having been listed as a consulted party in the environmental impact statement (EIS) preparation notice published by the County of Hawai`i (COH) on July 23, 2022, for an Environmental Impact Statement for the Proposed Puna Geothermal Venture Repower Project, submits these initial comments regarding potential impacts of the proposed action. We request that Puna Pono be confirmed as a consulted party and be provided documents and information relevant to this process pursuant to the Hawaii Environmental Policy Act (HEPA) – Hawaii Revised Statutes (HRS) Chapter 343 and related Hawaii Administrative Rules (HAR) Title 11 Chapter 200.1. Please address the following matters in the draft EIS (we reserve the right to supplement these requests).	Thank you for your participation in the EIS process; please see responses to your specific comments below. Puna Pono Alliance was included on the list of non-profit groups consulted in Table 5-1 of the EISPN and is included as a consulted group in the Draft EIS.	EIS Process
16	2	During the Public Scoping Meeting on August 17, 2022, testimony was overwhelmingly critical of harmful impacts experienced for decades by residents of the community. One speaker acknowledged how PGV was supportive of community needs after the 2018 Kilauea Volcano eruption. PGV has shown that it can do the right thing when it must, yet too often lax regulatory oversight has allowed PGV to take a lesser path that appears more profitable yet ultimately proves harmful to its neighbors. That essence of much testimony – harm to PGV's neighbors and lax regulatory oversight – is an important topic that is of interest to most people involved in this process. Also important were the repeated calls for cultural and psycho-social impact studies with respect to Hawaiian traditional spiritual values.	The Draft EIS discusses how the facility is operated consistent with permit requirements and conditions as well as local, state, and federal regulations. Potential impacts to public health and cultural practices from the Project Area are analyzed in Sections 3.11 and 3.8 of the Draft EIS.	EIS Process, Public Health and Safety, Cultural Practices
16	3	The meeting was conducted in an objectionable manner. Those participating virtually by way of an internet broadcast were often not provided with comprehensible audio, and captioning delivered as people spoke was virtually useless. Further, the moderator did not plainly emphasize that written or emailed comments were acceptable by Monday August 22, but tended instead to limit or discourage more expansive participation (such as by telling the audience that it they had heard some comments similar to what they wanted to say, they could skip testifying). That constriction of public participation is contrary to the spirit and letter of HEPA and represents procedural error.	Comment noted; the public scoping meeting was held consistent with the requirements in HAR § 11-200.1-23(d) to provide the public an opportunity for public comment related to the scope of the Draft EIS. At the meeting, the date that comments were due was included on the public comment form handout and the EIS process poster displayed at the front of the room. The date that comments were due was included in the official publication of the EISPN in *The Environmental Notice*. It was also added to PGV's EIS informational website. Public comments on the Proposed Action were not limited as you describe. The moderator did note that individuals were not required to testify if they felt that their comments were already captured by others. No one was prevented from testifying if they wanted to, and it was	EIS Process

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			explained at the meeting that written scoping comments were accepted through August 22, 2022.	
16	4	One of the later online speakers, Shannon Rudloph, spoke about the death of her friend trapped at home near PGV as unabated hydrogen sulfide escaped from a plant valve during Tropical Storm Iselle. PGV made the tragic mistake of not shutting down before the storm made landfall and many community residents paid the price for that error. Community knowledge of such events is far more widespread than governmental regulatory agencies are willing to recognize, and that gap in perception accounts for much of the distrust the community feels toward government and PGV in geothermal related matters.	Comment noted; potential impacts to air quality from the Proposed Action are analyzed in Sections 3.3 and 3.11 of the Draft EIS. Additionally, from the beginning of geothermal energy production in 1993 to the present, there has not been medical or first responder confirmation that anyone (including PGV employees or community members) has suffered a fatality as a result of H_2S exposure from PGV operations.	Air Quality
16	5	PGV's EIS consultant spoke to her intended objectivity during this process and some speakers encouraged her to try to actually be unbiased to the point that she could accommodate the basis for feelings of resident resentment, while some speakers seemed to expect nothing more than typical paper-churning pablum.	Comment noted.	Out of scope
16	6	The notice begins by saying: Puna Geothermal Venture (PGV), a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant in the Puna District on Hawaiʻi Island and proposes to replace the current 12 operating power-generating units with up to four upgraded power-generating units (Project). The notice, at page 1-2, says: Under a recent new interpretation of statutory definitions of "land" by the PUC [Public Utilities Commission], the heat extracted from the geothermal fluid beneath the site, a resource to which the State of Hawai`i claims title, is state "land," so the Project's use of the geothermal resource triggers environmental review. However, the PUC correctly recognized how HRS § 171-1, with regard to management and disposition of public lands, defines land as "includ[ing] all interests therein and natural resources including water, minerals, and all such things connected with land, unless otherwise expressly provided". HRS § 182-1 defines minerals as "including all geothermal resources" and defines geothermal resources as "the natural heat of the earth, the energy, in whatever form, below the surface of the earth ...". Therefore, the PUC's recognition that PGV's use of geothermal resources is a use of state land (a HEPA trigger) may be recent, but it is the correct – rather than a novel – reading of those statutes.	Comment noted; the text in the EISPN and Draft EIS is consistent with the current legal interpretation. Note that it has been updated in the Draft EIS to reflect that the referenced definition is "state land" rather than "land."	EIS Process (Trigger)
16	7	As the notice says at page 1-7 "the State of Hawai`i owns all mineral rights (including geothermal resources) in the state, including those for the Project, and has issued a Geothermal Resources Mining Lease for the existing PGV facility under which the Project would continue to operate." About February 20, 1981, pursuant to HRS Chapter 182, Reservation and Disposition of Government Mineral Rights, State of Hawai`i Geothermal Resource Mining Lease No. R-2 (Lease R-2) was issued to Kapoho Land Partnership (owner and lessor of land leased by PGV where the subject geothermal facility is located). PGV's use of state minerals (as defined by HRS § 182-1) pursuant to Lease R-2 is a use of state land (as defined by HRS § 171-1) subject to HRS § 343-5(a)(1) regarding environmental review. Yet the notice, at page 1.1, erroneously says that "[i]n August 1987, although there was no statutory trigger, an [EIS] for the now operating power plant was voluntarily prepared by PGV" (emphasis added). State owned mineral rights, including the geothermal resources formally leased for use by PGV, always have been part of the geothermal project's existence. Thus, reference to the 1987 EIS by Thermal Power accepted by Hawai`i County (with regard to a planned geothermal project that Thermal Power then sold to PGV) as having been voluntarily prepared – a statement that is so common as to have become a rote part of the PGV myth – simply reflects, at best, how there was a regulatory omission by oversight in earlier HEPA situations. That myth should be noted and corrected by the EIS, not perpetuated by baseless repetition (e.g., no statutory trigger).	Comment noted; any asserted trigger for the 1987 EIS is outside the scope of this document.	Out of scope
16	8	HAR § 11-200.1-2 defines Supplemental EIS (SEIS) as an "an updated EIS prepared for an action for which an EIS was previously accepted, but which has since changed substantively in size, scope, intensity, use, location, or timing, among other things". The PUC, recognizing the fact that PGV's use of state land invoked HEPA, ordered that an SEIS must be prepared. On the other hand, on September 23, 2020, the Office of Environmental Quality (OEQC), published the following contrary determination in The Environmental Notice: Department of Health (DOH), State of Hawai`i has determined that additional environmental review is not required for the permit renewal for Puna Geothermal Venture (PGV)'s non-covered source permit NSP No. 0008-02-N. As noted in the linked document, numerous records, documents, demands, opposition to demands, and comments are incorporated into the record for this decision. The DOH has carefully reviewed and considered all of these filed and/or submitted demands, and documents in support of, and in opposition to, the demands, along with the January 8, 2020 PGV response in opposition to these demands, and has also reviewed and incorporates into the record the Department of Land and Natural Resources' (DLNR) previous decision of September 8, 2019 that a new or supplemental environmental review is not required for PGV's operations.	In response to the PUC decision, the County of Hawaiʻi Planning Department has determined that an EIS is the appropriate level of analysis for the Project.	EIS Process

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16	9	The DOH determination, like that of DLNR relied upon by DOH, was substantially based on an erroneously supposed absence of the HEPA state land use trigger. In all the proceedings referenced herein, Puna Pono has continually asserted how state constitution Article XI § 9 protects its members' interests in a clean and healthful environment. Determinations by DOH and DLNR regarding HEPA issues based on the erroneously supposed absence of a HEPA trigger violate those constitutional rights. Harm to PGV's neighbors relating to lax agency regulatory oversight has been frequently (but not exclusively) attributed to specific DOH defalcations (such as the fact that PGV's air pollution permit expired in December of 2014). On October 6, 2014, pursuant to HAR 11-60.1-74, PGV applied to the DOH for renewal of Non-Covered Source Permit No. 0008-02-N dated December 15, 2009 (the previous 5 year permit expired December 14, 2014). That application led to the contested case proceeding that at this date is still unresolved, after nearly eight years. Demands for an SEIS in the contested case led to the previously noted September 23, 2020, publication of a DOH determination that no additional environmental review is required for the renewal of permit NSP No. 0008-02-N. As said in the DOH determination, DLNR had decided on September 8, 2019, that a new or supplemental environmental review was not required for PGV's applications to drill new geothermal wells. Both DOH and DLNR determinations relied heavily on PGV's argument that it did not use state land. After the determinations in 2019 by DLNR and 2020 by DOH, the PUC applied correct statutory law in a March 31, 2021, order requiring PGV to complete an SEIS. The PUC ruling is correct, the DOH and DLNR rulings are not.	Comment noted; the Applicant's position on the PUC's ruling is set forth in its filings before the PUC related to the ARPPA. This Draft EIS has been prepared in response to the PUC's decision.	EIS Process
16	10	The PUC order, at page 11, said, "Puna Pono explains that many changes have occurred in the decades since the 1987 EIS, including geological changes related to the 2018 Kilauea eruption, associated seismic activity, and greenhouse gas considerations". Yet the PUC's order said (page 25) that it could not be the accepting authority for PGV's supplemental environmental review. "Given the presence of at least three agencies with authority and relevant expertise, the Commission directs Hawaiian Electric to work with PGV, DOH, DLNR, and the County of Hawaii to determine the appropriate accepting authority for supplemental environmental review". Hawaiian Electric sought reconsideration, arguing that if HEPA applies then "the Commission would be both the Approving Agency and the Accepting Authority": The Commission may not take the position that it cannot be the Accepting authority. Under the definitions set out in HAR §11-200.1-2, "accepting authority" for an application means "the agency that initially received and agreed to process the request for approval, that makes the determination that the EIS fulfills the requirements for acceptance." "Approving agency" means "an agency that issues an approval prior to implementation of an applicant action." Similarly, under HAR § 11-200.1-7(c): Whenever an applicant proposes an action, the authority for requiring an EA or EIS, making a determination regarding any required EA, and accepting any required EIS shall rest with the approving agency that initially received and agreed to process the request for an approval. Here, the only agency that will consider HELCO's application for approval of the power purchase agreement is the Commission. There are no other agencies that will review this Applicant's "action." Accordingly, even assuming, arguendo, that the application is subject to Chapter 343, the Commission is both the Approving Agency and the Accepting Authority. There is no provision within HEPA or applicable law that allows the Commission to opt out.	Comment noted; HRS § 343-5(f) authorizes the Office of Planning and Sustainable Development to designate the approving agency, and it has selected the County of Hawaiʻi Planning Department, consistent with HRS § 343-5(e), which provides that "[t]he planning department for the county in which the proposed action will occur shall be a permissible accepting authority for the final statement."	EIS Process (Approving Agency)
16	11	The County of Hawai`i has no discretionary permit jurisdiction. The only agency acknowledging such jurisdiction in this matter, as shown by the record, is the PUC. While the County of Hawai`i once had discretionary permit authority for geothermal projects (at the time it accepted the 1987 EIS) that authority was repealed by the Legislature in 2012 (Act 97). The EIS should address this aspect ot the procedural background as well as matters relating to the legitimacy of the County serving as the final accepting agency for a project involving the use of state land (see HRS § 343-5(d)(1) providing the final authority to accept an EIS shall rest with "[t]he governor, or the governor's authorized representative, whenever an action proposes the use of state lands or the use of state funds...").	Comment noted; rationale for the selection of the Planning Department is consistent with HAR 11-200.1-7. See also the response to Comment 10 above.	EIS Process (Approving Agency)
16	12	As a precursor to those HEPA rulings, in May of 2018, Kilauea Volcano substantively impacted the Puna environment by an extraordinary eruption in its lower east rift zone, resulting in widespread destruction, damage, and creation of a new topography and shoreline. The PGV facility was damaged, shut down and isolated from public roads by the eruption, with some infrastructure and equipment having been destroyed and covered by lava. At page 1.1, the County notice says "[i]n May 2018, approaching lava from the 2018 eruption of Kilauea on the Lower East Rift Zone (LERZ) inundated the main access road to the power plant, the wellheads of two geothermal wells, the substation of the complex, and an adjacent warehouse that stored a drilling rig". That damage led to the wrongful issuance of a new DOH air permit relating to the lost equipment, a step taken by DOH without notice and, in fact during (as DOH has admitted, because of) the pending contested case considering renewal of the 2014 air permit that covered the lost equipment. The EIS should review the administrative record of that stealth permit to disclose how blatantly wrongful DOH issuance of the new eruption-related air permit (without HEPA review) actually was.	Comment noted; the scope of this EIS is to analyze the impacts of the Proposed Action. The existing permits for the PGV facility are listed in Table 2-2 and are out of the scope of analysis for the Draft EIS. Potential impacts associated with geologic hazards are discussed in Section 3.1 and potential impacts to air quality are discussed in Sections 3.3 and 3.11 of the Draft EIS.	Geologic Hazards, Air Quality
16	13	Geothermal resources used by PGV in its operations include the natural heat of the earth and energy derived therefrom in the form of ground water, brine and steam found in hot porous rock that is brought to the surface through wells drilled by PGV used to run electricity generators. Waste from used geothermal resource liquids is re-injected into the ground through wells drilled by PGV. During the 2018 Kilauea eruption, magma and lava flow affected the geology, structure and heat in the area around PGV. Ormat, PGV's owner, acknowledged the significance of that situation in an SEC Annual Report pursuant to the Securities Exchange Act for fiscal year ending December 31, 2018 (https://bit.ly/2viCKXe) at pages 75 and 76 of Item 1A. Risk Factors where Ormat said the May 3, 2018, Kilauea eruption "covered the wellheads of three geothermal wells, monitoring wells and the substation of the PGV complex and an adjacent	Potential impacts associated with geologic hazards and the Project are discussed in Section 3.1 of the Draft EIS. Regarding geothermal energy production, PGV reached the maximum capacity of 38 MW prior to the 2018 eruption. Since the plant began operating again after the eruption, PGV has been ramping up production in an effort to get back to the facility's current stated capacity of 38 MW.	Geologic Hazards, Hydrology

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		warehouse storing a drilling rig also was consumed by the lava" (the equipment being the subject of DOH's wrongful stealth permit that intentionally circumvented an ongoing 2014 permit contested case proceeding) and noted "significant physical damage to the geothermal resource and continued shut-down following the stop of the lava flow could have an adverse impact on the power plant's electricity generation". Further: Absent any additional geologic/hydrologic studies, increased power generation, failure to reinject geothermal fluid or improper maintenance of the hydrological balance may affect the operational duration of the geothermal resource and adversely affect PGV's ability to generate electricity. The PUC record reflects how prior to the 2018 eruption PGV's well KS-14 had a production temperature of 596°F, approximately 22% steam and 78% brine. In December of 2019, KS-14 had a temperature of 632°F, approximately 86% steam and 14% brine. Eruption related heat increase resulted in nearly four times more steam and five times less brine. That is why PGV needs to replace those original generating units with units designed to match the new steam dominant resource. PGV's ability to generate electricity was affected by the eruption. PGV told the PUC that the decision to reconfigure the facility "was based on the higher steam fraction in the geothermal resource," and the "higher production temperature is thought to be a result of magma moving near the geothermal reservoir and causing an influx of hotter fluid". PGV also said "Ormat never before experienced a situation where steam fraction was changed by volcanic eruption." PGV has been unable to generate electricity at the present facility's stated capacity. It is important to recognize how the eruption substantively changed the circumstances of PGV's situation, how regulatory agencies avoided facing those matters, and all in the context of the well known harm suffered by community residents over decades.		
16	14	Hawaiian Electric told the PUC on August 12, 2021, that "replacing the original twelve (12) steam/binary Ormat Energy Converter ('OEC') units with three (3) new, more efficient OEC units" would involve DOH approval of renewal of PGV's present air permit [the subject of an on-going contested case] followed by amendment of the renewed permit "promptly after" the DOH approves the renewal. In other words, the only thing keeping PGV from applying to amend the permit now is its incongruous delay for approval of the older permit that will then require prompt amendment. However, PGV's amendment of its pending application to renew the DOH air pollution permit to include the plans for repowering PGV's facility with replacement units necessary to accommodate the production afflicting eruption related heat increase should be submitted without delay pursuant to HAR § 11-60.1-64 titled Duty to supplement or correct permit applications, that provides "[a]ny applicant for a noncovered source permit who fails to submit any relevant facts or who has submitted incorrect information in any permit application shall, upon becoming aware of such failure or incorrect submittal, promptly submit such supplementary facts or corrected information...". PGV's consultant should recognize the inherent fallacy of omitting the DOH air pollution permit renewal from the scope of this HEPA proceeding. Important considerations in the DOH permit are of significance in any HEPA review, especially considerations relating to the monitoring of PGV pollution and the community's right to be informed of emissions. The eight year record of the ongoing contested case regarding the DOH permit renewal is informative in greater detail. In the PUC, PGV's May 14, 2021, joinder in an April 12, 2021, motion filed by Hawai`i Electric Light Company (at page 5) said that "when the [new power purchase agreement] becomes effective upon the Commission's approval, PGV will then be able to undertake the work to repower its geothermal power facility". The PUC has approved the new HELCO-PGV power purchase agreement and this HEPA EIS effort is part of PGV's undertaking to accomplish the repowering of its facility. It is well past the appropriate time for PGV to have submitted supplementary facts and corrected information that would conform its pending DOH permit renewal application with more accurate material that is relevant to the on-going repowering effort. Kon v. DOH, Intermediate Court of Appeals (ICA) No. CAAP-21-0000389, is an appeal from a declaratory judgment action regarding HEPA requirements in PGV's pending application to renew its DOH air pollution permit. The answering brief filed by PGV on December 30, 2021, notes that "full scale output has not yet been fully restored following the 2018 eruption" and a planned repowering of the Facility will require modification of the DOH permit. It quotes DOH saying when "PGV's [repowering] plan is sufficiently finalized and before any construction is commenced, PGV will need to submit an application to amend its permit". DOH also said the renewed permit will "not authorize construction of a new facility or expansion of the existing Facility" because "PGV has not accounted for the proposed changes in the instant permit renewal application". PGV noted "repowering of the Facility will be the subject of further environmental review" but notes that "any change to the Facility could arguably jeopardize PGV's permit shield, pursuant to which the terms and conditions of the 2009 NSP ... 'shall remain in effect and not expire until the application for renewal has been approved or denied'" – acknowledging that if PGV admits the facility is in need of improvements in the pending permit renewal application, it could jeopardize the ability to continue operation while agency matters are pending. An Alice in Wonderland suspension of reasoning is an integral part of the ongoing DOH contested case. The Kon vs. DOH case, originally filed as Civil No. 3CCV-20-0394, a civil declaratory action demanding an SEIS, resulted in the following ruling: "Plaintiffs' Motion seeks a ruling that PGV's use of geothermal resources is a use of 'state land,' one of the 'triggers' under HRS § 343-5a). ... [¶] The Court finds that PGV's use of geothermal resources involves the use of state land". That ruling became final and was not appealed. Therefore, PGV's use of state land has been established by a final state court ruling as well as by PUC's administrative ruling. While the DOH and DLNR continue to process PGV applications as if no state land use HEPA trigger was present, those	Existing permits, including the air permits, are listed in the EISPN Table 2-2 and are also included in the Draft EIS. The existing NSP permits were issued in accordance with DOH procedures. The scope of Phase 1 of the Proposed Action analyzed in the EIS is the proposed change of equipment and increasing capacity to 46 MW and the permits needed for the related construction and operation. Phase 2 of the Proposed Action (increasing capacity to 60 MW) would require an amendment for Noncovered Source Permit No. 0008-02-N as stated in the EISPN Table 4-1. Potential impacts to air quality from the Project are analyzed in Sections 3.3 and 3.11 of the Draft EIS. Comment noted; the text in the EISPN and Draft EIS is consistent with the current legal interpretation.	Existing Conditions, Air Quality, EIS Process (Trigger)

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		regulatory oversights are plainly erroneous. At page 4-2, the County notice refers to PGV's DOH permit that is the subject of the eight year old ongoing contested case proceeding as "Existing, renewal in progress, Amendment needed for the Project" – but DOH's determination of the absence of a HEPA trigger remains stubbornly unchanged. PGV and DOH have been playing an inappropriate shell game with permit proceedings. The contested case for PGV's renewal application has continued for eight years while PGV has enjoyed the benefit of a permit shield based on its 2014 renewal application, while admitting that amendment of the 2014 renewal application could jeopardize its permit shield. Thus, clinging to the illusion that the PGV repowering plan is not yet sufficiently finalized, DOH has indulged PGV by not requiring amendment of the application in the contested case and allowing PGV to continue to operate while that agency matter is pending. Excluded information about planned changes at the PGV facility (and actual changes for replaced equipment covered by the stealth permit*) deprives the contested case parties of opportunities to review and examine relevant facts in violation of their constitutionally protected due process and environmental health rights. * On December 9, 2018, PGV applied for a modification of its existing permit because of lava "inundating Drill Rig 51 engines and associated equipment". Expressly recognizing how the existing permit was in a contested case, without revealing PGV's modification application, and without applying HEPA in the obviously changed circumstances, on January 25, 2019, DOH in secret, without public notice and without informing contested case parties, issued a new permit to PGV (amending the 2014 permit) that was subsequently expanded to include further changes.		
16	15	An issue that should be addressed by the EIS is how many community residents see DOH serving as a handmaiden for PGV's economic interests – with the attitude that the Constitution and applicable environmental statutes and regulations intended to protect the public be damned. Some contested case parties have expressed resentment at how they feel the agency's disrespect, and long-standing feelings of community resentment arise from continual adverse impacts since the poorly regulated geothermal experiment began several decades ago. The September 9, 2013, final report of a study of geothermal health and safety issues funded by the County of Hawai`i (the Adler Report) includes these statements: Events during the HGP-A era and during the 1991 blowout provided exposures associated with adverse health effects. This knowledge, along with other information contained in this report ... has led the Study Group to conclude there is evidence that there were health effects from the exposures during the development of geothermal before 1993. The full extent and severity of those effects has not been documented. ... Risks from geothermal energy production in Lower Puna exist. The actual extent and impacts of those risks remains unresolved. What is known is that hazardous chemicals are brought up by PGV. PGV adds industrial chemicals to the mix in the process and then sends the composite fluid back down. However, fluids inevitably escape to air, water, or at surface level. Harmful effects can only be understood through better monitoring and reliable health data.	The comment about the DOH's alleged role in the Proposed Action is beyond the scope of the EIS. Existing conditions and potential impacts to hydrology, air quality, socioeconomics, and public health and safety (including ongoing monitoring) are included in Sections 3.2, 3.3, 3.6, and 3.11, respectively, of the Draft EIS.	Socioeconomics, Public Health and Safety
16	16	A list of emergencies declared by the Hawai`i County Civil Defense Agency at Puna Geothermal Venture between June 1991 and August 1999 (that is not a complete list of incidents at the facility) is included as table 3 in Geothermal Energy in Hawai`i: An Analysis of Promotion and Regulation, Annie Szvetecz (University of Montana 2001), an informative resource. PGV has admitted many dozens of hydrogen sulfide releases it acknowledges while the community has noted many additional events. PGV is believed to have settled hundreds of claims by residents and its employees for injuries and damages relating to its facility's operation. These specific facts of upset conditions and injury (including death) should be thoroughly reviewed in the draft EIS.	Section 3.11 of the Draft EIS includes a description of the facility's procedures for identifying, reporting, and responding to any exceedances as stated in permit requirements for public health and safety. The scope of the Draft EIS is to analyze the impacts of the Proposed Action and alternatives as described Sections 1.2, 1.5, and 2.2 of the Draft EIS.	Public Health and Safety
16	17	The 1987 EIS contemplated categorical potential impacts including geology, hydrology, meteorology and air quality, noise, biological resources, land use and infrastructure, public health and safety (including emergency plans), socioeconomics, cultural resources (including native Hawaiian religious beliefs and practices) and aesthetics. Those are fundamental categories, but in this case they deserve careful review for what they missed and what has changed since the 1987 EIS was accepted.	Potential impacts from the Proposed Action to geologic resources, hydrology, air quality, noise, biological resources, land use, public health and safety, socioeconomics, cultural resources, and visual resources are included throughout Chapter 3 of the Draft EIS.	General Analysis
16	18	At page 2.4 the notice says "[v]olcanic and seismic hazards for the existing facility exist, with risks posed to engineered structures and installations. These risks have been significantly mitigated through procedures in facility siting, design, and operation as described in the 1987 Puna Geothermal Venture Project EIS (PGV 1987)". The 1987 EIS said "[t]he risk of the site being overrun by lava from a vent located outside the project area is largely a function of topography.... Review of historical eruptive events shows an average lava thickness of approximately 18 feet with a range of 37 feet to a few feet .... The project site is situated on relatively level ground at an elevation of over 40 feet above the surrounding terrain". The value of the facility's relative elevation was self-evident in the 2018 lava flow, but the flow consumed the buffer. Now the facility has no such protection be elevation relative to the existing topography. The image on the cover page of the County notice (left) plainly shows how the formerly elevated site is now on a level plane with surrounded by new lava. The risk of being overrun by lava in a future eruption, especially based on the present topography, must be addressed by the draft EIS.	Geologic hazards, including a description of the existing environment and potential impacts, are discussed in Section 3.1 of the Draft EIS. Potential impacts from natural hazards are discussed in Section 3.11 of the Draft EIS.	Geologic Hazards, Public Health and Safety
16	19	At page 2.5 the notice says "potential seismic hazards are generated by earthquakes and include ground motion, ground ruptures, and subsidence". The EIS must also address induced seismicity resulting from PGV's operations.	Potential impacts of geologic hazards are discussed in Section 3.1 of the Draft EIS.	Geologic Hazards

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16	20	At page 1.6, the notice says "[t]he HGP-A plant operated for approximately eight years and demonstrated the technical and economic feasibility of geothermal energy in Hawai`i". That experimental facility is notorious in the community for open and unabated venting of steam and hydrogen sulfide that gassed the community, including children (photo, right) traveling to school. The EIS should carefully, accurately and thoroughly review the history of the HGP-A facility to provide not only a historical perspective but also a background story for the profound community opposition demonstrated at the recent scoping session.	Background conditions for air quality are included in the environmental setting section (Sections 3.3 and 3.11) of the Draft EIS. The Draft EIS also includes a description of the facility's requirements for identifying, reporting, and responding to any exceedances as stated in permit requirements for public health and safety. The history of the HGP-A facility is outside the scope of this EIS.	Public Health and Safety
16	21	The 1987 EIS said that "two principle potential biological impacts are the safety and preservation of the native Hawaiian hawk population, and rare or endangered plant species". During the blowout dead birds were found lying in the street in Pahoa, 4.1 miles away from the plant. Birds have been used for hundreds of years in coal mines to act as early warning systems to miners of the presence of noxious gasses. There was a survey and study of native birds and the Ope'ape'a (Hawaiian Hoary Bat) conducted by Michelle H. Reynolds, Brian A. Cooper and Robert H. Day in 1997, published in Pacific Science, Vol. 51, University of Hawaii Press. One area surveyed was the PGV area. The presence of listed biota were documented. Endangered Newell's Shearwater nests and fledges in Pualena Crater, across the street (Kapoho Rd.) from PGV. Since the study was done there have been several hurricanes and 2 lava eruptions that have destroyed prime habitat. We no longer know if these species are still present in the area, or in what numbers. HRS 342 3-1 defines air pollution as including substances that may endanger plant or animal life. The EPS has described the toxicity of hydrogen sulfide on human and non-human species. H2S rules are set for healthy adults and do not factor in the impact of such pollution on the wildlife in the area, particularly listed endangered species. That birds are more sensitive to these gasses has not been considered by DOH in setting allowable levels in their air permit, nor was it discussed in the original EIS. These matters need to be addressed in the draft EIS.	Potential impacts to biological resources are discussed in Section 3.5 of the Draft EIS. A biological survey of the Project Area (Appendix G of the Draft EIS) was also prepared for the Draft EIS. Potential impacts from hazardous materials and solid waste are discussed in Section 3.10 and potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS.	Biological Resources, Hazardous Materials, Public Health and Safety
16	22	Notice page 1.6 says, "[n]either PGV nor Ormat have additional land positions for geothermal energy that would give them the ability to utilize other locations on Hawai'i Island or elsewhere in the state to commercially produce energy using geothermal resources." However, in February of 2012 DLNR published an Environmental Impact Statement Preparation Notice for Ormat titled Ulupalakua Geothermal Mining Lease and Geothermal Resource Subzone Modification Application. Also in 2012, Hawaii Electric Light Company requested proposals for new geothermal energy production that resulted in the selection of Ormat to provide an additional 25 MW of geothermal energy for Hawai`i Island (but Ormat eventually withdrew from the negotiation of that contract). In 2019, Ormat announced that it had commenced commercial operation of its first geothermal and solar hybrid project, a 7MW solar expansion of its Tungsten Mountain geothermal project in Nevada. Further, Act 205, signed June 22, 2022, appropriated $500,000 dollars to the department of Hawaiian home lands for the investigation, exploration, and identification of geothermal resources on Hawaiian home lands. Public events on February 5 and 19, 2022, covered topics relating to geothermal energy exploration and development, featuring, among others, Mike Kaleikini identified as Director of Hawai`i Affairs for PGV/Ormat and also a Commissioner of the Department of Hawaiian Home Lands. Given these facts, it is misleading to suggest PGV and Ormat have no potential interest in geothermal or related energy development beyond the present facility. An update to the PUC from Hawaiian Electric dated July 1, 2022, said: PGV notified the Company that changes in market conditions have transpired since the terms of the ARPPA were negotiated and has indicated its desire to negotiate an amendment to the ARPPA to mitigate the impacts. At this time the Company is still reviewing PGV's request.	The text was intended to convey that there are no other properties that are currently commercially viable on Hawai'i Island. The text in the Alternatives section of the Draft EIS (Section 1.5) has been revised to clarify this point.	Alternatives
16	23	The EIS should disclose and discuss these circumstances, including the practical and existing alternative of a solar energy generating and battery storage component and revised economic factors due to PGV's recent notice regarding changed market conditions. There are numerous practical alternatives to the action as proposed and the discussion should not be limited to a no-action alternative.	Comment noted; other applicants would need to put forward those projects for analysis. PGV is not proposing a solar or battery storage energy project at this location as part of this Project; therefore, this is not a reasonable alternative to include in this Draft EIS.	Alternatives
16	24	The notice frequently refers to the installation of new OECs designed by Ormat to utilize steam and brine from the geothermal resource. Please discuss the development and design of the OECs intended for use at PGV, particularly to what degree was their design specifically intended to address post-eruption PGV conditions and where else, if anywhere, these specific types of units are also (or will be) in service. Also, the draft EIS should address whether the project is actually an expansion of PGV's existing facility or, rather, is it a new generating facility, including matters such as: use of a unique new generator type; the capacity of the new generators relative to the existing post-eruption production; physical and spatial factors such as the size and location of the new equipment relative to the existing equipment (the 10 existing steam-binary energy converters will be replaced with 2 new energy converters placed in a new location, with new piping). As the present generating capacity is closer to 23 MW, a repowered generating capacity increase to 46 MW will be a 100% increase.	Additional information regarding the description of the Proposed Action is included in Section 2.2 of the Draft EIS.	Proposed Action
16	25	Puna Pono's members have varying points of view with regard to appropriate electricity production. Some Native Hawaiian members are more concerned with spiritual and cultural matters. Members with backgrounds in science and technology, usually concerned with Native Hawaiian issues, may also focus on environmental and economic impacts of energy production in their evaluation of various alternatives. It seems to be a generally held view that PGV has been the subject of lax regulatory oversight while operating in Puna, and that laxity has burdened the community. It also is a common view of PPA's members that placing a large power production facility serving the entire island on top of an active rift zone of Kilauea should be a non-starter. The recent eruption is a lesson not to be ignored: the plant was damaged and totally cut off from land access and connection to the utility company's grid, and could be again.	Potential impacts from geologic hazards to the plant are discussed in Section 3.1 of the Draft EIS. Potential impacts to cultural resources and practices are discussed in Sections 3.7 and 3.8 of the Draft EIS. Potential impacts to socioeconomics and environmental justice are discussed in Section 3.6 of the Draft EIS. The location of the Project is consistent with zoning, and the facility is operated consistent with permit requirements. Regarding the site's location, siting of a geothermal facility is dependent on the identification of the following three key elements: heat, water, and natural geological permeability. At the PGV facility, heat is supplied from the Kīlauea volcano, water is supplied primarily from the nearby ocean (and some rain), and the	Geologic Hazards, Cultural Practices, Historic Resources, Socioeconomics, Public Health and Safety

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			relatively young geology of the Lower East Rift Zone is naturally permeable in numerous locations. PGV and Ormat are aware of and understand the hazards associated with developing a geothermal facility near volcanic areas such as the Lower East Rift Zone. The risks associated can result in having to shut the plant down for extended periods, such as the case of the 2018 Kīlauea eruption. However, these are risks that PGV and Ormat address through the development and implementation of Emergency Response Plans and other operating procedures and by close coordination with county and state officials. Potential impacts from geologic hazards and public health and safety are discussed in Sections 3.1 and 3.11, respectively, of the Draft EIS.	
16	26	Many Puna Pono members live off of the grid, relying on their own electricity generation and storage, and therefore have no need for electricity in any quantity from PGV. As noted, there is a generally held view is that regulatory oversight of PGV has been so lax over the years as to be a burden on the community. This seems to trace back to early days of geothermal development when U.S. Senator Daniel Inouye embraced the subject enthusiastically, providing political and financial support for geothermal development in Hawai`i. Despite the passage of several decades it seems that initial badge of political sanction at the highest level of the state political hierarchy set the tone, and subsequent years have done little to change the tone, of treating geothermal developers as most favored clients of state agencies. PGV has shown that when it wants to take steps to provide greater protection for the community and matters that affect the environment, it can. As a profit driven enterprise, PGV has a primary need to satisfy and sustain its investors, and from time to time it seems to have taken advantage of lax regulatory conditions to avoid certain expenditures, sometimes at the expense of the community and environment. Therefore, an essential necessity for continuing PGV's operations is to assure that greater protection for the community and the environment on a continuous basis has a higher priority. On the other hand, it may not be possible for PGV to operate in an appropriate manner, because it is abusing natural resources. The Hawaiian chant E komo maloko o Halema`uma`u speaking in the firstperson voice of the deity Pele, declares that whatever is hot is sacred to her. In the chant, the first-person voice representing the deity invites listeners to go to Halema`uma`u and see her display and her movements. The listener is invited to view her parts and how she dances and moves – but the listener is admonished not to take what belongs to the deity, and whatever is hot belongs to the deity. In other words, where the earth is hot it still belongs to the goddess and is sacred. The sacred heat of the earth is Pelehonuamea's realm, it is not meant for human exploitation. Seeking an appropriate balance between spiritual concerns of significant parts of the Puna community and the perceived needs of PGV's politically favored commercial enterprise and closely related needs of Hawai`i Electric to survive in both political and economic terms is the actual discussion of the moment. Interruption of PGV's production by upset conditions, natural incidents, and degradation of the quality of the geothermal resources to an extent that declines in geothermal well capacity mean PGV cannot meet obligations under any PPA, self-evident serious risks to the Puna community and environment, including induced seismicity, related repercussions on resiliency and grid costs, the fact that any actual need for new electricity generation is located on the west side of Hawai`i Island and the substantial costs of transmission from the PGV Puna site to the locations of actual need unnecessarily adding to consumers' cost of electricity, existence of economical alternative options for energy production and the inhibiting effect of PGV's large industrial generating plant in Puna on those options, the unexpected withdrawal of Ormat from previous PPA negotiations for financial reasons, regulatory snafus in administration of DOH permits required for the operation of the PGV's facility that foretell extended litigation, PGV's need to obtain constant and continuous supply of necessities for operations and maintenance from off-Island sources, and further matters, from Puna Pono's perspective, make plans for PGV to operate a new 46 MW facility an uncertain prospect, at best. All of these concerns need to be addressed individually and cumulatively in the draft EIS.	Comment noted. Please refer to Section 3.8 of the Draft EIS and the Cultural Impact Assessment attached to the Draft EIS as Appendix I for a discussion on the potential impacts to cultural practices under the Proposed Action. Regarding community engagement, PGV responds to all correspondence, including emails, and phone calls. PGV also hosts quarterly public meetings announced on its website and advertised in the community, which include opportunities for questions and answers with plant operations and management personnel.	Cultural Practices
16	27	Eruption related changes in the geology, topography, configuration and demography around PGV's site are self-evident. Those chnages and related effects on resource and risk exposure and assessment, emergency planning and response and environmental matters must be subjects of environmental review.	Potential impacts from geologic and natural hazards to the plant are discussed in Sections 3.1 and 3.11 of the Draft EIS.	Geologic Hazards, Public Health and Safety
16	28	The following non-exclusive summary list includes additional matters for the draft EIS. is PGV using enhanced geothermal preventative maintenance generally and specific schedules pentane risks, emissions and emergency plans re-injection statistics and risks monitoring I'o nests and endangered species studies Albezia along the transmission line corridor and access to HELCO drone footage maintenance toxic gas emergency plans (including evacuation) real time monitoring and indication and public warning of H2S leaks	The impacts to the various resources listed in the comment are discussed throughout Chapter 3 of the Draft EIS.	General Analysis, Geologic Hazards, Current Operations, Hazardous Materials, Hydrology,

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		Emergency Planning and Community Right-to-Know Act (EPCRA) compliance risks of reinjection of H2S into the ground drinking water impacts monitoring of heavy metals and impacts real time meteorological data with modeling to show public direction and concentration of gas plume during an emergency incident and emergency notification system and evacuation plan for neighbors DOH record of investigating incidents and impacts of upset conditions data measurement of facility noise and drilling noise PGV staffing, including during storms County emergency response, no PGV specific emergency response plan PGV's ownership for accountability purposes Lack of roads and infrastructure in lower Puna, effect on response times and exit routes for emergencies changes in biological topography, population, infrastructure, geology, wind patterns, ecological environment, numbers of trees and their effects Pentane amount, location, hazards and tracking of escaped Pentane risk of pentane explosion and impact it could have on wellheads impacts of geothermal drilling, accidents and injection on geology, fresh water lens, and reefs risk of drilling into magma and lack of emergency response plan to mitigate that risk community impacts of the stress from living with the risk of PGV incidents impact on neighbors of not being able to safely take shelter in their home during winds storms and hurricanes when there are not enough shelters available on the island and no shelters for animals left behind cooling of the hot eruption field causes cracking and breaking of the rocks that changes the impedance of the rocks to the flow of water changed situations regarding subsurface water, rock structure and temperature, geothermal resource fluids and the fresh water lens changes in demographics and the transportation and utilities network PGV's emergency procedures, hazard mitigation and response planning effects on groundwater used for non-PGV purposes (such as whether any groundwater sources have been cut off or whether residual heat is causing sources such as wells and springs to dry up) By this reference, Puna Pono refers to and incorporates all comments on the scope of the draft EIS, whether or not they duplicate or expand upon the issues noted above.		Air Quality, Public Health and Safety, Noise, Biological Resources
Alice Kim				
17	1	As a lifelong resident of Hawaii, I support Puna Geothermal Venture's plan to increase its power production to 60 MW and replace its current power-generating units with upgraded ones. Supporting Puna Geothermal Venture (PGV) will support the State of Hawaii in reaching its 100% renewable energy source mandate by 2045. As Hawaii's only commercial geothermal power plant, PGV produces about 20 percent of the Hawaii Island's electricity. PGV's contributions to the Hawaii Island's renewable energy was made obvious during the 2018 lower Kilauea eruption. After the eruption shuttered PGV's power plant, as a result, the Hawaii Island increased its fossil fuel use.	Thank you for your participation in the EIS process; please see responses to your specific comments below.	General Support
17	2	We should encourage geothermal energy production because it benefits the people of Hawaii by offering the following: - Create local professional jobs - Lower the cost of electricity - Greatly reduce carbon emissions involved with creating energy - Serve as a consistent, stable source of energy compared to other energy sources - Provide baseload power, or the minimum amount of power that a utility company must generate for its customers, and doing so ensures reliability of the electricity grid and reduces costs. - Generate revenues for the betterment of Native Hawaiians - Increase the self-sustainability of the Hawaiian islands and reduce the import of oil	Potential impacts from the Proposed Action, including benefits of the Proposed Action to socioeconomics, are discussed in Section 3.6 of the Draft EIS.	Socioecono mics
17	3	Hawaii still has a long way to go in terms of reaching its 100% renewable source mandate by 2045, and geothermal energy will play an important role in making that happen. With Hawaii's volcanism, limited landmass, and fragile natural resources, we should support PGV's plans for expansion and upgrading its facilities. Furthermore, we should encourage the use of geothermal, Hawaii's only cost-effective baseload renewable energy source.	The Project's consistency with government plans and policies is discussed in Section 4.0 of the Draft EIS.	Consistency with state goals
Selah Levine				

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18	1	I attended the meeting on Wednesday August 17, 2022. I do not like public speaking so I did not give my comments at the meeting. However, I would like to communicate my comments and concerns in this email. I have lived approximately 3 miles downwind from PGV for the past 10 years. Personally, my 2 biggest "enviornmental" concerns are the hazardous chemicals released by PGV and the noise. During hurricane iselle I was terrified when there was a release of hydrogen sulfide. Being downwind without windows in my living space was frightening. I had no way to protect myself and was unable to evacuate during the storm. PGV is the only geothermal plant in the world located in close proximity to homes and schools. This alone should be reason enough to shutdown this plant.	Thank you for your participation in the EIS process; please see responses to your specific comments below. Section 3.11 of the Draft EIS describes how PGV responds in the case of natural disasters as required in permit requirements and consistent with the ERP for public health and safety.	General Opposition, Public Health and Safety
18	2	My second concern is the noise. This is a daily problem. Being downwind I can clearly hear the engines and drilling all night, every night. I would also like to note that since the 2018 eruption leveled most of the homes and vegetation that was a buffer between my home and PGV, the noise is now even worse. These are the concerns that affect me personally, though the damage to the natural environment is also a huge concern. It is impossible that PGV does not have detrimental effects on the health and safety, of wildlife and ground water respectively, in the area.	Potential noise impacts from the Project are discussed in Section 3.4 of the Draft EIS, as well as potential impacts to public health and safety, biological resources, and hydrology, which are discussed in Sections 3.11, 3.5, and 3.2, respectively.	Noise, Public Health and Safety, Biological Resources, Hydrology
18	3	The alternative to renewing this contract is to not renew it. I support not renewing the PGV contract as well as shutting down the facility ASAP.	Comment noted. Since this is an applicant action, closing the plant at this time is not proposed by the applicant and is not a reasonable alternative.	Alternatives
18	4	Lastly, after attending the meeting it was clear that there are many in the community who feel threatened and uneasy about living near PGV. There was only one positive comment given in regard to PGV in a room full of people. Many very angry and almost in tears. These people are a part of this environment. It was obvious that PGV has has damaged the health and wellbeing, if not physically than mentally, of the people in this community.	Comment noted; the Draft EIS analyzes the impacts of the Proposed Action throughout Chapter 3.	General Opposition
Paul Kuykendall and Suzanne Wakelin				
19	1	My name is Paul Kuykendall and I am a farmer whose ohana is one mile makai of PGV in Keahialaka. I am also co-founder of the Waihu O Puna Watershed Coalition and am commenting on our coalition's behalf. Please note that I intend to follow this EIS process and request that I be included in all future notifications and opportunities for public comment. My comments on the PGVRP EIS Preparation Notice are as follows: This PGV repowering proposal looks forward to increased power production and promises minimal impact on the community and the ʻāina. But if you look back at the history of PGV's 35 years of geothermal power production and the minimal regulation by the county and state of Hawaii, you can easily see the probable future unless there is a significant change in the way geothermal power is conducted and regulated.	Thank you for your participation in the EIS process; please see responses to your specific comments below. Your name has been added to the contact list in the Draft EIS.	EIS Contact List
19	2	**Noise** When geothermal started in Puna, the EPA recommended 45 dBA during the day and 55 dBA at night for noise regulation. Since then the state and the county have increased the limit to 70 dBA, 5 times higher than the previous limit, the noise level of a busy freeway, day and night in what once was a quiet agricultural district. I live a mile from the plant. There is lava on three sides of my home and lava in the direction of PGV. This means no trees or plants to mitigate the noise and the noise bounces off the lava walls which are higher than the house. This makes the noise louder than before the 2018 lava flow. The noise is louder than the coquis, louder than the wind, louder than the ocean waves–first thing in the morning, during dinner and in the middle of the night. PGV's noise monitors are on the opposite side of the plant from my home, so they do not reflect the noise from the plant when the noise is at its worst–when the wind is blowing in my ohana's direction. Each 10 dB increase represents a 10x increase in sound intensity. As far as the sound volume is considered, we perceive a 10x sound intensity as a 2x increase in sound volume. Although Hawaiʻi state law says that noise levels can be up to 70dBA during the day or the nighttime, with which PGV justifies their noise output, HRS §11-46-13 also says that The council of any county may adopt and provide for the enforcement of ordinances regulating any matter relating to excessive noise. No ordinance shall be held invalid on the ground that it covers any subject or rule of the State; provided that in any case of conflict between the statute or rule and ordinance, the law which affords the most protection to the public shall apply. The first county Geothermal Resource Permit (GRP) followed the EPA guidelines 45 dBA during the day and 55 dBA at night except it allowed the allowable noise levels to be exceeded by a maximum of 10 dBA 10 percent of the time. DBA is a logarithmic scale so that Every 3-decibel increase in a sound actually represents a doubling of the sound's intensity so the allowed exception was three times higher. In 2012, the county, after an upswell of complaints about 24/7 drilling that kept keiki from sleeping, passed an ordinance that banned nighttime drilling. Though that ordinance is still on the books, PGV simply ignored it and the county never enforced it, saying they might be sued if they enforced it. PGV has drilled many wells 24/7 since then. The county has done nothing.	Potential noise impacts from the Project are discussed in Section 3.4 of the Draft EIS. Regarding the noise ordinance per Section 46-17, HRS, a legal ruling found that the noise ordinance referenced was preempted by state law and cannot be enforced at the facility. The facility operates within allowable noise limits with DOH standards and DLNR's rules regarding safe drilling practices protecting public safety.	Noise

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		Noise pollution has a negative impact on the health and well-being of people, animals and birds that live near the plant. It increases stress, interferes with sleep and eating. Disrupts activities such as meditation, farming, yoga exercises and daily life. It has a particularly large impact on those of us who dwell in buildings that do not have air conditioning because we have to choose between breathing and heat with less noise. Some additional aspects associated with drilling and plant operational noise include: Audible noise spectrum Low-frequency noise spectrum Intensity, frequency & timing Geometry of noise sources Impact on specific local wildlife, communication, threat detection, stress Changes in temporal patterns, behavior, vigilance of surrounding neighbors & wildlife Impacts on neighbors, chronic noise stress, sleep disturbance Physiological stress Increases in noise intensity at night/with prevailing wind patterns		
19	3	**Light Pollution** Light pollution impacts people, birds, and animals. PGV says they shield lights, but they light up the sky for miles around the plant. This has a negative impact on birds who navigate the night sky. Petrels and other birds have been shown to reduce populations near light and noise. It hurts people and animals too. We love stargazing at the night sky. When PGV returned, we could no longer see constellations that we could see before the light pollution. It makes sleep more difficult for people, animals and birds. Why does PGV need to light up the night sky?	Potential impacts to aesthetics and biological resources from the Project are discussed in Sections 3.9 and 3.5, respectively, of the Draft EIS.	Visual Resources, Biological Resources
19	4	**H2S Steam releases** The 1987 PGV EIS talks about smell. Of course it's not the smell, but toxic H2S gas that can kill you at 100 parts in a million. In 30 years, there have been more than 70 documented geothermal release emergencies. That averages one in less than every 6 months. Because the monitoring is so poor this is a fraction of the actual incidents. Over and over, there is a leak of toxic gas and no alert until neighbors call 911 when they get sick. Then the fire department comes out with monitors. The other neighbors aren't notified while the county waits for the report from the fire department. Meanwhile PGV has sensors at their well pads, but they don't share that data with the public or the county. Afterwards, PGV calls in their numbers to DOH and DOH says there was not enough H2S to affect neighbors. The next accident is not only likely, but predictable, and so is the lack of alerts and the gaslighting. Tropical storm Iselle is a recent example. I had toured the PGV plant twice and thought that we were too far away to be affected by the H2S leaks that emanated from PGV. When Tropical Storm Iselle hit in 2014, I found out I was wrong. My wife, her 80-year-old mother and I were all nauseous, had severe headaches and trouble breathing. More than a hundred of my neighbors were sickened, some passed out. The fire department never made it out to the plant due to albizias down on the road and people couldn't flee the toxic plume. The director of DOH, from the safety of Honolulu, told the star advertiser that there wasn't enough H2S released to sicken anyone–based on numbers given to them by PGV. The EPA fined PGV $76,500, not even a parking ticket for a company that makes millions each month. The EPA found that PGV had failed to take necessary steps to prevent accidental releases of hydrogen sulfide. The lava flow made a potentially deadly change: There are no trees or plants on the lava-covered areas to mitigate H2S flows. Since our homes are located in the kipukas (areas not covered in lava), it means the homes are lower than the surrounding lava, which can be 30-50 feet higher. This creates low areas inhabited by families where H2S would pool, since it is 20 percent heavier than air. These kipukas would collect and limit the dispersion of H2S by wind, and would turn our homes and gardens into death traps in concentrations as low as 100 ppm. PGV's monitors are on the opposite side of the plant from my ohana, so they would not reflect a H2S plume that flowed downhill toward my ohana. They are worthless for my ohana. There would be no alert of an H2S plume. Risk of toxic geothermal steam releases also bring risk to gardens, forests, animals and birds.	Potential impacts to air quality from the Project are analyzed in Sections 3.3 and 3.11 of the Draft EIS. As discussed in these sections, real-time data on H_2S concentrations are available on PGV's website at https://punageothermalproject.com/. Section 3.11 of the Draft EIS describes current H_2S conditions related to public health and safety and potential impacts under the Proposed Action. The locations of the monitoring stations used by the facility were approved by the State Department of Health. The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	Air Quality, Public Health and Safety
19	5	**Water Contamination** PGV drills through the freshwater lens that our drinking water wells draw from. If their injection wells are compromised, toxic heavy metals in geothermal steam, anti-corrosives which PGV adds to injectate and the pentane that PGV uses will contaminate our drinking water and the near shore ponds and springs, including fishponds that have been malama-ed by my Hawaiian friends for more than 13 generations, more than 300 years.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Additionally, potential impacts to public health and safety are discussed in Section 3.11.	Hydrology, Public Health and Safety
19	6	Even if the wells stay intact, every geothermal steam release sends toxic heavy metals and caustic soda onto our roofs and water catchment systems. The toxics that land on the ground end up in the freshwater lens as well. PGV likes to say that the quality of our freshwater lens isn't very good in lower Puna. That might have something to do with the 1991 PGV well blowout that spewed toxic geothermal steam for a 10 mile radius for 31 hours.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Potential impacts from hazardous materials are discussed in Section 3.10 and potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS.	Hydrology, Hazardous Materials, Public Health and Safety

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19	7	I also am concerned about oil and grease contamination of freshwater lens. According to PGV well monitoring reports it has already happened.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Additionally, potential impacts from hazardous materials are discussed in Section 3.10.	Hydrology, Hazardous Materials
19	8	Geothermal power uses large amounts of water in the life cycle for geothermal power production. Please disclose the amount of water that will be consumed during this life cycle both for construction and for operation and drilling so we can assess the impact on the ʻāina and the watershed. Use of large amounts of water could affect wells citizens use in the area as well as the content and temperature of nearshore springs and ponds. In assessments of water use at power plants, two water quantities are commonly listed: water withdrawn and water consumed. The former is defined as water taken from ground or surface water sources mostly used for heat exchangers and cooling water makeup, whereas the latter is water either consumed in the process or evaporated and hence no longer available for use in the area where it was withdrawn. Supplemental water is also added to injectate. Water consumption also includes water withdrawals related to construction stage activities (e.g., in drilling muds and cement). Please quantify water use for each activity during the life of this project. During the drilling process, fluids or "muds" are used to lubricate and cool the drill bit, to maintain downhole hydrostatic pressure, and to convey drill cuttings from the bottom of the hole to the surface. To accomplish these tasks, drilling muds contain chemicals and constituents to control factors such as density and viscosity and to reduce fluid loss to the formation. Operators formulate muds on site and alter the recipe according to the physical conditions and chemical properties of the site and as conditions change during drilling. Muds are screened to remove cuttings brought to the surface, and are periodically changed during drilling in response to changing conditions. The mud remaining in the circulation system after drilling may be disposed of. These processes both use water and have the potential to contaminate the soil and the freshwater lens. Please disclose how much water is used for a well and what chemicals, minerals, polymers and pfas are used in drilling, and how drilling mud is handled and disposed of for each well.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Additionally, the amount of geothermal resource needed for the Project is included in Section 2.2 of the Draft EIS.	Project Description, Hydrology
19	9	Similar concerns exist for well casing and the cementing of casing. How much water and what additives are used for the cement. Since the cement will run the length of the well bore, additives and cement will come in contact with the freshwater lens. Please list how much water and what additives are used for this process. We know that since the eruption, the resource that PGV uses is higher temperature. If not handled responsibly, geofluids are a potential source of water and soil contamination due to elevated TDS and the presence of toxic minerals. Proper well drilling processes and blowout prevention controls are extremely important for minimizing these risks. We already experienced a blow out in 1991 at PGV, after PGV said it was a small possibility. Well casing failure, pipeline leakage, and other surface spills are also possible pathways for contamination.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS, as well as a description of approved drilling operations. Potential impacts from hazardous materials and solid waste are discussed in Section 3.10 and potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS.	Hydrology, Geology, Hazardous Materials, Public Health and Safety
19	10	Comparison of the geofluid composition with U.S. drinking water standards will show that geothermal fluids pose a large potential risk to water quality. To allow us to analyze the potential risk posed by the release of geofluids, please compare the geofluid composition data from PGV with U.S. drinking water standards and share the results. That way we can see what is at risk to the freshwater lens and to local catchment systems if another blow out, drilling accident or well casing failure occur. Because Hawaii County water systems were destroyed in the lava flow, local residents rely on water catchment and private wells for their drinking and agricultural water. Rainfall has changed radically since the lava flow due to the destruction of rainforests in the affected areas. For these reasons, groundwater is the last resort drinking water source for the people and animals living in the area when rainfall is inadequate. To simply say that the injection is done below the water table does not take into account the fact that the injected fluids can contaminate along the entire pathway to the bottom of the injection wells. It is unconscionable to risk fouling this water source without studies to determine the geological impact of injecting millions of gallons of geologic fluids into the earth. The comparison with the drinking water standards clearly shows that there is a risk from the release of geofluids into drinking water, especially in terms of toxics such as antimony, arsenic, lead, and mercury. In general higher concentrations of contaminants were observed in the high-temperature than the moderate-temperature geofluids. The resource at PGV is known to be high-temperature.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS including baseline conditions, as well as a description of approved drilling operations. Please refer to the County of Hawaiʻi Kīlauea eruption infrastructure recovery update page online here for information on county projects to replace lost water-related infrastructure: https://recovery.hawaiicounty.gov/infrastructure.	Hydrology, Geology
19	11	Use of anti-corrosion fluids such as Chemtreat, inject chemicals into the geothermal fluids that are acutely toxic to aquatic life, such as the fish, limu and shrimp that live in nearshore ponds and reefs. We know that at one point PGV was injecting about one 55 Gallon barrel of this toxic anti-corrosive fluid into the āina every day. What anti-corrosives or other contaminants are injected in wells and how much per MW? Please provide Safety Data Sheets (SDS) for all chemicals used at PGV so we can determine the risk to the watershed.	Potential impacts to hydrology (including the nearshore marine environment) from the Project are discussed in Section 3.2 of the Draft EIS, as well as a description of approved drilling operations.	Hydrology, Geology
19	12	Even though PGV describes its production system as "closed-loop" in addition to corrosion inhibitors, PGV also injects Pentane into the aina every day, as noted in the USGS 2015 study, "Groundwater Chemistry in the Vicinity of the Puna Geothermal Venture Power Plant, Hawaiʻi, After Two Decades of Production." Please quantify fugitive emissions of pentane and quantify how much is injected into wells and how much escapes into the air yearly for the past 35 years and the estimate for future production levels. Pentane was also detected in a monitoring well. Well casing failure, pipeline leakage, and other surface spills are also possible pathways for contamination.	Potential impacts to air quality and hydrology from the Project are discussed in Sections 3.3 and 3.2 of the Draft EIS; the hydrology section also includes a description of approved drilling operations.	Air Quality, Hydrology, Geology

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		There would be the possibility of gas breakout from injection wells into shallow aquifers.What are the long-term effects of gas accumulation in injection zones, which for the PGV well field is located below the production zone.		
19	13	Wells can be damaged even if the surface lava doesn't reach the plant, if an eruption shears off the wells underground. If the wells are damaged, they could blow out. They would release steam that could contain hydrogen sulfide and CO2, and whatever else is underground. That happened at a place called Krafla in Iceland in the 1970s. This may have happened at PGV when they doused the wells with water before the lava flow, but didn't cement the wells. What is the status of the wells that were covered by lava? What is happening below the service? Are they contaminating the freshwater lens now? Apparent changes at PGV water monitoring wells demonstrate the potential for contamination of the ground-water system from geothermal wells, and suggests the need for long-term hydrologic monitoring to identify cause-and-effect relations. Changes since the lava flow have increased the probability of contamination. A degree of hydrologic connection between the ground-water system and the underlying geothermal system is indicated by the occurrence of hot, saline ground water at several locations within and south of the LERZ. Potential effects include (1) changes in water level in wells caused by pumping of groundwater to support geothermal development and/or operation of geothermal production and injection wells, (2) contamination of the groundwater system from leakage of geothermal fluids and gases, and (3) changes in discharge characteristics of warm anchialine ponds along the coast. Hydrologic connections between such reservoirs and thermal groundwater discharging along the southeast coast are possible. Under such circumstances, pressure changes induced by development of geothermal reservoirs could cause decreases in flow and temperature of this thermal water. Warm waters from the anchialine ponds along the southeast coast appear to be mixtures of fresh groundwater and heated seawater derived from sources either within the LERZ or south of the surface expression of the rift.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. The status of the wells that were covered by lava is discussed in Section 2.1.1 of the Draft EIS.	Hydrology
19	14	Opae Ula are small red shrimp that can only be found in the wild in the Hawaiian islands. They naturally live in pools near the shore filled with brackish water called anchialine pools. I am especially concerned about heavy metals which bio-accumulate and could contaminate the freshwater lens, and thus wells citizens use for drinking water and agriculture. They could also contaminate near shore fresh water ponds and springs as well as brackish ponds which have been used by Hawaiians for many generations as fish ponds and to water and feed animals near the coast. The temperature, ph, TDS and content of near shore ponds could be affected by contamination of geothermal fluids.	Potential impacts to hydrology (including the nearshore marine environment) and biological resources from the Project are discussed in Sections 3.2 and 3.5, respectively, of the Draft EIS.	Hydrology, Biological Resources
19	15	Geothermal power uses large amounts of water in the life cycle for geothermal power production. Please disclose the amount of water that will be consumed during this life cycle both for construction and for operation and drilling so we can assess the impact on the 'aina and the watershed. Use of large amounts of water could affect wells citizens use in the area as well as the content and temperature of nearshore springs and ponds. In assessments of water use at power plants, two water quantities are commonly listed: water withdrawn and water consumed. Water consumption also includes water withdrawals related to construction stage activities (e.g., in drilling muds and cement). During the drilling process, fluids or "muds" are used to lubricate and cool the drill bit, to maintain downhole hydrostatic pressure, and to convey drill cuttings from the bottom of the hole to the surface. To accomplish these tasks, drilling muds contain chemicals and constituents to control factors such as density and viscosity and to reduce fluid loss to the formation. Operators formulate muds on site and alter the recipe according to the physical conditions and chemical properties of the site and as conditions change during drilling. Muds are screened to remove cuttings brought to the surface, and are periodically changed during drilling in response to changing conditions. The mud remaining in the circulation system after drilling may be disposed of. These processes both use water and have the potential to contaminate the soil and the freshwater lens. Please disclose how much water is used for a well and what chemicals, minerals and polymers and pfas are used in drilling and production. Similar concerns exist for well casing and the cementing of casing. How much water and what additives are used for the cement? Since the cement will run the length of the well bore, additives and cement will come in contact with the freshwater lens. Please list how much water and what additives are used for this process. Contamination of ground-water resources from accidental release of geothermal fluids into shallow aquifers could result from casing leaks in the geothermal wells and accidental well blowouts. Subsequent contaminant migration could be rapid because of relatively high groundwater velocities in parts of the region. Ground-water velocities in the dike-free parts of the rift zone might be as great as 10 ft/d or more. Under such conditions, contaminants could move distances of several miles in a period of a few years. We are already seeing increased chloride in monitoring wells.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Potential impacts from geologic hazards are discussed in Section 3.1. Potential impacts from hazardous materials are discussed in Section 3.10, and potential impacts to public health and safety are discussed in Section 3.11.	Hydrology, Geology, Hazardous Materials, Public Health and Safety
19	16	PGV's application for additional injection permits uses 30 year old studies of the hydrological resource. Cited in their application: Cox, M. and Thomas D., 1979, Cl/Mg ratio of Hawaiian ground water as a regional geothermal indicator in Hawaii, Hawaii Institute of Geophysics Technical Report, HIG- 79-9, 51 p.Druecker, M., and Fan, P., 1976, Hydrology and chemistry of groundwater in Puna, Hawaii, Groundwater, V. 14, No. 5, pp. 328-338.Fetter, C., 1980, Applied Hydrogeology, Merrill Publishing Co., Columbus, Ohio, pp. 299-	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Potential impacts from geologic hazards are discussed in Section 3.1. Potential hazardous materials and solid waste are discussed in	Hydrology, Geology, Hazardous Materials

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		301, 155- 153.Iovenitti, J., 1990, Shallow Ground Water Mapping in the Lower East Rift Zone Kilauea Volcano, Hawaii, Geothermal Resources Council Transactions, V. 14, Part 1, pp. 699-703.Thomas, D., 1987, A Geochemical Model of the Kilauea East Rift Zone, in Volcanism in Hawaii, USGS Professional Paper 1350, pp. 1507-1525. While it is egregious to use 30 year old data to support a permit to inject millions of gallons of fluids that could affect groundwater, when coupled with the fact that a lava flow in 2018 radically altered the geological landscape, rainfall and water flows, it is reckless to do so without current studies of the current geology and environment. With the recent lava flow, it is possible and perhaps likely that the injected fluids would contaminate the groundwater and coastal navigable waters in the area. We don't know because no recent studies have been done. A method has been developed to prevent calcium carbonate scaling that involves continuous down-well injection of scale inhibitors, typically specialized and proprietary polymers. Does PGV use any polymers or PFAS in its operations?	Section 3.10, and potential impacts to public health and safety are discussed in Section 3.11.	and Solid Waste, Public Health and Safety
19	17	PGV's application for injection wells states: Injectate into the Existing Wells and any authorized Proposed Wells covered by this Permit is limited to the following materials: geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal non-condensable gases that are produced during the operation of the well field and the geothermal power plant located on the Permittee's property (the PGV Power Plant); chemical additives for process system and well casing biofouling, corrosion, and scale control; and supplemental water. PGV does not include pentane in that list of additives which is known to exist in the injectate in the PGV system. Please quantify the amount of Pentane and other contaminants, and in the injectate. Please quantify the supplemental water used in injectate. Chemical additives "for process system and well casing biofouling, corrosion and scale control" will damage the health of any living being they encounter. They must be studied before they are released into the earth and water that flows through it. The draft permit continues: "Supplemental water may consist of steam turbine seal water, rinsate from the water softener system, sulfatreat heat exchanger cooling water, raw/quench water,production well bleed system, abatement fluids, sulfatreat system vacuum pump seal water, condensate from the sulfatreat system, periodic produced drilling fluids, and fluids from the plant water storage tank and the emergency steam release facility (ESRF). Some of these fluids may contain the additives. . . ." Unfortunately for the local community, these fluids would cause egregious and long- lasting harm if they were allowed to foul drinking water. Further, they could foul local near-shore water and harm the fish and aquatic life which lives there. Studies must be conducted to evaluate the impact on coral reefs, fish and plant life. Tracer studies must be conducted to determine how these toxic materials could flow through the freshwater lens and to coastal waters. These studies would help us evaluate their impact on life there.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS.	Hydrology
19	18	Another concern is how much "supplemental water" and other material will PGV pump into the earth? With 16 wells (5 existing and 11 new wells) each capable of injecting, under pressure, millions of gallons of water per day, the impact on both the geological structure and fresh and coastal waters could be severe. If enough "supplemental water" is pumped into 17 injection wells, it could break up existing geologic structures and cause fouling of the freshwater lens. Where will the "supplemental water" come from? If it comes from PGV's recently drilled water wells into our fresh water lens in large enough amounts it could affect the quality and quantity of the freshwater drinking water wells. It could also affect how much fresh water flows to the ocean. If they draw thousands or millions of gallons of fresh water from a few hundred feet, then inject it at 6000+ feet, this could have a huge impact on the local ecology. We must know the source of the "supplemental water" to be injected and the quality and quantity before the safety can be evaluated. PGV has 5 existing injection wells. They applied for 11 additional wells. This would increase their injection wells by more than 200 percent. What will be the plant design and justification for such a radical increase in injection wells? I asked PGV what they needed the new wells for and they said they could accommodate their production with current wells. Again with the lava flow, and no studies, the impact on the local community and drinking water is impossible to predict. Due to the lava flow, the underlying geologic structure, rainfall, wind patterns, the egress routes in emergencies, the local population and county infrastructure have all changed radically. PGV is essentially drilling wells into an unknown geological structure using new technology in their power plant.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Potential impacts from geologic hazards are discussed in Section 3.1, and potential impacts to public health and safety including natural hazards are discussed in Section 3.11 of the Draft EIS.	Hydrology, Geology, Public Health and Safety
19	19	In September, 2012 the Hawaii Island Mayor asked Peter S. Adler, PhD to conduct an independent "joint fact finding" Study Group that would examine the type and extent of health impacts from Hawaii Island Geothermal Operations. The group recommended that any future geothermal development should do baseline studies to determine the water resource and ecological and health impacts prior to future geothermal drilling and development. The study stated:	Potential impacts to hydrology and public health and safety from the Project are discussed in Sections 3.2 and 3.11, respectively, of the Draft EIS.	Hydrology, Public Health and Safety

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		Geothermal development can affect the health and wellbeing of people surrounding the plant during dramatic accidents like the KS-8 blowout in1991 and potentially during smaller upsets and operational releases such as occurred in 1997 and 2005. By establishing a baseline health study, future health studies can more easily establish the magnitude and responsibility of health effects. Further, geothermal development may affect water wells downstream from the development area as well as the coastal basal brackish groundwater and the ocean near the geothermal plant. By establishing a baseline, future water studies will be able to more easily establish the magnitude and possible responsibility for environmental impact from geothermal development. The baseline water study conducted by USGS, while it did show that Petane was in the injectate, did not test wells makai of PGV and only tested one pond below the pond. A baseline study that establishes baselines for well makai of PGV and nearshore ponds and offshore springs needs to be conducted to determine the safety of an increase in geothermal power production.		
19	20	**Other drilling impacts** There must be a full account of all of the other impacts of the drilling processes as well as the environmental cost in terms of use of fossil fuels for drilling, pollution from drill rig equipment, machinery etc. including Diesel engine emissions from drill rigs & associated equipment, effect of lighting of the construction site on wildlife, birds, associated chemicals, additives, muds etc. and methods and costs of proper disposal in terms of shipping etc. and accountability of leakages and other issues associated with incomplete removal and disposal.	Potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS. Impacts to biological resources are discussed in Section 3.5 and impacts to noise are discussed in Section 3.4 of the Draft EIS. Solid waste disposal is discussed in Section 3.10 of the Draft EIS.	Hydrology, Biology, Noise, Hazardous Materials and Solid Waste
19	21	**Financial accountability** Puna Geothermal Venture is owned by two partners: ORNI 8 LLC and ORPUNA LLC. ORNI 8 LLC is an LLC registered in Hawaii. ORNI 8 LLC is owned by ORTP LLC, a limited liability company registered in Delaware. It is clear that Ormat is taking extraordinary steps to insulate itself from liability in the case of a well blowout, as happened in 1991, or if they foul our fresh water aquifer. I am concerned about their financial accountability in the event of an ecological disaster.	Comment noted; PGV is committed to the conditions of the current permits for the Project. Regarding financial accountability, the GRP requires 25 million dollars in umbrella coverage for PGV. The Geothermal Asset Fund is also available for anyone that can demonstrate they have been adversely affected by geothermal development. Additionally, the EPA includes a requirement for a letter of credit for well abandonment per the UIC permit. Potential impacts to hydrology are discussed in Section 3.2 of the Draft EIS.	Existing Operations, Hydrology
19	22	**Regulatory capture** DOH and the State of Hawaii have enabled geothermal power polluters in Puna to operate, poorly regulated, for more than 50 years–a classic example of regulatory capture. DOH actions and decisions have been clearly erroneous in view of the reliable, probative, and substantial evidence on the whole record, with predictable detrimental impacts on citizens health, well-being and happiness. In the process they have violated local citizen's rights under state constitution, air pollution control laws and regulations and EPCRA. DOH resisted regulation of hydrogen sulfide from the beginning of geothermal exploration, until compelled to do so by the courts. A Geothermal Public Health Assessment final report, published on September 9, 2013, by Peter S. Adler PhD, states, In 1990 after legal objections and court proceedings, the State of Hawai'i DOH issued air permits to PGV for the construction of a 25 MW power plant and geothermal well field. The air permits required the installation of three ambient air monitoring stations to measure concentrations of H2S in neighborhoods near PGV and on the fence line surrounding the power plant. Following a lawsuit initiated by community members against DOH, the State established legal H2S limits of 25 ppb for a one-hour average and 10 ppb for a 24-hour average. That was in 1990. Well before then, Puna's first geothermal plant was open-venting toxic hydrogen sulfide and heavy metals into the air near homes and children's bus stops and dumping heavy metals into unlined ponds that seeped into groundwater. When the first geothermal plant in Puna, HGP-A, was drilled in 1976, the project was presented as a strictly experimental, two-year demonstration project and not a production well. The project was presented to the public as a two year project, but the EIS for the project, published in 1976, stated it would only be a six month test. This is significant, because the EIS identified mercury as a major toxin in the geothermal brine that would be open-vented and stated that since it was a 6 month test, the load on the environment would be acceptable. The "Environmental Assessment of the Hawaii Geothermal Project Well Flow Test Program," published in November 1976, states: Heavy metals, notably mercury, are also evolved in an aerosol state from geothermal fluids. Sampling by the staff of the Hawaii Geothermal Project has given high priority to geotoxicology of mercury. Representative plant species in the area of the well yielded mercury levels that were relatively uniform in the various species and individuals. The mean levels at the site were somewhat lower than concentrations found at Volcano House and SulfurBanks. Mercury tends to accumulate over long periods of time in plants and can be concentrated in higher levels of the food chain. (my emphasis) Nevertheless, no significant accumulation is expected during the six-month well test. " (my emphasis).	Potential impacts to hydrology are discussed in Sections 3.2 and 3.3 of the Draft EIS. The PGV facility operates under two air permits and the applicable regulations (Table 4-1; also Sections 3.2, 3.10 and 3.11 of the Draft EIS). PGV complies with requirements for reporting upset conditions, and these are outlined in the various permits and their conditions in Sections 2.2, 3.2, 3.3, 3.4, 3.10, and 3.11 of the Draft EIS. Potential impacts to air quality are discussed in Sections 3.3 and 3.11, potential impacts from hazardous materials are discussed in Section 3.10, and potential impacts to public health and safety are discussed in Section 3.11.	Hydrology, Air Quality. Hazardous Materials, Public Health and Safety

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		The six-month test went on open-venting geothermal toxins, which included heavy metals that were known risks to plants, people and animals, for five years. In 1982, despite commitments to the public that the test would be 2 years and experimental, a three-megawatt commercial power plant went on line, run by HELCO. No community meetings were held explaining the change. The geothermal power plant continued for eight years and was shut down in 1989. HGP-A dumped the toxic geothermal brine into unlined ponds that fouled the air, land and water. The site eventually became an EPA superfund site. Though the presence of heavy metals in geothermal brine was known at the very beginning of the geothermal program, DOH, over more than 50 years, has assiduously avoided protecting citizens and the public from them. These heavy metals, which were deposited in unlined ponds with geothermal fluids by HGPA and have blanketed Puna Makai with every release of geothermal steam over 50 years, have flowed with rain into neighbors drinking water catchment tanks, it has flowed into the freshwater lens that sits below the porous rock that defines Puna makai's landscape. This puts neighbors at risk if they drink catchment or well water from the lens. It puts coastal and nearshore springs at risk. There are past and potential impacts of geothermal releases and injection on Hawaiian cultural practices. This includes the opae ula and fish ponds in Keahialaka that have been in the care of Hawaiian ohana for tens of generations. There was a major accident at PGV in 1991, when a well blow out vented more than 2,200 pounds of hydrogen sulfide (along with heavy metals) over a 31 hour period, killing animals and forcing the evacuation of at least 75 Puna residents. Adler reports, Since the blowout, DOH has recorded six incidents when permitted H2S limits were exceeded by PGV, including KS8 well drilling, well clean out activities, seal leaks, and equipment malfunctions. The one-hour limits ranged from 31 ppb to 789 ppb with the permit limit being 25 ppb on a one-hour average. Fines totaling $55,200 were assessed. These violations occurred from 1991 to 2005. As of February, 2013 PGV has reported 70 upset conditions involving H2S, 41 of which resulted in written reports to DOH, 28 involved verbal or courtesy notifications, and one resulted in a permit violation for exceeding the 25 ppb hourly average. How does a regulated plant have 70 upset conditions? More than any other power plant in the state of Hawaii. How does this keep happening? Through the willful neglect of state regulatory agencies. Repeatedly, DOH has relied on internal "experts" that contradict the experience of local citizens and mainstream science to reach conclusions that geothermal power plants do not risk citizen health. One of many examples was reported by the Environmental Reporter in May 1993 in the aftermath of the 1991 geothermal well blow-out at PGV: A "Health Risk Assessment'" prepared by epidemiologist Barbara Brooks for the state Department of Health concluded that the public would not experience any adverse health effects from accidental releases of hydrogen sulfide from the geothermal wells at Puna Geothermal Venture's facility on the Big Island. The DOH risk assessment would appear to fly in the face of the Goddard report, which found that "estimates of 10-mile impacts of H2S within the plume cloud centerline are high enough to yield observed symptoms" of hydrogen sulfide exposure. (my emphasis) Further, a worst-case impact event with the same emissions as the [June 1991] uncontrolled venting where winds were near calm or at 1.0 mph would have increased impacts an estimated four to 10 times. Under worst-case conditions, the distance to where health complaints were reported would be extended several fold. . . The DOH report does not refer to the Goddard & Goddard study, nor does it reference any of the health effects reported by residents following any of the several "unplanned" releases of geothermal steam by PGV over the last three years. (my emphasis) The DOH Health Risk Assessment is also inconsistent with well-documented modeling results presented in Appendix H of the PGV Emergency Response Plan. This modeling, done using the Industrial Source Code Short Term (ISCST), was "state of the art" in the 1980's. This is no longer on the "approved" model list, being supplanted by more recent models, but the results are reasonably accurate, at least at that time. The current situation is unknown, as there has been no updated modeling results presented to the public. Hence, the need for updated environmental documentation, to include modeling. The Environmental Reporter continues to quote Goddard: "The 17-year history of repeated adverse upsets associated with the HPG-A and PGV attempts to develop geothermal energy at the Puna site indicates that, in this location, development is beyond the current engineering 'state of the art,'" Goddard wrote. He called on the EPA to convene a panel of experts on underground injection control wells from its own staff and from the geothermal industry which "should review in detail each Puna geothermal well, direct the appropriate abandonment studies, prepare abandonment plans, and supervise proper well abandonment. His concluding statement described the Puna District East Rift Zone as "not an appropriate setting in which to develop the Island of Hawai'i geothermal energy resources." (my emphasis, a major concern)		

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		The DOH pattern of ignoring EIS reports, facts, independent consultants, and the impacts on residents has continued for 50 years. After local citizens were gassed by a PGV hydrogen sulfide release during Tropical Storm Iselle, they were gaslighted by DOH in the local media. Even though the DOH had received 10 complaints by sickened residents, Deputy Director for Environmental Health Gary Gill's first action was to tell the Star Advertiser, "In a hurricane, cyclone or tropical storm with winds going 50 mph, any kind of long-term exposure to hydrogen sulfide would be nearly impossible," of course Gill did not mention the fact that hydrogen sulfide is heavier than air and it traveled downhill under the treeline during the storm. Deputy Director Gill, from his safe perch in Honolulu, based his comments on reports by PGV without any independent data and no investigation on his part. Deputy Director Gill was not present in Puna Makai during Iselle (we were). Iselle came ashore as a hurricane, but quickly broke up into a series of violent squall lines interspersed with periods of relative calm. There are no wind records because PGV was not in compliance with backup power requirements and the monitoring systems were down. Dangerous quantities of hydrogen sulfide gas could easily have wafted into communities surrounding PGV, with residents trapped by fallen trees and debris. PGV could have shut down prior to storm arrival to avoid catastrophic consequences. They chose not to do so. This was during a time when residents were still recovering from the storm and could not respond because they were sick from the gas and dealing with the damage from the storm including poor cell phone reception, lack of internet or passable roads. More than a week later, a young DOH investigator visited our farm after Tropical Storm Iselle. Of course there was nothing to investigate a week after the incident. My wife and I gave the investigator a tour of our farm which was 1 mile from PGV. Over fresh goat milk and cookies, I asked him why DOH has sent a relatively new investigator for such a major incident. He responded, "I am the only one in the office who wanted to make the trip." Then I asked, why did DOH wait a week before sending out an investigator. He responded, "It's part of the DOH 'no look, no find' policy." This policy has been the hallmark of 50 years of regulatory neglect. This consistent lack of DOH regulatory oversight has led to PGV's cavalier approach to safety regulation. The EPA was so concerned about PGV's H2S release during Iselle, while the air monitors were not functioning and the subsequent maintenance on wells without monitors, that they inspected PGV's site. KHON 2 reported: The EPA conducted a chemical facility inspection in August 2013 and found that the company had failed to take necessary steps to prevent accidental releases of hydrogen sulfide. Specifically, the company had not tested and inspected its equipment with the frequency consistent with manufacturers' recommendations, good engineering practices, and prior operating experience. The inspectors also found that with respect to PGV's storage, use and handling of pentane, a flammable substance used as a working fluid in the facility's electricity producing turbines, PGV failed to: • Conduct periodic compliance audits of its accident prevention program and document that identified deficiencies have been corrected. • Implement adequate written operating procedures that provide clear instructions for safely conducting activities. • Ensure that the frequency of inspections and tests of equipment is consistent with manufacturers' recommendations, good engineering practices, and prior operating experience. • Analyze and report on a worst-case release scenario and estimate the population that would be affected by an accidental release of pentane. KHON 2 also reported: The U.S. Environmental Protection Agency announced Tuesday a settlement with PunaGeothermal Venture for Clean Air Act chemical safety violations at its geothermal energy plant. After an EPA inspection, the facility has now complied with the rules designed to minimize accidental chemical releases. The company has also agreed to pay a civil penalty of $76,500. Note DOH did not do the inspection that resulted in the remedial actions and fine. The EPA had to step in and do the job that DOH should have done. Nonetheless, the $76,500 penalty is a mere slap on the wrist for a $7 billion dollar Ormat who makes millions from PGV revenues.		
19	23	**DOH and State of Hawaii regulatory capture** The State of Hawaii and DOH has acted in an arbitrary, capricious manner, characterized by abuse of discretion or clearly unwarranted exercise of discretion to keep PGV operating with minimal regulation. This is exemplified by Governor Ige's response to concerns about the changed conditions around PGV after the lava flow. In a response to Senator Russell Ruderman, he states,	Potential impacts to noise are discussed in Section 3.4 and potential impacts to air quality are discussed in Sections 3.3 and 3.11 of the Draft EIS. As discussed in Section 3.11 (public health and safety), real-time monitoring data are available on the PGV website at https://punageothermalproject.com/.	Noise, Air Quality, Public Health and Safety

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		DOH monitors the ambient air for the primary purpose of measuring ambient air concentrations of hydrogen sulfide (H2S) to ensure that the air quality standards are met. The DOH ambient air monitoring station previously located in the Leilani Estates subdivision was lost to the Kilauea East Rift Zone eruption in 2018. With Puna Geothermal Venture's plans to restart operations of its facility and the potential for the community to be impacted, the DOH re-established an air monitoring station at the Leilani Community Association. This station enables the DOH to provide the community, emergency personnel, and other interested parties with important air quality information for this area. On the face of it, this sounds good. Yet an examination of the details show the cynical nature of these statements. In taking this action, DOH did not notify or consult with the community or ask for public comments on where to locate the new monitoring system. If they had, citizens would have told DOH that moving the replacement monitor 1.5 miles away from the site of the one covered by lava, and 1.5 miles further away from the PGV well field would not provide any useful data, only zeros regardless of plant conditions. Of course, that may well have been DOH's intention. The new site, now 1.9 miles southwest of PGV, will not inform citizens of H2S conditions at PGV. My home on the other hand is one mile from PGV, with nothing but a lava field between us. The new monitoring site which the governor touts is almost twice as far from PGV as my 'ohana's kitchen and bedrooms. This action illustrates that DOH and the governor prefer no data to useful data. If DOH had consulted with local citizens, we would have told them what should be obvious to DOH: H2S is heavier than air so it flows downslope. This happened during Tropical Storm Iselle when PGV gassed my family in our home and made a significant number of neighbors sick, including some who passed out. The new DOH monitor is also 120 feet higher in elevation than PGV and all the PGV monitors are at a higher elevation and are north of the well field. Since H2S would flow downhill, this helps ensure H2S readings are minimized or non-existent. The current "monitoring system" has no sensors makai and downslope of PGV. The closest monitors to the south and north of PGV leave a gap of 1 mile where a H2S plume would flow downhill, without registering on the monitors. It's as if DOH and PGV sited the monitors to avoid a H2S plume emanating from PGV and flowing makai. This alarms me and my neighbors who live downslope, directly makai of PGV. DOH's capricious and arbitrary actions are putting my 'ohana and neighbors at risk by intentionally putting sensors where they are least likely to register H2S. Senator Ruderman voiced another concern in his letter: Virtually all the trees, shrubbery and forests that were in the area are now gone. This results in noise and toxic fumes traveling much farther than before the eruption. Was this taken into consideration in awarding new Air Quality permits? In the noise monitoring? In what way was this considered? Governor Ige, advised by DOH, responds: It is not anticipated that the absence of trees, shrubbery, and forests would result in H2S emissions traveling a greater distance because PGV is a closed system whose normal operations result in minimal fugitive H2S emissions. As the Adler report and numerous citizen's and formal government officials testimonies' point out, 70 H2S incidents do not indicate the "closed loop" system is resulting in "minimal fugitive H2S emissions" during "normal operations". When you have 70 incidents in 30 years of operation, "normal" is on average one H2S incident every 5 months that puts neighbors' health at risk. This does not account for the many incidents where citizens report a leak and the inadequate monitoring system does not record it. By this specious argument, DOH and the governor brush off Senator Ruderman's legitimate concerns for the safety of local citizens in order to make the unwarranted claim that they do not have to address the lava flow and it's change in the terrain and complete absence of trees, shrubbery and forests. What should happen is an assessment of the new environmental conditions and a subsequent EIS. This action by DOH and the governor is an unwarranted abuse of discretion resulting in a violation of citizens' right to a safe and healthy environment.	The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	
19	24	**Poor Emergency Response due to inadequate monitoring** The lack of adequate monitoring has interfered with Hawaii County Civil Defense responses to incidents and hampered fact-finding after incidents so that improvements could be made. Poor monitoring and alert systems put people's lives at risk. Here are three of the more than 70 incidents that help illustrate the problem of poor monitoring: • March 13, 2013 PGV released 6 lbs of Hydrogen Sulfide. They filed a report saying trees had caused the plant to trip. Firemen, standing with neighbors at the perimeter of the plant measured H2S readings of 3 ppm and 1ppm.	Potential impacts to air quality and public health and safety from the Project are discussed in Sections 3.3 and 3.11, respectively, of the Draft EIS. Potential impacts from noise associated with the Project are discussed in Section 3.4 of the Draft EIS.	Air Quality, Public Health and Safety, Noise

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		• April 6 2013, a pipe leak released 13 lbs of H2S. • During Tropical Storm Iselle, citizens estimated 300-600 lbs of H2S were released. For all three of these incidents, the monitoring system approved by DOH did not register any releases. The first two plumes must have missed the monitors. The last one did not register any releases because all the monitors went offline when the power line to PGV went down, even though they had diesel generators to power the plant and were required to provide backup power to the monitors. PGV then proceeded to do maintenance on their wells for the following week while the monitoring system was shut down, which resulted in more releases that were reported by local citizens and conveniently not documented by the non-functioning monitors or PGV. Local citizens, along with former state and county officials will testify to the impacts of deficiencies in monitoring of geothermal toxins on emergency response, as they have many times in the past. As Christopher A. Biltoft, testifies, “Hydrogen sulfide, when released in high concentrations, is a dangerous toxic gas. The potential for its release into public space must be properly addressed, along with adequate source monitoring, modeling, and communication with the affected public.” The combined effects of these incidents, coupled with ongoing noise, vibration, and anxiety and stress about not knowing whether their lives were at risk and about future incidents has had a significant detrimental impact on the health and safety of local citizens.		
19	25	**Multi-hazards of PGV**. The county’s multi hazard emergency response plan doesn’t mention the hazard of a hurricane or lava causing a release of h2s, heavy metals, and pentane at PGV. Or a pentane explosion. The state declared an emergency to get PGV to move the Pentane they had stored at the plant when the lava was flowing. By definition PGV is a multi-hazard emergency that has already happened but is ignored by PGV and the county plan, putting lives at risk.	Potential impacts to air quality and public health and safety are discussed in Sections 3.3 and 3.11, respectively, of the Draft EIS. The county’s hazard emergency response plan is not the subject of this EIS. However, Sections 2.1, 2.2, 3.4, 3.5, 3.10, and 3.11 of the Draft EIS describe PGV’s Emergency Response Plan, which is also available on PGV’s website at https://punageothermalproject.com/wp-content/uploads/2023/02/PGV-Emergency-Response-Plan-230101.pdf%22.	Air Quality, Public Health and Safety
19	26	**Induced Seismicity** In the region used by PGV, the dominant pattern of seismicity aligns parallel to the Kilauea Lower East Rift Zone. The majority of earthquakes occurs at 2-3 km depth, possibly associated with activity at the geothermal production plant. (Microseismicity and 3-D Mapping of an Active Geothermal Field, Kilauea Lower East Rift Zone, Puna, Hawaii, USA 2010) We need more studies and data regarding induced seismicity at PGV before we can know whether increasing power production and injection wells will increase earthquakes. I live one mile from the plant. Since PGV restarted, I have had larger and more cracks in the foundation of my home. Risks to homes, people and structures are too great to proceed without more data. • Other related issues that must be addressed are: • Co-temporal dynamic triggering of disposal-induced earthquakes • Delayed dynamic triggering of disposal-induced earthquakes • Ground motions from induced earthquakes • Effects of differential localized pressures and thermal gradients between upcoming well and injection well sites • Increase in underground pore pressure and effect on fault geometries • Relationship of injection fluid volume and pressure to induced seismicity • Injectate slip triggering of nearby faults • Effects of cumulative induced earthquakes on eruption dynamics of volcano	Potential impacts associated with geologic hazards and the Project are discussed in Section 3.1 of the Draft EIS. As discussed in Section 3.1 of the Draft EIS, the design and operation of the PGV facility are intended to minimize the likelihood of induced seismicity. It is also noted that the Project is sited in its location due to the presence of geothermal resources. Those who site homes in Lava Zone 1 assume the risk that seismic activity and other volcanic hazards may damage the residences.	Geologic Hazards
19	27	**Lava events** PGV has drilled into flowing lava before. In fact, they had some wells that produced lava just like fissures. It has been documented that dacite lava at ~1000 degrees Celcius was encountered and caused problems at least one well while drilling in 2005. This was not reported to the public until 5 years later when published by Bill Teplow, one of PGVs drilling consultants. How will PGV deal with that and protect nearby neighbors? Wells can be damaged even if the surface lava doesn’t reach the plant, if an eruption shears off the wells underground. If the wells are damaged, they could blow out. They would release steam that could contain hydrogen sulfide and CO2, and whatever else is underground. That happened at a place called Krafla in Iceland in the 1970s. In fact, they had some wells that produced lava just like fissures. The PGV facility is located over extant fissures and given that Lava Zone 1 is by definition (by USGS) "Includes the summits and rift zones of Kīlauea where vents have been repeatedly active in historic time." These areas are the most dangerous because all, or nearly all, erupted lava first emerges from the ground within Zone 1. Although there are portions of PGVs facility that were not directly impacted by the 2018 lava eruption, there is likelihood that a subsequent eruption could emerge from the land directly beneath any or all of the facility at any time in the future with direct risk to the safety of operating production or injection wells, piping, pentane storage, etc. This EIS should look at the fact that USGS has documented that East rift zone fissure eruptions have occurred every 12-15 years when averaged over the past 2000 years and the 30 years prior to the 2018 eruption when Pu‘u‘o‘o erupted continually for 30 years without other fissure activity during that time is actually an anomaly in the geologic history of the region. The 1987 EIS lists the historical activity in the region and explicitly says: Potential volcanic hazards consist of lava eruptions. lava flows. ash falls. splatter falls. and their associated surface disruptions. The risk associated with these hazards has been greatly reduced by locating the plant site and new wellpads on high ground to avoid lava flows in the low areas. Quickly constructed berms or blankets of volcanic cinders will be utilized to protect the lower wellpads and key elements of pipelines from lava flow. Each wellhead in low ground will be protected from lava flow by timely full closure of the master valves and by burying the cellar and wellhead with insulating cinder piles.	Potential impacts associated with geologic hazards and the Project are discussed in Section 3.1 of the Draft EIS. Additionally, while PGV encountered magma while drilling KS-13, the magma was not flowing and PGV did not produce any fissure. Potential impacts to public health and safety including natural disasters are discussed in Section 3.11 of the Draft EIS.	Geologic Hazards, Public Health and Safety

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		The actual events from 2018 clearly show that the treatment of this issue in that 1987 document was a severe underestimate. In addition to our justifiable concerns about our homes and farms in the local community regarding this lava event, we were subject to real and significant fear about the dangers from the plant, risks to the safety of the wells, risk of pentane explosions due to the poor management of the situation and the lack of accountability and transparency during the period between the start of the eruption in 2018 and when the State stepped in with expert help to mitigate the situation. By all accounts, PGV continued to pump water down the wells after the start of the eruption so that they would be able to more easily restart the wells at a later date. This should not have occurred and likely deteriorated the situation causing the subsequent much larger eruption of fissure 17 right by the wellfield itself which caused the majority of the damage of the 2018 eruption overall. This EIS should properly examine and evaluate the hazards associated with trying to operate an industrial facility in this region and given the extreme risks associated with the lava hazard, PGV should not be allowed to operate in this lava hazard area.		
19	28	**Social Justice** In addition to the history of health impacts, poor to non-existent regulation, and gas- lighting by state and county officials, we experienced a lava flow in 2018 (a declared national disaster) which destroyed 700 homes and isolated many more homes and farms. We are a low-income ethnically-diverse community. This increase in geothermal power production puts our lives and drinking water at risk. We also have to live with the impacts of noise and light pollution. Puna already produces more power than any other district and uses a small fraction of that which is produced there. The power Puna doesn't use is transported to Kona and Kohala for a power plant that will make electricity not for this area but for luxury hotels on the other side of the island. Helco is compensated for the line loss of shipping the power to the other side of the island by charging rate payers. This means that Puna residents live with the impacts of power generation and subsidize the cost of line loss for shipping the power to wealthy areas. Also, the most immediate neighbors to PGV do not have Helco power since Helco has not deemed it profitable to run electric lines there, even though they have two high power transmission lines to PGV. Again, no benefits, only negative impacts for neighbors. This is a clear social justice issue for the repowering of PGV.	Potential impacts from the Project to socioeconomic and environmental justice considerations are discussed in Section 3.6 of the Draft EIS. The location of the Project is consistent with zoning, and the facility is operated consistent with permit requirements. Regarding the site's location, siting of a geothermal facility is dependent on the identification of the following three key elements: heat, water, and natural geological permeability. At the PGV facility, heat is supplied from the Kīlauea volcano, water is supplied primarily from the nearby ocean (and some rain), and the relatively young geology of the Lower East Rift Zone is naturally permeable in numerous locations.	Environment al Justice
19	29	**Alternatives** At page 1.6, the notice says "[n]either PGV nor Ormat have additional land positions for geothermal energy that would give them the ability to utilize other locations on Hawaiʻl Island or elsewhere in the state to commercially produce energy using geothermal resources." The notice then says the only alternative that will be considered is the no action alternative. That approach is too narrow and restricted, as illustrated by the following facts. In February of 2012 DLNR published an Environmental Impact Statement Preparation Notice for Ormat titled Ulupalakua Geothermal Mining Lease and Geothermal Resource Subzone Modification Application. Apparently a plan to develop geothermal energy production on Maui has not advanced, as far as further public notice is concerned, but it is possible. Also in 2012, Hawaii Electric solicited proposals for an additional 25 MW of geothermal energy for Hawa''i Island. Ormat submitted the successful proposal, but eventually withdrew from negotiations of that contract. In 2019, Ormat announced that it had commenced commercial operation of a geothermal and solar hybrid project, with 7MW of solar production, at its Tungsten Mountain geothermal project in Nevada. Hybrid solar generation and battery storage are plainly alternatives to be considered for PGV. Act 205, signed on June 22, 2022, appropriated $500,000 dollars for the investigation, exploration, and identification of geothermal resources on Hawaiian home lands. Public events in February of this year relating to local geothermal energy exploration and development, featured, among others, Mike Kaleikini identified as Director of Hawai\`i Affairs for Ormat and a Commissioner of the Department of Hawaiian Home Lands.	The text was intended to convey that there are no other properties that are currently commercially viable on Hawaiʻi Island. The text in the Alternatives section of the Draft EIS has been revised to clarify this point.	Alternatives
19	30	**Transparency** Given these facts, it is misleading to suggest PGV and Ormat have no potential opportunities or interests in geothermal or related energy development beyond the present facility plans. The EIS should disclose and discuss all of these circumstances, as well as any additional alternatives.	Comment noted; it is outside the scope of this EIS to analyze developments outside Hawaiʻi Island as reasonable alternatives for the proposed Project. Section 3.13 includes a description of cumulative effects, which includes relevant past, present, and reasonably foreseeable future actions.	Alternatives, Cumulative Effects
19	31	**Sustainability** Another major factor that must be considered is the risk to the Islandʻs of Hawaiʻi by having a large fraction of the utility power dependent on this facility given the likelihood of this plant having to shut down or being destroyed by the very real and known lava hazards in the location of the plant. What mitigation must be done to protect the power supply of all the homes and businesses who depend on utility grid power when (not if) lava disaster strikes the production capability of PGV? It makes more sense to use other less risky power production using solar power plants and stored power to reach the States goals to reduce fossil fuel consumption.	Potential impacts from geologic hazards to the plant are discussed in Section 3.1 of the Draft EIS. The No Action Alternative (i.e., rejection of the Project) is described in detail in Section 1.5 of the Draft EIS. Without the up to 38 MW of power generated through 2027 (or an extended PPA term) PGV is currently authorized for and without authorization for the additional power that would be generated under the Proposed Action (i.e., up to 46 MW under Phase 1 and up to 60 MW under Phase 2), it is assumed Hawaiian Electric would need to meet the increasing demand for power through the burning of fossil fuels at its existing facilities on Hawaiʻi Island or partnering with other renewable energy providers. Other renewable energy projects would need to be economically feasible, require approval from the PUC, and comply with other local, state, and federal laws and regulations.	Geologic Hazards
19	32	**Due process and lack of transparency** Poor monitoring hampers emergency response, but it is useful to PGV and DOH in one very important way. It keeps the local community and the media from knowing what the actual releases are. This protects PGV and DOH from scrutiny by the public and the media. It also hampers local citizens' ability to document the link between releases and impacts on the community.	Potential impacts from the Project for the various resources listed in the comment are discussed throughout Chapter 3 of the Draft EIS.	Noise, Air Quality, Geologic Hazards

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		The only "closed loop" in this system that has had more than 70 incidents in 30 years, is the inadequate monitoring that keeps information from flowing to the local citizens, emergency response, and the media when there is an incident. This helps keep the veil of secrecy intact, protects PGV and DOH from accountability in the numerous lawsuits that have followed geothermal steam releases, and it violates citizens' right to know what is polluting their air (EPCRA) and their ability to seek redress for the impacts on their health. Even this brief look at PGV history tells us what the future will look like unless there is a change in regulation. The final EIS, like the last one, will be a work of fiction. It will say all impacts are minimal or mitigated. Of course, they won't be. The noise, the H2S and heavy metal releases will impact neighbors, our water and the 'aina. PGV will say they meet all regulations. If PGV can't meet the regulations, the state will change them. The state of Hawaii will continue to ignore the plight of neighbors, plants and animals that live near the plant. The county, the accepting agency for the EIS, will accept all this too. PGV will continue to lessen regulation, to expand industrial operations, and to gas and gaslight neighbors. This will continue until the next emergency. Then there will be silence, minimal media coverage and the cycle will continue. I request that the County, as the accepting agency for this EIS, become less accepting of the noise, light pollution, potentially fatal hazards and impacts on neighbors–and actually regulate them. The first alert of an emergency shouldn't be neighbors getting sick or worse. This EIS should properly examine and evaluate the hazards associated with trying to operate an industrial facility in this region and given the extreme risks associated with the lava hazard. PGV should not be allowed to operate in this lava hazard area. There have been so many documented safety issues for the local community to deal with from the normal operation of PGV and the lack of willingness from the authorities to look clearly at the ways that the community has been both ignored and abused on an ongoing basis during the time of geothermal in Hawai'i. It is clearly an issue for residents to deal with the potential for natural disasters, to have to move out from their homes and farms and perhaps lose them altogether. It is another magnitude scale issue altogether for the island's power supply to be so dependent on the safe operation of PGV. This time is long overdue to take a full and comprehensive look at all of the issues and take the appropriate action to prohibit further development in the East Rift Zone.	The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	
Robert Petricci				
20	1	Notice from 23 July 2022 states that the PGV Repower Project EIS Preparation includes a 30-day public review and comment period. I submit this written testimony and also adopt the position and statements submitted for this EIS by Puna Pono Alliance, Chriss Biltoff, Paul Keikandal, Sara Stiener, and Susan Wakeland as my own, so as not to be redundant.	Thank you for your participation in the EIS process; please see responses to your specific comments below.	
20	2	Written comments for the draft Environmental Impact Statement review as follows are to supplement my oral comments submitted at the public meeting on 8/17/2022. I was cut off by the mediator before I could finish speaking on the record for the Proposed Puna Geothermal Venture Repower Project draft EIS. These comments are meant to empower and educate with no profit incentive on my part. I am not paid nor do I profit from providing the following information and comments. The county and state can not say the same, there is a profit motive for both who receive payments amounting to millions of dollars from geothermal royalties and taxes, PGV also has a profit motivation to make as much money as they can, including cutting corners, your company is also being paid. It is hard to deny large sums of money can influence decisions for projects like this, particularly when situated in one of the poorest communities in the state. Residents do not get paid or have paid staff to do this, why do we do it? There is no profit motive here for us. My motivation for spending so much of my time preparing this to the best of my ability with the scant resources I can muster is to do my best to make sure you have the best, most accurate information available to help you produce a well informed, EIS, that refelcts the reality on the ground for me and other area residents. I am not perfect and may make a mistake here or there, feel free to correct anything you consider inaccurate before the next public meeting. The state DOH, and sources ; like Don Thomas are natoriously tainted and biased, if ask I produce proof that what I am saying is true. They are not going to give you information that would expose some of the terrible possibly things they have done to me and the rest of the area residents over the last 42 years.	Comment noted; the meeting was held consistent with the requirements in HAR § 11-200.1-23(d) to provide the public an opportunity for public comment on the scoping of the Draft EIS. We appreciate that you supplemented your oral comment with these written comments. As discussed in Section 1.4 of the Draft EIS, the purpose and need for the Proposed Action is to continue to supply electrical power produced using renewable geothermal resources to HELCO to support Hawai'i Island's electricity needs.	EIS Process
20	3	.At the end of the Pahoa meeting organized for public input and comments there was still some time left for speakers, I asked the mediator (after waiting to be sure no one else wanted to speak) to allow me to finish my comment because she had stopped me before I was done, she refused. That is not in the spirit of how to encourage or incorporate community input in this EIS, IMO. The venue selected for the 8/17/2022 was woefully insufficant from a community input stand point, and when there was time for more comment I was not allowed to provide information critical to the EIS in a public setting. I have a lot of experience and knowledge, you do not, did you want to hear it? I say that having run at least 50 public meetings about geothermal. You could have intervened and asked the moderator to let me finish, you chose not to, I believe that was a mistake. I am trying to convey that by not intervening in an easy way that would have allowed me to more fully participate and interact with you, you missed an opportunity.	See response to comment 2 above. The public scoping meeting was held consistent with the requirements in HAR § 11-200.1-23(d) to provide the public an opportunity for public comment on the scoping of the Draft EIS. The format of the meeting was intended to give all speakers an equal opportunity to provide comments, without giving some people more time than was allowed for others. No one was prevented from testifying if they wanted to, and it was explained at the meeting that written scoping comments were accepted through August 22, 2022.	EIS Process
20	4	You might be surprised by some of the things you still have to learn about this project judging by what was in the draft EIS. I think you will find if you read these written comments and the rest of the community comments with an open mind that there is much more to this than the draft EIS takes into account. Is this EIS as the draft suggests just going to be window dressing to try and meet HEPA law or are we going to do a comprehensive EIS that objectively looks at the impacts and risk as well as perceived benefits this power plant expansion will have on the area residents? That is a very real concern of mine after reading the draft EIS, and not being allowed to finish speaking at	Please note that the document that you commented on was the EIS Preparation Notice, not the Draft EIS. The socioeconomic impacts of the Proposed Action are discussed in Section 3.6 of the Draft EIS. Potential impacts associated with geologic hazards are discussed in Section 3.1 of the Draft EIS.	Geologic Hazards

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		the public meeting when there was time left. Time will tell, however if history is an indicator it will not be comprehensive or look at things like what happens to one of the most fractured and unstable geologic locations on the planet when you re-inject cooled fluids into extremely heated rocks, voids, and or exsisting fractures. One of the elephants in the room that no one wants to talk about is the volume at which PGV does that, and what happens at the bottom of the pipe roughly 5,000 feet down.		
20	5	What Mike Kalikini from PGV has told me several times at public meetings over the years is that at 38 megawatts PGV is reinjecting at the rate of approximately 4,000 GPM 24/7 365 days a year. That equates to over 2 billion gallons a year at 38 megawatts. I would like the EIS to tell us over the last 29 years barring the years the were knocked offline and unable to supply power what is the total amount of cold fluids PGV has put into that super heated rock over the life of plant operations. Do you know, does DLNR, DOH, the county, does PGV know?. This EIS must look at what impact that has on the rift zone and geologically around the plant and beyond to have any hope of being seen as legitimate by me and the community. What Mike Kalikini also told me is that when the cooled re-jectate comes in contact with super heated rock it explodes. His exact description was "what happens when you put cold water on a hot imu rock, it explodes". I will never forget that and need a lot more information about the pressure at the bottom of the pipe and what happens. The EIS should be the vehicle to look objectively at that, particularly as the lava from the 2018 eruption that occured around the PGV plant found it's easiest path to the surface right along the PGV boundary. Exactly where was PGV re-injecting, in relation to the boundary where the vents opened? What is the pressure at the bottom of the pipe where it contacts the hot rock and what happens when it does so under the weight of a 5,000 foot column of fluid? Does it cause any type of fracturing? I was told again by Mike Kalikini that PGV tries to re-inject far enough away from the resource not to cause cooling of the resource but close enough that the water can travel back through fractures and be reheated as it moves through the hot rock back to the resource to recharge it. Without that the resource would be used up recharging the resource would decline.	Potential impacts from geologic hazards to the plant are discussed in Section 3.1 of the Draft EIS. The hydrological considerations of the Proposed Action, including a description of the injection wells and process, are described in Sections 2.2 and 3.2 of the Draft EIS.	Geologic Hazards
20	6	Was there a clear statement to the community about having more time to submit written testimony at the public meeting in Pahoa? If not, that was another missed opportunity for community input. If there was a clear announcement I missed it.	At the meeting, the date that comments were due (August 22, 2022) was included on the public comment form handout and the EIS process poster displayed at the front of the room. The date that comments were due was also included in the official publication of the EISPN in *The Environmental Notice*. It was also posted on PGV's EIS informational website.	EIS Process
20	7	I live on Pohoiki road near enough to PGV that if there is an accident I may need to literally run for my health and safety, possibly even my life. I have lived in the area since buying property and building a home in Leilani Estates in 1981, I have extensive first hand personal knowledge and experience of geothermal development in Hawaii, including public hearings, litigation, accidents, community protest, community arrest for civil disobedience, legislation, and serving on the Addler health study group for mayor Kanoi. I had 2 Jerome H2S samplers purchased by the county for the residents in my care. I was the first responder to accidents for the community for decades. People would call me at all hours of the day or night when there were leaks, accidents, or noise problems at the PGV site and I would go to see what was going on. I responded to countless leaks and accidents at PGV. I still have the information from the jerome data loggers, in my possession, PGV has paid me damages as a result of injury from exposure to their toxic releases and for being evacuated during emergencies at the plant that made my home unsafe to be in as well.	Comment noted.	Informational only
20	8	Moving power great distances like is needed for PGV central generation model is inherently expensive and vulnerable to disruption, will the EIS please address that. Producing power where it is actually needed is far more reliable, sustainable, and affordable, will the EIS reflect those facts?. If the stated goal is to be safe, reduce cost, and be reliable, PGV is greatly handicapped, please explain how moving power great distances reduces cost or boost reliability and what makes PGV so safe with it's history that contradicts that claim. To prove that is true, can you name another power plant in the state of Hawaii that has caused numerous emergency evacuations and paid hundreds of people damages for health claims? I know of none, if that is the case, and I believe it is, it could be argued in fact PGV is and has been the most dangerous power plant in Hawaiian history and still is, yet the draft EIS calls the safe and reliable, please explain that..Also please explain how locating the power plant right where lava found its easiest path to the surface in 2018 makes PGV either safe or reliable when it is well known PGV will be subject to geological disruptions that could cause uncontrolled release of known toxins at deadly level and or be destroyed or incapacitated again.	Potential impacts associated with geologic hazards are discussed in Section 3.1 of the Draft EIS. Potential impacts to public health and safety are discussed in Section 3.11 of the DEIS. The location of the Project is consistent with zoning, and the facility is operated consistent with permit requirements. Regarding the site's location, siting of a geothermal facility is dependent on the identification of the following three key elements: heat, water, and natural geological permeability. At the PGV facility, heat is supplied from the Kīlauea volcano, water is supplied primarily from the nearby ocean (and some rain), and the relatively young geology of the Lower East Rift Zone is naturally permeable in numerous locations. PGV and Ormat are aware of and understand the hazards associated with developing a geothermal facility near volcanic areas such as the Lower East Rift Zone. The risks associated can result in having to shut the plant down for extended periods, such as the case of the 2018 Kīlauea eruption. However, these are risks that PGV and Ormat address through the development and implementation of Emergency Response Plans and other operating procedures and by close coordination with county and state officials.	Geologic Hazards, Public Health and Safety
20	9	The draft EIDS appears to be an exercise in trying to meet the requirements of HEPA laws while not really doing the work necessary to include information and comments from the residents, White washing or biased interpretations are prevalent in the PGV EIS draft document we are being asked to comment on. You will have to excuse me but after participating in the process of geothermal testing and development for the last 42 years, living less than a mile away from Geothermal development 1981, until forced from my home in 2004	The Project was in a scoping period following the publication of the EIS Preparation Notice (EISPN). A digital copy of the EISPN is available by selecting the July 23, 2022, edition of the state's *The Environmental Notice*	EIS Process

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		because my health was deteriorating, I have learned a few things at least. I have been a plaintiff in many regulatory and civil litigation actions against both PGV and DOH. Why would I do that? I have tried to regulate PGV in the absence of state or county oversite for self preservation too many times to remember them all. PGV has paid me damages and the Hawaii supreme court has ordered PGV to do rulemaking as a result of some of that litigation I was a party to, because the state DOH simply refuses to follow the law. It is not a new problem with regulation, it is a historical one. With the extensive history of accidents and litigation making PGV the most contested power plant in state history. On top of the many accidents and evacuations making PGV arguably the most dangerous power plant in the state. Is it time yet to address these issues or is this EIS just going to kick the can down the road again. When does this become a crime? Intentionally trying to end run state laws and regulations for 42 years at some point becomes intentional, is that a crime? Can the EIS address that please? The EIS needs to consider and I look at why that is, the residents' actions and complaints have changed many times over the years, it is not the same people over and over although some of us have been here since day one.	at https://files.hawaii.gov/dbedt/erp/The_Environmental_Notice/2022-07-23-TEN.pdf. The Draft EIS is available on the Office of Planning and Sustainable Development's Environmental Review Program website here: https://planning.hawaii.gov/erp/ea-and-eis-new-rules/. The EIS has been prepared to satisfy the requirements of Hawai'i Revised Statutes, Chapter 343, to disclose the environmental impacts of the Proposed Action. The EIS is being prepared as required by the Public Utilities Commission's Decision and Order No. 38276 requiring PGV to prepare an EIS in connection with the Amended and Restated Power Purchase Agreement for the PGV facility. PGV is operating the facility consistent with all applicable laws and regulations and in accordance with all permit conditions.	
20	10	This EIS draft so far looks like another example of how to do another end run around real monitoring, emergency response and evacuation for residents, or existing laws and requirements. That includes repeated examples of PGV being allowed to operate with expired permits, and in violation of permits and promises made to use best available technology (BACT) that were not enforced. This includes operating without an air monitoring system that provides reliable exposure levels to area residents from toxins released by PGV during operation and upset conditions. This is not a new problem, if PGV is not harming the residents with these constant releases why don't they want to collect the data to prove that? Simply put, after 25 years this has to be by design, if I wanted to prove I was not hurting people by releasing known dangerous levels of toxins I would want to have the data to prove it. They do not want that data, nor does the state DOH or DLNR, why not? With the long standing concerted effort to find ways around state and county permitting and laws for decades it begs the question: "do the of meetings or communication between PGV and regulators to figure out how to operate outside the norms of permitting and governing laws rise to the level of subverting the process or even conspiring to do so behind closed doors? I would like the EIS to explore the interaction between regulators and PGV, and the resulting decisions that have allowed PGV such latitude. How regulators actions and inactions to this day have resulted in no usable data to establish exposure levels to residents after 42 years of health complaints from the community. How is it possible that after all these accidents, protests, arrests, PGV settled damages for resident harm litigation, it is not like they do not understand the problem the lack of good data causes? At this point can the EIS determine if it is incompetence, collusion, or intentional means to prevent the collection of usable data through source monitoring and computer modeling. Can the EIS answer why PGV is allowed to use 1980 air sampling stations in the 21rst century if not to avoid collecting real data on what exposure levels in the community are?.Further at this point do the actions of regulators and PGV rise to the level of a conspiracy to do such, if not why not.. If that is truly the case does that rise to the level of a criminal offense? Please answer that question and how it is possible to operate for decades like this if it is not by design or collusion of regulators and PGV. Is it possible the state and county are influenced or motivated by the millions of dollars in royalties PGV pays (but only when operating) more so than the laws governing the process or are they simple incompetant to protect the public health, wellbeing, and good? While some might not take these comments seriously I can assure I and other residents do. Please do the work necessary to adequately address the issues I have raised. There was testimony about money PGV has given to community projects which is commendable, I have to wonder though if that money would have been better spent on a real system to collect exposure levels in the same community?	See the response to comment 9 above; also see the impact analysis in the Draft EIS regarding potential impacts to air quality (Sections 3.3 and 3.11), hydrology (Section 3.2), and public health and safety (Section 3.11). The locations of the monitoring stations used by the facility were approved by the State Department of Health. The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	EIS Process, Air Quality, Hydrology, Public Health and Safety
20	11	On another note, PGV's prominence at the Pahoa "public" meeting gave the appearance of them being in control of what was happening.	Comment noted; the Proposed Action is an Applicant action, and it is the responsibility of the Applicant to hold the public scoping meeting. The meeting was organized and run by the Applicant's third-party HEPA consultant. Additional information regarding the HEPA process is available online at https://planning.hawaii.gov/erp/.	EIS Process
20	12	page 1-1 of the EIS......States....."although there was no statutory trigger, an Environmental Impact Statement (EIS) for the now operating power plant was voluntarily prepared by PGV"..... That statement is simply not true, as anyone reading the PUC record knows. Again calling into question the legitimacy and reliability of this draft EIS document we are commenting on here, IMO. HEPA laws require PGV to do an EIS as per the PUC record, this is not voluntary. The company that prepared the document was paid by who, That and the statement that PGV is safe and reliable come right out of PGV handouts, the facts say it is not the case. It is disturbing and disheartening to see that in a so-called unbiased draft EIS. Can you explain how that was put into the draft, where exactly did that information come from? I disagree with the author's conclusion that this EIS is not required by law. State land use (the geothermal resource) clearly triggers HEPA requirements as pointed out publicly many times. This EIS is not voluntary, it is required. There are multiple false or misleading statements in this document that need to be corrected if this EIS hopes to have any legitimacy whatsoever. No new EIS was done or NCSP permit issued (the old permit had expired) even after the major changes since the 2018 eruption that closed the plant for years, not exactly reliable, then there was the blowout at KS-8 and Tropical Storm Issell. Including the state owned geothermal resources used by	Comment noted; the text that you refer to addresses the 1987 EIS and is consistent with the law at that time. The text in the EISPN and Draft EIS regarding the HEPA trigger is consistent with the current legal interpretation. Additionally, potential impacts to hydrology and public health and safety (including natural hazards) are discussed in Sections 3.2 and 3.11, respectively, of the Draft EIS.	EIS Process (Trigger), Hydrology, Public Health and Safety

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		PGV that is now much hotter and includes changes both underground and in the ground elevations around the PGV plant and well field caused by the 2018 eruption.		
20	13	The facts clearly show PGV has been largely self regulating since it began drilling operations. DOH's finding that no further environmental review was required for this expansion and new equipment is just another example of that regulatory bias and failure to perform its responsibility to protect the public health. Hawaii DOH, DLNR, and the county have long allowed PGV to operate in a manner that is dangerous to the surrounding community, and has caused harm. This goes back to the beginning when PGV first started drilling wells. The county GRP permit clearly stated in the 51 condition negotiated with the community that PGV was "required' to use best available control technology (BACT). The conditions "required" PGV to use BACT, there was no ambiguity there, BACT is required period. DOH, DLNR, and the county never enforced this or other conditions such as a viable emergency response plan for the community. Instead allowing PGV to open vent wells to the detriment of the health, safety, well being, and enjoyment and use of their property as documented in the county's Adler report. Without any way to document actual levels the community was exposed to that was over 20 years ago. They allowed this with no way to track the levels or impacts of the toxic gasses being released unabated into our community. I have a problem with that and this EIS needs to address it The three PGV air samplers and the 1 DOH air samplers are another example of PGV not using BACT, it is not a "monitoring" system as there has never been any usable data generated to determine the level of exposure residents have been subjected to. Chris Biltoff, an expert on such systems has pointed this out to the state and county regulatory agencies as have others repeatedly to no avail. The county and state regulators refuse to update the wholly inadequate samplers that only register levels of gas that happen to hit them, and only if they do not fail as happened during Issell. PGV and DOH as well as the county had not installed a backup power source as we saw when the samplers were knocked offline during the disaster of Tropical Storm Issell. Issell trapped the community, there was no escape for residents as PGV was out of control and vented dangerous levels of H2S. They almost lost the power plant that evening while people were trapped and could not escape. Over a hundred residents filed for damages which PGV paid, some people were knocked unconscious by the gasses. There is no reliable data to document the exposure levels in the community because for all intents and purposes there is no monitoring system The samplers have been shown in court cases not to provide the data needed to establish exposure levels]in the surrounding community. Is that BACT? I would like a specific answer to why it is or is not BACT. Please explain in detail why there is no workable, tested emergency response plan for area residents from Civil Defense or DOH even as the roads are blocked by lava. PGV is being allowed to continue to put us at risk using expired permits (one expired 8 years ago) and no emergency response plan to get the community out when, not if the next major accident occurs? During litigation on several occasions after accidents and releases this was shown to be the case and has allowed PGV to dodge responsibility for hurting people because of a lack of data to show what the levels are during accidents and upsets. This has to be intentional after 25 years of this, it is not like PGV and the regulators do not know that, is it a criminal conspiracy? I think it needs to be investigated to see how this is even possible. How could no viable data on exposure levels in the community possibly be BACT? PGV only started using BACT during well clean outs after I was arrested for simple trespass trying to stop the illegal, dangerous, and harmful release of unabated toxins and pollutants during well cleanouts. I was acquitted of the simple trespass at PGV under a lesser of evils defense. Circuit court judge Rikki May Amano found me not guilty of breaking the law because it was a lesser evil than to allow PGV to violate the permit and poison the community than it was to break the law to try and stop them. That was the last time PGV open vented a well clean out, not because of DOH, DLNR, or the county but because a resident was forced to be the regulatory agency for the permit conditions. That is not good regulatory oversight when a resident has to be arrested to enforce what the permit requires. After that PGV started using a cyclonic separator and abatement during well clean out that was actually BACT at the time, but much more costly. Was PGV even punished for that blatant permit violation that hurt so many residents, was regulation improved? Were the regulators incompatant ot in collusion to save PGV money at the expense of community health and well being? That is a fair question that needs to be answered, It is time to find out. These and other ongoing permit violations show there was and is no real oversite or enforcement of PGV permits, making PGV self regulating. Nothing has changed with DOH and DLNR continuing to allow PGV to operate for years on expired permits, dodge EIS laws and operate without real monitoring even after they were shown by experts that the sampling stations are not BACT monitoring and that without actual source monitoring and computer modeling there is no way to accurately collect the data needed to determine exposure levels to nearby residents. The list of examples of regulatory malfeasance and failure is long, documented, and irrefutable.	Comment noted; independent reviews of the air data collected verify their accuracy and comply with the requirements of the air permit. PGV includes air monitoring data to the County of Hawaiʻi and PUC for review as part of regular updates. Potential impacts to air quality from the Project are discussed in Sections 3.3 and 3.11 of the Draft EIS. As discussed in Sections 3.3 and 3.11 of the Draft EIS, real-time data of H_2S levels are posted on PGV's website. The location and operation of the monitoring stations, as well as the methods for analysis and reporting with the data from the stations, are consistent with Department of Health permit requirements.	Air Quality
20	14	Further, PGV noted "repowering of the Facility will be the subject of further environmental review" but notes that "any change to the Facility could arguably jeopardize PGV's permit shield, pursuant to which the terms and conditions of the 2009 NSP ... 'shall remain in effect and not expire until the application for renewal has been approved or denied'" – acknowledging that if PGV admits the facility is in need of improvements in the pending permit renewal application, that could jeopardize its ability to continue to operate while agency matters are pending. How is that not a conspiracy? How much more outrageous and for lack of another valid reason, corrupt can the regulators be in their failure to perform to protect the public good? When added to the totality of the history of allowing PGV to avoid the law and permit requirements? Has this risen to the level of a criminal conspiracy, to help PGV while throwing the community under the bus by the state and county agencies charged with regulating them, if not how is this possible after decades of problems???	Existing permits, including the air permits for the PGV facility, are listed in the EISPN Table 2-2 and are also included in Table 4-1 of the Draft EIS. The scope of the Proposed Action analyzed in the EIS is the proposed change of equipment and the permits needed for its construction and operation. Phase 2 of the Project would require an amendment for Noncovered Source Permit No. 0008-02-N as stated in the EISPN Table 4-1. Potential impacts to air quality from the Project are analyzed in the Draft EIS. Note that HAR § 11-60.1-62(b) explicitly allows a permittee to continue operating so long as a renewal application is submitted and pending.	Air Quality, Hydrology, Public Health and Safety

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		Further, allowing PGV to operate on an expired NCSP permits for 8 years even after major changes to the equipment, the resource, and the new typography is not pono., it seems corrupt. PGV and DOH publicly saying after the new permit is granted based on the 2014 application (before the geologic and equipment changes) PGV submitted for renewal of the NCSP, they would then immediately revise or supplement the permit to show the changes, is not a fair process, how is that even legal? It is clear this is an end run around what the law requires or should require for a dangerous industrial project being built and operated in a pre-existing residential community. Why even have a public hearing if you just do what you want without regard to the reality of the project, then amend it? Isn't that a conspiracy to end run the permit process? It does not protect the health and safety of residents, it protects PGV at our expense, exposing the collusion of regulators and PGV, IMO. This shows again the failure of DOH, DLNR, and the county to perform reasonable regulatory oversight to protect the community. Instead the regulators are protecting PGV at the harm and detriment to me and the other residents hurt by their failure to perform their responsibility to protect the health, well being, and safety of area residents in a reasonable and professional unbiased way.. The contested case debacle underway now for the DOH NCSP has dragged on for 8 years while PGV has been allowed to continue to operate in a dangerous manner. Another example of how the whole process has been regulated since the beginning. Having participated for the full 8 years it is my observation that DOH and hearing officer Steven Jacobson appear for all intents and purposes intentionally using the process to allow PGV to operate on a permit that no longer is even relevant to the "new" PGV operating conditions and equipment, to protect PGV's permit shield. While at the same time putting the burden to keep going on the residents, even to the point of trying to cut people out or wear them down, how is that a reasonable, legal, regulatory process to protect the health and well being of area residents? If community members, PGV employees, or first responders are killed or injured as a result of these failures to perform reasonable regulatory responsibility, who is responsible? Who is liable, at this point they can not say they did not know what they were doing or what was happening? PGV has settled hundreds of lawsuits for damages, yet from a community standpoint nothing has changed. We do not even have a community evacuation plan, another permit requirement the county simply ignores even after a long list of emergencies and accidents including Tropical Storm Issell and the KS-8 31 hour blowout at PGV in 1991.	Additionally, potential impacts to hydrology and public health and safety (including natural hazards) are discussed in Sections 3.2 and 3.11, respectively, of the Draft EIS.	
20	15	I am very familiar with the history of geothermal in Hawaii, having lived near the projects since before they began in 1981. As such I was ask to be a member of the county Adler group that examined the history and impacts of geothermal on the community. We filed our reported findings on September 9, 2013. Many of the things we found serve as the basis for and support my comments here. Here is an excerpt from the county's Adler geothermal working group....."Events during the HGP-A era and during the 1991 blowout provided exposures associated with adverse health effects. This knowledge, along with other information contained in this report ... has led the Study Group to conclude there is evidence that there were health effects from the exposures during the development of geothermal before 1993. (we do not have the data to show the effects because there isn't any real monitoring data, that is still the case today).The full extent and severity of those effects has not been documented. ...Risks from geothermal energy production in Lower Puna exist.The actual extent and impacts of those risks remains unresolved. What is known is that hazardous chemicals are brought up by PGV. PGV adds industrial chemicals to the mix in the process and then sends the composite fluid back down. However, fluids inevitably escape to air, water, or at surface level. Harmful effects can only be understood through better monitoring and reliable health data." The 1987 EIS completely ignored the true horror of HGP-A and negative impacts to the community, or the impact of reinjection on the rift zone. To this day nothing has changed because of the ongoing regulatory failures to perform basic responsibilities to protect the public good, PGV was and is for all intents and purposes still self regulating. As my comments, the record, and history clearly show. I would like to state for the record that the County of Hawaii is not an alternative accepting agency for this EIS because it admittedly has no HEPA jurisdiction. The county and state appear to be more worried about collecting their royalty checks from PGV than following the law or protecting my community. They have never enforced the conditions in PGV's GRP permit or reasonable regulatory oversight.	Potential impacts to public health and safety from the Project Area are analyzed in Section 3.11 of the Draft EIS. Please note that the HGP-A project was not developed by PGV or Ormat and the 1987 EIS is not the subject of this EIS. HRS § 343-5(f) authorizes the Office of Planning and Sustainable Development to designate the approving agency, and it has selected the County of Hawaiʻi Planning Department, consistent with HRS § 343-5(e), which provides that "[t]he planning department for the county in which the proposed action will occur shall be a permissible accepting authority for the final statement." Potential impacts to hydrology are discussed in Section 3.2 of the Draft EIS.	Public Health and Safety, Hydrology, EIS Process (Approving Agency)
Ken Hayashida, KAI Hawaii, Inc.				
21	1	As a member of the Hawaii Leeward Planning Conference, I am writing in support of the Puna Geothermal Venture Repower Project and the Draft Environmental Impact Statement they are in the process of completing. With the new repowered facility, the amount of power added will increase the facility contract from 38 MW to 46 MW and will decrease the typical residential customer's bill over the course of the contract term. Once the additional 8 MW come online, Hawaii Island's renewable energy total will be close to 70 percent. I support Puna Geothermal Venture's Repower Project as it will create a cleaner, more sustainable energy source for the future.	Thank you for your participation in the EIS process; your comment has been noted.	General Support
Russell Tsuji, Department of Land and Natural Resources				
22	1	Land Division: Pursuant to your request for comments on the above matter, we offer the following: The Hawaii District Land Office has no objection to the proposed replacement of the current power generating units as outlined in the EISPN Project Summary. The Land	Thank you for your participation in the EIS process; your comment has been noted.	

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		Division will provide further comments when the Draft Environmental Impact Statement is available for review. Please contact me should you have any questions.		
22	2	Division of Forestry and Wildlife Comments: The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your request for comments for the EISPN regarding the proposed Puna Geothermal Venture Repower project located at 14-3860 Kapoho-Pāhoa Road, Pāhoa, on the island of Hawaiʻi; TMK: (3) 1-4-001: 001, 1-4-001: 002, and 1-4-001: 019. The proposed project consists of replacing the current 12 operating power-generating units with up to four upgraded power-generating units. The proposed project would be constructed within the current PGV facility site fence line. Other work includes installing new piping and reducing existing steel structures, piping, mechanical components, and associated flange connections (associated with the replacement of the currently operating equipment).	Thank you for your participation in the EIS process; please see responses to your specific comments below.	
22	3	The State listed Hawaiian Hoary Bat or ʻŌpeʻapeʻa (*Lasiurus cinereus semotus*) could potentially occur at or in the vicinity of the project and may roost in nearby trees. Any required site clearing should be timed to avoid disturbance to bats during their birthing and pup rearing season (June 1 through September 15). During this period woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed. Barbed wire should also be avoided for any construction because bats can become ensnared and killed by such fencing material during flight.	Comment noted; this protection measure for the Hawaiian hoary bat has been incorporated into Section 3.5 of the Draft EIS.	Biological Resources
22	4	Artificial lighting can adversely impact seabirds that may pass through the area at night by causing them to become disoriented. This disorientation can result in their collision with manmade structures or the grounding of birds. For nighttime work that might be required, DOFAW recommends that all lights used to be fully shielded to minimize the attraction of seabirds. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season, from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea. Permanent lighting also poses a risk of seabird attraction, and as such should be minimized or eliminated to protect seabird flyways and preserve the night sky. For illustrations and guidance related to seabird-friendly light styles that also protect seabirds and the dark starry skies of Hawaiʻi please visit https://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf.	Comment noted; this protection measure for seabirds has been incorporated into Section 3.5 of the Draft EIS.	Biological Resources
22	5	State-listed waterbirds such as the Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica alai*), and Hawaiian Goose (*Branta sandvicensis*) could potentially occur at or in the vicinity of the proposed project site. It is against State law to harm or harass these species. If any of these species are present during construction, then all activities within 100 feet (30 meters) should cease, and the bird or birds should not be approached. Work may continue after the bird or birds leave the area of their own accord. If a nest is discovered at any point, please contact the Hawaiʻi Island Branch DOFAW Office at (808) 974-4221.	Comment noted; this protection measure for the Hawaiian stilt, Hawaiian coot, and Hawaiian goose has been incorporated into Section 3.5 of the Draft EIS.	Biological Resources
22	6	The State listed Hawaiian Hawk or ʻIo (*Buteo solitarius*) may occur in the project vicinity. DOFAW recommends surveying the area to ensure no Hawaiian Hawk nests are present if trees are to be cut. ʻIo nests may be present during the breeding season from March to September.	Comment noted; although there are no trees proposed to be cut, this protection measure for the Hawaiian hawk is included in Section 3.5 of the Draft EIS.	Biological Resources
22	7	DOFAW recommends minimizing the movement of plant or soil material between worksites. Soil and plant material may contain invasive fungal pathogens (e.g., Rapid ʻŌhiʻa Death), vertebrate and invertebrate pests (e.g., Little Fire Ants, Coconut Rhinoceros Beetles), or invasive plant parts that could harm our native species and ecosystems. We recommend consulting the Big Island Invasive Species Committee (BIISC) at (808) 933-3340 to help plan, design, and construct the project, learn of any highrisk invasive species in the area, and ways to mitigate their spread. All equipment, materials, and personnel should be cleaned of excess soil and debris to minimize the risk of spreading invasive species.	Comment noted; protection measures for preventing and minimizing introduction and spread of pests are included in Section 3.5 of the Draft EIS.	Biological Resources
22	8	DOFAW recommends using native plant species for landscaping that are appropriate for the area (i.e., climate conditions are suitable for the plants to thrive, historically occurred there, etc.). Please do not plant invasive species. DOFAW also recommends consulting the Hawaiʻi-Pacific Weed Risk Assessment website to determine the potential invasiveness of plants proposed for use in the project (https://sites.google.com/site/weedriskassessment/home). Please refer to www.plantpono.org for guidance on the selection and evaluation of landscaping plants.	Comment noted; Section 3.5 of the Draft EIS clarifies that PGV uses native plants to the extent possible to landscape the well sites and power plant consistent with Condition 32 of the Geothermal Resource Permit (2) issued by the County of Hawaiʻi Planning Commission.	Biological Resources
22	9	Due to the arid climate and risks of wildfire to listed species, we recommend coordinating with the Hawaiʻi Wildfire Management Organization at (808) 850-900 or admin@hawaiiwildfire.org, on how wildfire prevention can be addressed in the project area.	Comment noted; PGV maintains an Emergency Response Plan that includes fire hazard risks and response actions, as described in Sections 2.1.8, 2.2.9, 3.10, and 3.11 of the Draft EIS. Due to the lack of vegetation surrounding the site following the 2018 eruption, the risk of a wildfire at the site is very low.	Biological Resources
22	10	We appreciate your efforts to work with our office for the conservation of our native species. These comments are general guidelines and should not be considered comprehensive for this site or project. It is the responsibility of the applicant to do their own due diligence to avoid any negative environmental impacts. Should the scope of the project change significantly, or should it become apparent that threatened or endangered species may be impacted, please contact our staff as soon as possible. If you have any questions, please contact Paul Radley, Protected Species Habitat Conservation Planning Coordinator at (808) 295-1123 or paul.m.radley@hawaii.gov.	Comment noted; thank you for your participation in the EIS process.	Biological Resources

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Heather Irwin, Keone Kalawe, and Keikialoha Kekipi				
23	1	My name is Heather Irwin, a resident of Puna. I am writing to you on behalf of Keone Kalawe and Keikialoha Kekipi, both residents and active community members of Puna. We wanted to address the topic of PGV and the Environmental Impact Study. There are great concerns about the Opae Ula (shrimp) and possible toxicity impacting their viability as well as safety. Beyond the shrimp, there could be toxins being released under ground that is impacting both the land we grow food on, as well as leaching into the ocean and streams. All of which impacts the marine life, as well as everything and everyone else.	Thank you for your participation in the EIS process; your comment has been noted. Potential impacts to biological resources and water quality are addressed in Sections 3.5 and 3.2, respectively, of the Draft EIS.	Biological Resources, Hydrology
23	2	Safety, preservation, and protection is our greatest concern. Will there be monitoring wells to ensure everything is safe, preserved and protected? What additional measures will be taken to ensure the toxic release isn't hurting us all? Many things are already endangered. (Please see links below) With the new land created from the 2018 Lava Flow, there surely needs to be more measures in place to monitor all the new areas.	Potential impacts to public health and safety from the Project Area are analyzed in Section 3.11 of the Draft EIS, as well as potential impacts from geologic hazards, which are addressed in Section 3.1 of the Draft EIS. Sections 2.1.1 and 3.2 of the Draft EIS describe the use of monitoring wells for the PGV facility.	Public Health and Safety
23	3	In Nevada they are finding that there are impacts to native species. That perhaps it is not as safe to all (plants/animals as well), as perhaps previously believed.	Potential impacts to biological resources are discussed in Section 3.5 of the Draft EIS.	Biological Resources
23	4	Additionally, having ohana all throughout Puna, one thing I hear the most griping about regarding PGV is noise pollution. When visiting ohana in Leilani Estates, you hear obnoxious grinding, churning, and sometimes screeching, all hours of the day and night. Understandably there was one trees and thick growth to muffle the noise pre-eruption, that is now no longer the case and people really seem to be suffering and their day-to-day peace they should find at their homes is being disrupted. (Heathers Comment)	Potential noise impacts from the Project and mitigation measures are discussed in Section 3.4 of the Draft EIS.	Noise
23	5	Lastly, why is it that Hawaii County pays more per KWH than both Maui and Oahu? When we are generating power right here in our backyards? Not much incentive to have PGV in your backyard potentially harming the environment, when people locally see absolutely no benefit but perhaps a few specialized jobs. How does PGV help us on a local level here in Puna? (Heathers Comment) https://biologicaldiversity.org/w/news/press-releases/legal-agreement-halts-construction-at-nevada-geothermal-project-to-weigh-harm-to-rare-toad-2022-08-01/ https://ecos.fws.gov/ecp/species/6944 https://www.gohawaii.com/trip-planning/travel-tips/responsible-travel/protected-species https://www.ucsusa.org/resources/environmental-impacts-geothermal-energy https://keolamagazine.com/malama-mokupuni/oopu-opae-tahitian-prawns/	Comment noted. The cost of electricity is a product of many factors. According to the PUC, the proposed Project would increase production of power and assist with delinking electricity prices from oil, with the goal of reducing costs to HELCO rate payers on Hawaiʻi Island. Recurring operations at PGV have created direct jobs for plant and control room operators/supervisors, operations support personnel, maintenance staff, and administrators, while contributing to the local and statewide economy with income generation. The Proposed Action and PGV facility also support the State of Hawaiʻi's renewable energy goals to achieve net zero carbon emissions by the year 2045. Also, potential impacts to socioeconomic considerations are discussed in Section 3.6 of the Draft EIS.	Out of scope
Nick Heinrich				
24	1	I am in favor of PGV expansion. I believe Geothermal is the best source of electric power generation on the Big Island with its unlimited, very available, thermal energy resource. It is cost effective, possibly the least expensive. It has advantages over the other renewables: -smaller footprint (vs photovoltaic, windmills, biomass, ocean, hydro) -zero or minimal emissions -available 24 hrs. requiring no batteries -and worst of all, biomass combustion in low efficiency boiler power plants, polluting air and water. However, concerns with safe operation, location and redundancy must be addressed.	Comment noted. Potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS.	Public Health and Safety
Garth Yamanaka, Government Affairs Committee				
25	1	Thank you for the opportunity to provide comment on the PGV Repower Project. Environmental Impact Statement. The Japanese Chamber of Commerce and Industry of Hawaii (JCCIH) was established in 1951 and represents over 300 members of the business community on Hawai'i Island. The JCCIH continues to be a strong supporter of Puna Geothermal Venture (PGV), including the PGV Repower Project.	Thank you for your participation in the EIS process; please see responses to your specific comments below.	General support
25	2	Puna Geothermal Venture has been in commercial operation since 1993, providing clean, renewable geothermal energy for Hawaii Island. From an environmental aspect, the amount of power PGV has produced from 1993 to present, has displaced the need to burn more than 141 million gallons of oil. The amount of greenhouse gases avoided would be in the millions of tons. Hawaii's goal is to be 100% renewable energy by the year 2045. The Repower project would increase energy delivered to Hawaiian Electric from 38 MW to 46 MW. This increase would be accomplished by replacing 12 existing outdated generating units with 3 modern, more efficient generating equipment. There will be no need for increased geothermal resource to reach 46 MW. The reduction in generator units will result in lower noise emissions and reduced	Potential impacts to air quality and climate change from the Project are discussed in Section 3.3 of the Draft EIS.	Air Quality

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		potential sources of geothermal fluid emission points. Once the additional 8 MW's comes online, Hawaii Island will be around 70% of renewable energy.		
25	3	From an economic perspective, PGV will be providing energy that would be priced at more than 75% less of what residential consumers pay in 2022. Since 1991, PGV has provided living wage employment to over thirty full time employees and for hundreds of part time and contract workers. Taxes contributed to the State and County are in the millions of dollars annually. For these stated reasons and many more, the JCCIH strongly supports the PGV Repower Project.	Potential impacts to socioeconomic considerations from the Project are discussed in Section 3.6 of the Draft EIS.	Socioecono mics
Robert Petricci, revised				
26	1	Same as Ltr 16, comment 1	See response to letter 16, comment 1.	
26	2	Same as Ltr 16, comment 2	See response to letter 16, comment 2.	
26	3	Same as Ltr 16, comment 3	See response to letter 16, comment 3.	
26	4	Same as Ltr 16, comment 4 (w/ minor edit in wording)	See response to letter 16, comment 4.	
26	5	Same as Ltr 16, comment 5 (w/ minor edit in wording)	See response to letter 16, comment 5.	
26	6	Same as Ltr 16, comment 6	See response to letter 16, comment 6.	
26	7	Similar to Ltr 16, comment 7 (w/ minor edit in wording)	See response to letter 16, comment 7.	
26	8	Same as Ltr 16, comment 8 (w/ minor edit in wording)	See response to letter 16, comment 8.	
26	9	Same as Ltr 16, comment 9	See response to letter 16, comment 9.	
26	10	Same as Ltr 16, comment 10	See response to letter 16, comment 10.	
26	11	Similar to Ltr 16, comment 11: I disagree with the author's conclusion that this EIS is not required by law. State land use (the geothermal resource) clearly triggers HEPA requirements as pointed out publicly many times. This EIS is not voluntary, it is required. There are multiple false or misleading statements in this document that need to be corrected if this EIS hopes to have any legitimacy whatsoever. No new EIS was done or NCSP permit issued (the old permit had expired) even after the major changes since the 2018 eruption that closed the plant for years, not exactly reliable. The state owned geothermal resources used by PGV is now much hotter and includes changes both underground and in the ground elevations around the PGV plant and wellfield caused by the 2018 eruption, that triggers the HEPA requirement.	See response to letter 16, comment 11.	
26	12	Similar to Ltr 16, comment 12: The facts clearly show PGV has been largely self regulating since it began drilling operations. DOH's finding that no further environmental review was required for this expansion and new equipment is just another example of that regulatory bias and failure to perform its responsibility to protect the public health. Instead of calling us names like rabidly antigeothermal" to somehow justify their bias, DOH needs to be shaken up and start doing their jobs for once. Hawaii DOH, DLNR, and the county have long allowed PGV to operate in a manner that is dangerous to the surrounding community, and has caused harm, that is why people here object to PGV. This goes back to the beginning when PGV first started drilling wells. The county GRP permit issued over massive testimony by the community against granting the permit. 51conditions were then negotiated with the community. Those conditions were supposed to address the concerns raised by the community. PGV was "required' by the permit to use best available control technology (BACT). The conditions "required" PGV to use BACT, there was no ambiguity there, BACT is required period. DOH, DLNR, and the county never enforced this or other conditions such as aviable emergency response plan for the community. Instead allowing PGV to open vent wells to the detriment of the health, safety, wellbeing, and enjoyment and use of their property by the residents as documented in the county's Adler report. Without anyway to document actual levels the community was exposed to, that was over 20 years ago. DOH, DLNR, and the county allowed this with no way to track the levels or impacts of the toxic gasses being released unabated into our community. I have a problem with that and this EIS needs to address the lack of oversight and permit compliance.	See response to letter 16, comment 12.	
26	13	Same as Ltr 16, comment 13 with the following phrase added at the end: “how will the EIS fix that?”	See response to letter 16, comment 13.	
26	14	Same as Ltr 16, comment 14	See response to letter 16, comment 14.	
26	15	Same as Ltr 16, comment 15	See response to letter 16, comment 15.	
26	16	Same as Ltr 16, comment 16	See response to letter 16, comment 16.	
26	17	Same as Ltr 16, comment 17	See response to letter 16, comment 17.	
26	18	Same as Ltr 16, comment 18	See response to letter 16, comment 18.	
26	19	Same as Ltr 16, comment 19	See response to letter 16, comment 19.	
26	20	Same as Ltr 16, comment 20	See response to letter 16, comment 20.	
26	21	Same as Ltr 16, comment 21	See response to letter 16, comment 21.	
Donald Thomas				
27	1	I am submitting this letter in support of the Puna Geothermal Venture Repower Project. I am a several-decade resident of Hawaii Island; I am a member of the University of Hawaii faculty as a researcher and currently hold the title of Director for the Center for the Study of Active Volcanoes. Beginning in 1973, my research focus has been on Hawaii’s volcanic,	Thank you for your participation in the EIS process; please see responses to your specific comments below.	

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		geothermal, and groundwater processes. I did extensive research on the Kilauea East Rift Zone hydrology and geochemistry and led research on the geothermal fluid chemistry of the Lower Puna geothermal system and assisted in the management of the process chemistry of the State-managed HGP-A Geothermal Generator. My research expanded to a more general investigation of groundwater hydrogeology of Hawaii and I am currently conducting an investigation of the hydrogeology of the Red Hill region of Oahu in collaboration with staff of the Hawaii Department of Health in response to the recent fuel releases occurring there. I am also assisting the staff of the Hawaii Commission on Water Resources Management in assessing groundwater resources and flow in the Keauhou, Kiholo, Anaehoomalu, and Waimea aquifer sectors and have provided support to the Hawaii County Department of Water Supply in their efforts to develop new groundwater resources in the Keauhou aquifer. Due to my frequent (pro bono) interactions with State and County agencies, I do not perform private sector consulting and have not done so for the last ~30 years; hence, I have no current or future financial interest in Puna Geothermal Venture's proposed Repower Project.		
27	2	My support for the Repower Project, and for further development of geothermal power in Hawaii, is based on my belief that geothermal power production is an established and proven technology that has been successfully implemented world-wide. It has generally proven itself as a more cost-effective, and environmentally benign, technology than power generation from fossil fuels. As implemented at Puna, it has negligible emissions of carbon dioxide, no emission of nitrogen oxides, or sulfur dioxide – all products of fossil fuel power generation – of which our major sources are located in the island's major population centers of Hilo and Kona. Although there are some emissions of hydrogen sulfide, the release rate of that gas is also trivial when compared to the nitrogen and sulfur oxides of our current oil-fired generation.	A description of baseline conditions and potential impacts to air quality from the Proposed Action are discussed in Section 3.3 of the Draft EIS.	Air Quality
27	3	In my opinion geothermal is superior to solar and wind power – the former is available 24/7 and is dispatchable, whereas solar and wind power, as currently implemented, are intermittent, have very limited reserve capacity, and are both subject to catastrophic losses due to severe weather events which, with only a casual review of current media, appear to becoming much more frequent than in the past. Without a significant, reliable, generation capacity available, a severe weather event that destroys a substantial fraction of solar and wind capacity will cripple both our economy as well as delay and substantially prolong recovery efforts by months to years.	As discussed in Section 1.3 of the Draft EIS, the electricity generated by the PGV facility is firm generation (i.e., continuous and reliable). The potential impacts to the Project from geologic hazards and natural hazards are discussed in Sections 3.1 and 3.11, respectively, of the Draft EIS.	Geologic Hazards
27	4	With respect to the many claims of adverse effects that have been made against Puna Geothermal Venture's operations, similar claims about geothermal operations have been made for decades but, on investigation, the most serious claims have been found to be groundless. Claims that the operation was adversely affection groundwater chemistry of Lower Puna were investigated by the USGS who found that there was no evidence of geothermal fluids in either existing test well or in coastal springs. I can further confirm that finding since I collected groundwater samples in Lower Puna in 1975, before the first geothermal well was drilled in Hawaii. The water chemistry reported by the USGS for the same wells that I sampled nearly fifty years ago were not materially different from that found in the 1975 samples collected. At that time (1975) several wells had been drilled in the region and all the wells located within the geologic trace of the rift showed both chemical and thermal evidence of natural discharge of geothermal fluids into the shallow groundwater system. Those early test wells were drilled in an effort to develop both irrigation and drinking water sources – due to their chemical compositions (in 1975) none were deemed acceptable as irrigation or drinking water sources.	A description of baseline conditions and potential impacts to water quality from the Project are discussed in detail in Section 3.2 of the Draft EIS.	Hydrology
27	5	The claims of health effects from the geothermal emissions are, I believe, equally groundless. I reference two important epidemiological studies conducted on the effects of exposure to hydrogen sulfide in the ambient air: **Investigation of Hydrogen Sulfide Exposure and Lung Function, Asthma and Chronic Obstructive Pulmonary Disease in a Geothermal Area of New Zealand**, by Michael N. Bates[1]*, Julian Crane[2], John R. Balmes[1], Nick Garrett[3] (1 School of Public Health, University of California, Berkeley, California, United States of America, 2 School of Medicine and Health Sciences, University of Otago, Wellington, New Zealand, 3 Faculty of Health, Auckland University of Technology, Auckland, New Zealand), PLoS ONE 10(3): e0122062. doi:10.1371/journal.pone.0122062. **Chronic Ambient Hydrogen Sulfide Exposure and Cognitive Function**, by Bruce R. Reeda,b, Julian Cranec, Nick Garrettd, David L. Woodsa,e, and Michael N. Batesf,* (aDepartment of Neurology, University of California, Davis, USA, bAlzheimer's Disease Center, Veterans' Administration Northern California Health Care System, Martinez, CA, USA, cSchool of Medicine and Health Sciences, University of Otago, Wellington, New Zealand, dFaculty of Health, Auckland University of Technology, New Zealand, eHuman Cognitive Neurophysiology Laboratory, Veterans' Administration Northern California Health Care System, Martinez, CA, U.S.A, fSchool of Public Health, University of California, Berkeley, CA, U.S.A., Neurotoxicol Teratol. 2014 ; 42: 68–76. doi:10.1016/j.ntt.2014.02.002. Both studies investigated the potential adverse health effects arising from exposure to ambient air Hydrogen Sulfide for residents in the city of Rotorua, New Zealand. These were large studies, with more than 1500 participants, who experienced exposure to varying levels of H2S for durations of, for some participants, decades, and tested for potential pulmonary as well as neurological impacts associated with that exposure. Very briefly, the results of those studies showed that there were no detectable impacts – neither neurological nor pulmonary – on the residents at the highest average aggregate exposures when compared to a control group having near-zero exposure to hydrogen sulfide. (In fact, the studies found evidence of better pulmonary health status of those in the higher exposure group that the authors speculated may have been associated with the therapeutic effects of hydrogen sulfide on those individuals who have reactive airway syndrome). To further investigate the relevance of the findings of these studies to Puna, I made a request to Puna Geothermal Venture to provide me with their fence-line H2S monitoring data; they provided me with hourly H2S averages that spanned approximately ten years of monitoring. In order to assess the average H2S readings in Puna in an equivalent way to those used in the New Zealand studies, I re-computed the average exposures that would have occurred at the power plan fence-line monitoring stations using the same	Potential impacts from the Project to public health and safety are included in Section 3.11 of the Draft EIS.	Public Health and Safety

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		averaging times that were used in the New Zealand studies. When I compared the fence-line averages to those in the highest exposure areas of Rotorua, I found that the maximum average fence-line values reported (e.g. during periods of steam venting) were approximately 1% of the averages in the highexposure areas that were routinely documented in the Rotorua study; at all other times, the average fence-line values were substantially below the Rotorua high-exposure values. Given that: residents of the Puna district live thousands of feet to several miles from the PGV fencelines; and that the PGV data showed fenceline H2S levels were highly dependent on wind direction which was quite variable, any individual in the surrounding communities would experience an actual long-term exposure to ambient air H2S far below those occurring for the Rotorua residents who experienced no epidemiologically detectable adverse health impacts. (I would note that a similar study was proposed by Dr. Bates, the lead author on one of the above papers, and funding was initially made available to conduct the study; however, at that time, newly-elected Mayor Kim, who had opposed geothermal development from the outset, elected to cancel the contract before it was finalized and, hence, no formal investigation of alleged health impacts on the residents of Lower Puna has been performed).		
27	6	Recently, more creative allegations of harm have been made that claim that actions by Puna Geothermal Venture before and during the onset of the lower Puna eruption, in some way, affected the course of the eruption and the locations of some of the more productive vents. Those claims were investigated by the scientific staff of the Hawaiian Volcano Observatory and were found to be without geologic merit. I would further offer that these claims are based on an extremely naïve understanding of the basic physics (and chemistry) of rock fracture and a complete absence of understanding of the pressure-temperature-volume relationships of water at elevated temperatures and pressures. Whereas the volume change of water to steam at 100°C and atmospheric pressure is an increase by >1600 times in volume, the same change in a deep borehole at a hydrostatic pressure of ~3000 psi, brings a volume change of only ~2.5; hardly the explosive reaction alleged by some in the community.	The potential impacts to the Project from geologic hazards are discussed in Section 3.1 of the Draft EIS.	Geologic Hazards
27	7	Recently, more creative allegations of harm have been made that claim that actions by Puna Geothermal Venture before and during the onset of the lower Puna eruption, in some way, affected the course of the eruption and the locations of some of the more productive vents. Those claims were investigated by the scientific staff of the Hawaiian Volcano Observatory and were found to be without geologic merit. I would further offer that these claims are based on an extremely naïve understanding of the basic physics (and chemistry) of rock fracture and a complete absence of understanding of the pressure-temperature-volume relationships of water at elevated temperatures and pressures. Whereas the volume change of water to steam at 100°C and atmospheric pressure is an increase by >1600 times in volume, the same change in a deep borehole at a hydrostatic pressure of ~3000 psi, brings a volume change of only ~2.5; hardly the explosive reaction alleged by some in the community.	The potential impacts to the Project from and to geologic hazards are discussed in Section 3.1 of the Draft EIS.	Geologic Hazards
Eileen O'Hara, Malama O Puna				
28	1	In Malama O Puna's opinion the lava flow was a perfect time to shut down PGV permanently. Other much less polluting and truly renewable energy systems currently exist at Natural Energy Laboratory of Hawaii's Ocean Thermal Energy Conversion (OTEC) and through island wide wind turbines and solar. These are currently putting out, and have the potential to put out much more power than PGV, with no risk to communities.	Thank you for your participation in the EIS process; please see responses to your specific comments below. Please note that in 2017 PGV provided approximately 31 percent of the electricity delivered to the HELCO grid. Currently at approximately 24 MW of production, the PGV facility provides the HELCO gride with approximately 20 percent. If Phase 1 of the Proposed Action is implemented, it is anticipated that the PGV facility would provide the HELCO grid with approximately 37 percent of its electricity and approximately 48 percent under Phase 2.	General Opposition
28	2	PGV has often not been a good neighbor. Blowouts of H2S, not shutting down during the 2014 approach of Hurricane Iselle causing a huge blowout and harming many nearby residents some of whom found themselves knocked unconscious, and by having an insufficient monitoring and public notification system which is soley administered by PGV and has not resulted in timely, clearly worded warning to people living with the 3-mile radius of the plant. We have always been of the opinion that placing a geothermal plant so close to neighboring communities was a bad idea to begin with and for the people living around PGV this has proven to be the case. Now, after the lava flow, the situation has worsened. There is nothing between the plant and the neighboring communities allowing gasses to travel faster and noise pollution to be much greater. The communities around PGV have a much larger population than they did when PGV was first built so the risk of harm has increased.	Potential impacts to public health and safety from the Project are discussed in Section 3.11 of the Draft EIS; also, potential impacts from noise associated with the Project are discussed in Section 3.4. Potential impacts associated with geologic hazards and the Project are discussed in Section 3.1 of the Draft EIS. It is also noted that the Project is sited in its location due to the presence of geothermal resources. Those who site homes in Lava Zone 1 assume the risk that seismic activity and other volcanic hazards may damage the residences.	Public Health and Safety, Noise
28	3	At the very least, we request that an independently operated (third-party) notification system be implemented with the ability to provide real time and immediate information to the public in the event of any action by PGV that could cause potential harm to residents. Further, there needs to be an expansion of water and air monitoring sites, not just within the PGV leased property, but within a 1-mile radius of the plant. Reporting of those monitors should be provided to the public in a weekly announcement emailed to residents within the 3-mile radius of the plant and available through daily updates to their website. We thank you for the opportunity to provide public comments on this draft EIS.	The Draft EIS includes a summary of air, noise, and water monitoring requirements associated with existing permits in Section 2.1 and also in the respective resource sections. Potential impacts from the Project to air quality are discussed in Sections 3.2 and 3.11, potential impacts to noise are discussed in Section 3.4, and potential impacts to hydrology are discussed in Section 3.2 of the Draft EIS.	Air Quality, Noise, Hydrology
Sara Steiner				
29	1	Pg. 2 "Discretionary Consent Required" I OBJECT THAT THE COUNTY OF HAWAII IS THE APPROVING AUTHORITY FOR THE EIS WHEN THE "DISCRETIONARY CONSENT REQUIRED" IS FROM THE STATE OF HAWAII DEPARTMENTS OF CLEAN AIR AND CLEAN WATER BRANCHES - MEANING GOVERNOR IGE and/or THE STATE OF HAWAII IS ACTUALLY THE APPROVING	Thank you for your participation in the EIS process; please see responses to your specific comments below.	EIS Process (Approving Agency)

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		AUTHORITY PURSUANT TO HAR 11-200.1-7(d) (1-5) which indicates the State is the Approving Authority because the State has the most discretionary authority due to PGV's outstanding Air Pollution permit (NSP N0. 08-002-N expired in 2014) and (UH-1529) Underground Injection Wells permits (expired 2020), the State of Hawaii has the most agencies involved and spends the most money on PGV's	HRS § 343-5(f) authorizes the Office of Planning and Sustainable Development to designate the approving agency, and it has selected the County of Hawaiʻi Planning Department, consistent with HRS § 343-5(e), which provides that "[t]he planning department for the county in which the proposed action will occur shall be a permissible accepting authority for the final statement."	
29	2	Pg 3 - states PGV is currently authorized for and operating a geothermal plant in the Puna District... PGV Is Only Authorized To Have 14 Wells According To Their Expired Air Pollution And Underground Injection Well Permits. They Have Already Drilled And Are Operating Since 2020 and wells KS-16, 17, 18, 19 And 20 without either Department Of Health Permits.	A list of existing permits, including the noncovered source permits and UIC permits, is included in the EISPN Table 2-2 and is also included in the Draft EIS as Table 4-1. Section 2.1.1 of the Draft EIS includes the number of authorized wells per permit.	Existing Conditions, Air Quality, Hydrology
29	3	Pg 9 - a) Is it BLNR or DLNR? - Hawaii has a Department of Land and Natural Resources that issues discretionary environmental impact permits to PGV. b) Is "CDA" Hawaii County Civil Defense Agency or the State of Hawaii Civil Dense Agency? c) WHAT IS THE HAWAII EMERGENCY RESPONSE COMMISSION? I don't see the "ERC" listed on the page 42 list of government agencies notified of this EISPN, and I reviewed the last 4 years of annual reports of the ERC to the Hawaii Legislature with no mention of Puna Geothermal Venture Emergency Response Plan except for in 2019: a 1 paragraph statement and a photo about fissures opening and PGV removing 55,000 gallons of pentane during the 2018 eruption and a mention of lava covering homes. d) According to a July 2022 UIPA request, the Hawaii County Civil Defense Agency (responsible for notifying and evacuating residents surrounding PGV in case of emergency) is operating off of their old 2016 Emergency Response Plan for evacuating residents in case of lava flow or hydrogen sulfide emergency, and the 2016 ERP shows the evacuation routes as the same before the 2018 eruption. Hawaii County Civil Defense also stated it is not aware of the location of the 3 Department of Health perimeter hydrogen sulfide monitors are located in July 2022, and they have no knowledge of when PGV's ERP was presented to the public for inspection or approval, and the Civil Defense and/or Hawaii Fire Department Hazmat team that is supposed to respond and protect the residents is located an hour away, in downtown Hilo. The State and County of Hawaii do not have an effective ERP to timely respond to a H2S leak, much less verify the amount of the leak, so this new EIS needs to have an effective immediate emergency response plan to notify the surrounding residents, and not just in their imaginary 3500' radius–1. The UIPA answer can be found at: https://uipa.org/request/puna-geothermalventure-emergency-response-plan/#- d) According to a July 2022 UIPA request, the Hawaii County Civil Defense Agency (responsible for notifying and evacuating residents surrounding PGV in case of emergency) is operating off of their old 2016 Emergency Response Plan for evacuating residents in case of lava flow or hydrogen sulfide emergency, and the 2016 ERP shows the evacuation routes as the same before the 2018 eruption. Hawaii County Civil Defense also stated it is not aware of the location of the 3 Department of Health perimeter hydrogen sulfide monitors are located in July 2022, and they have no knowledge of when PGV's ERP was presented to the public for inspection or approval, and the Civil Defense and/or Hawaii Fire Department Hazmat team that is supposed to respond and protect the residents is located an hour away, in downtown Hilo. The State and County of Hawaii do not have an effective ERP to timely respond to a H2S leak, much less verify the amount of the leak, so this new EIS needs to have an effective immediate emergency response plan to notify the surrounding residents, and not just in their imaginary 3500' radius–1. The UIPA answer can be found at: https://uipa.org/request/puna-geothermalventure-emergency-response-plan/#-	The reference to BLNR on page 1-7 of the EISPN is correct in regard to geothermal resource subzone management, and PGV does hold a permit with DLNR for the Plan of Operation (as shown in Table 2-2 of the EISPN). As stated when the acronym is first used in the EISPN on page 2-6, CDA stands for County of Hawaiʻi Civil Defense Agency. The acronym in the EIS has been updated to SERC. More information on the State Emergency Response Commission can be found online here: https://www.hawaiicounty.gov/departments/fire/local-emergency-planning-committee. Information on the SERC is included in Section 2.1.8 of the Draft EIS. Information on the updated ERP is included in Sections 2.1, 2.2, 3.4, 3.5, 3.10, 3.11, and 3.13 of the Draft EIS.	Hazardous Waste
29	4	PG 11 - a) I want this EIS to clarify on pg 9 when you talk about the 2012 "expansion" of PGV. You need to disclose it was paid for with a grant fraudulently obtained from the US Federal Government for an upgrade to Ormat's Nevada Brawley geothermal plant and Puna Geothermal Venture. The grant was made via the American Recovery and Reinvestment act of 2009. The suit was brought by two Ormat employees in Nevada in charge of the grant application who complained about falsified application information including dates and descriptions of the plant operations and wells. Approximately 10% of the $136.8 million awarded was allotted to PGV ($13,821,143.00 cash grant). This grant was earmarked to help pay for the cost of drilling KS-14 and the plant expansion when none of it was eligible for a grant. Ormat made an out-of-court settlement in 2016, but only 4% of the taxpayers money pilfered was returned. They fraudulently received $136,800,000 from the American taxpayers (supposed to be used for new electric plants not for both of Ormat's old already existing plants) but only paid back $5.5 million. See US v Ormat Industries; April 2016 attached to Exhibits.	Comment noted; this is outside the scope of analysis for the proposed upgrade of equipment at the Project site.	Out of scope
29	5	Pg 11 - a) Paragraph 1 says PGV is currently "authorized for and operating" a geothermal plant on Hawaii Island. SANTEC CONSULTING SERVICE IS HEREBY NOTIFIED THAT PGV IS OPERATING IN 2022 WITHOUT ACTIVE DEPARTMENT OF HEALTH AIR POLLUTION PERMIT OR CLEAN WATER BRANCH UNDERGROUND INJECTION WELL PERMIT. THIS EIS NEEDS TO CLEARLY STATE THAT PGV IS OPERATING WITH EXPIRED AIR POLLUTION PERMIT (2014) and EXPIRED UNDERGROUND INJECTION CONTROL PERMIT (2020). We, the people, have been waiting 7 years already (since 2015) for a contested case on the Air Pollution permit and I just found out 2 weeks ago that PGV's Underground Injection Permit expired in March of 2020 . THERE SHOULD BE A PART IN THE EIS WHICH TALKS ABOUT ALL THE MISSING PERMITS, FINES, VIOLATIONS AND LAWSUITS PGV HAS HAD OVER THE YEARS. PGV IS NOT A GOOD NEIGHBOR AND THE RESIDENTS HAVE SUFFERED FOR YEARS. b) 1.0 Why this EIS is Being Prepared. This EIS is also being prepared because the old EIS expires in 2022... and that EIS's are supposed to follow HRS 343. PGV's first version of their ARPPA submitted to the PUC claimed 2 new OEC's would replace the 12 old	A list of existing permits for the Project, including the noncovered source permits and UIC permits, is included in the EISPN Table 2-2, and required permits for the proposed Project are included in the Draft EIS in Table 4-1. Potential impacts to air quality are analyzed in Section 3.3 of the Draft EIS. Under HRS Chapter 343, EISs do not "expire." The EIS for the Project is being prepared in response to the PUC order as described in Section 1.1 of the Draft EIS. The description of the Proposed Action in Section 1.2 of the Draft EIS describes how Phase 1 is consistent with the number of OECs in the PPA and how an additional OEC would be added under Phase 2 of the Proposed Action, which would require amending the agreement prior to implementing Phase 2.	Existing Permits, Air Quality, Hydrology, Public Health and Safety, Cumulative, Geologic Hazards

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		ones as the resource had changed to mostly steam, then the ARPPA was amended in 2020 or 21 to need 3 OECs and were are told the resource has changed again back to liquids and now the total number of new OEC's is 4. c) PGV's stale 1987 EIS spent plenty of money telling us which way the wind blows the toxic Hydrogen Sulfide through the community, the noise flows (make sure this EIS discloses the fact that PGV got the 40db noise limit upped to their benefit to 70dbs) and the viewing impacts - but not one penny was spent on making any graphs, maps or charts which show how 60k+gallons of pentane would blow up and how 35 years of geothermal wells injecting 6-10.8 million gallons a day of acidic effluent with added chemicals to prevent scale and silica buildup fracture the ground and how those fractures propagate and also how PGV is going to mitigate (prevent) this (HINT - IMPOSSIBLE!). This EIS will need to show the cumulative effects of the underground fracturing of PGV's wells on the enviornment 4000-8000 or more feet underground, wells drilled sideways (and all kinds of crazy ways - see attached as an exhibit, Damage and Repair of KS-14 (2020) with multiple redrills and spuds and perforated pipes and they don't even know which way they are drilling, and also attached as an exhibit is 5 Pages from PGV's 2020 EPA application which show the fractures PGV creates and a side view of their enhanced engineered geothermal plant ... c) FYI - I sued the DOH Clean Air Branch and PGV when they determined (without consulting any outside authorities) that didn't require PGV to perform an EIS. The case got to the Intermediate Court and was dismissed BECAUSE AFTER 7 YEARS THE STATE OF HAWAII NEVER GOT THEIR ACT TOGETHER TO HOLD THE CONTESTED CASE AND THE COURT WAS GIVING PREFERENCE TO THE BAD FAITH GOVERNMENT AND PGV. This EIS should disclose all lawsuits filed against the State /County and PGV and should also disclose how long normal DOH contested cases should take to be held, for example, the DOH just held a contested case in 2022 against the US Military over the Red Hill water polluting within 2 months of stating their intention. THIS EIS NEEDS TO DISCLOSE THAT AFTER 7 YEARS THE HAWAII DEPARTMENT OF HEALTH'S CLEAR INTENTION AND ACTION IS TO NEVER HOLD A CONTESTED CASE HEARING WHERE THE PEOPLE GET TO HAVE THEIR SAY HEARD BY GOVERNMENT OFFICIALS. b) Paragraph 3, PGV's "voluntarily provided" 1987 EIS did not discuss the cumulative impacts of multiple injection wells thousands of feet underground on an unstable active volcanic rift zone, including the effects of the added chemicals to prevent silica and corrosion and biofouling. PGV's 1987 EIS said injection wells can cause M4.0 earthquakes and that was depth of discussion. I am providing to Santec Consulting copies of the 2018 United States Bureau of Land Management's protocol where to locate injection wells (OR IN PLAIN ENGLISH - HOW TO SAY "NO" WHEN IT ISN'T SAFE TO PUT GEOTHERMAL WELLS IN THE MIDDLE OF AN ACTIVE VOLCANIC RIFT ZONE) . I have also included the Induced Seismicity Monitoring Plan for the Newberry Geothermal Plant in California so that Santec can see the true depth of discussion on geothermal induced seismicity that needs to be included in the EIS, including PGV's plans for seismic monitoring and how the public will access that information REALTIME since we do not and cannot trust PGV to provide accurate information on anything. WHERE IS THE BACKGROUND SEISMIC STUDY AND WHERE IS THE SEISMIC MONITORING AND "MITIGATION" PROGRAM FOR PGV? The EISPN document does not contain the words "cumulative" or "induced seismicity" or "seismic monitoring" ONE (1) TIME - just the same as the 1987 EIS. WE NEED TO MOVE INTO THE NEW CENTURY USING NEW TECHNOLOGY - THIS EIS NEEDS TO SHOW THE FRACTURES PGV MAKES WHILE OPERATING AND HOW WE ARE GOING TO MONITOR THE UNDERGROUND CONDITONS AND HOW PGV IS GOING TO MITIGATE THEM! Enhanced Geothermal is illegal in the County of Hawaii. PGV looks and acts like an enhanced geothermal plant AND THAT IS ILLEGAL. c) 1.2 Proposed Action - states that PGV will use the same amount of resource. That is not true, the new OEC's will pump up to 10.8 million gallons of fluid a day, versus 6 million gallons a day in 2018. THAT IS AN 80% INCREASE OF RESOURCE AND A 80% INCREASE OF MICRO-EARTHQUAKES ON OUR UNSTABLE VOLCANO!	Comment noted. Section 3.11 of the Draft EIS includes a description of existing conditions and an analysis of potential impacts to public health and safety from the proposed Project. Section 3.13 of the Draft EIS includes a cumulative effects analysis. Potential impacts from geologic hazards are analyzed in Section 3.1 of the Draft EIS. The amount of geothermal resource that would be utilized in Phase 1 and Phase 2 of the proposed Project is described Section 2.2.1 of the Draft EIS. Under Phase 1, the amount of geothermal resource would not increase above current levels, and the additional capacity would be captured through efficiencies in the new equipment. Additionally, potential impacts from geologic hazards are discussed in Section 3.1.	
29	6	Pg. 12 - a) The State of Hawaii needs to be the accepting authority according to HAR 11-23-7. PGV has 2 outstanding permit applications at the State of Hawaii Department of Health that need to be accepted by the State of Hawaii, AIR POLLUTION AND UNDERGROUND INJECTION. The County can be the accepting authority but the State/ Governor SUPPOSEDLY has the "expertise and authority" to approve those permits. The county merely is issuing grubbing and grading permits. Our lives are at stake here and the State of Hawaii is foisting the approval of this EIS on the County which goes in opposition to HAR 11-23. The EIS needs to clarify that it should be the State as the Approving Authority. THE State "Office of Environmental Control or Planning (or whoever is now in charge of EISs) is operating in Bad Faith and is trying to make the County liable for approving our safety when THE STATE HAS TAKEN ALL REGULATORY AUTHORITY AWAY FROM THE COUNTIES RELATING TO GEOTHERMAL YEARS AGO SO THEY CAN SHOVE IT DOWN OUR THROATS FROM THE SAFETY OF OAHU. b) This EISPN claims there is no County or State money involved in running PGV. I tell you that is grossly incorrect. THE STATE AND COUNTY HAVE HAD TO RESPOND TO ANY AND ALL EMERGENCIES AT PGV SINCE THEIR INCEPTION AND THE STATE HAD TO DECLARE A STATE OF EMERGENCY AND PAY FOR ALL OF PGV'S EMERGENCY EQUIPMENT IN 2018: WATERPUMPS, METAL PLUGS AND CLAY TO CEMENT THEIR WELLS. The EIS needs to clarify that PGV has cost the State and County plenty of money since they started operations in the early 90's.	See the response to letter 29, comment 1, regarding the HEPA process. Regarding the use of public funding, PGV is not proposing to use state or county funds for the proposed action.	EIS Process (Approving Agency)

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29	7	Pg 14/15- Power Generation on Hawaii Island. a) In Table 1-1, the column on the right is headed "amount generated" (megawatts). The table actually lists nameplate capacity for the power plants listed, and not the amount generated. Since the "amount generated" is the most relevant quantity if one wants to seriously evaluate the power generation on the Big Island, I have included below a table with total amounts generated during the years 2010-2020 as the megawatt equivalent for each plant during this period. The rightmost column on Figure 1 below is capacity usage (production/capacity) and can be seen to vary from 16% to 58% for the power plants on the Big Island, rendering the capacity figures listed in Table 1-1 almost meaningless. There are 4 plants which have consistently, for the past 20 years, generated about 75% of the Big Island's total electricity. They are, in order of 2010-2020 production, Keahole (Kona Airport) 30.2 MWe, Hamakua (Honokaa) 23.6 MWe, PGV (Lower Puna) 22.3 MWe, and WH Hill (Hilo Airport) 20.8 MWe. Increasing contributions from wind, biodiesel, solar and others will diminish this percentage as time passes. The two oil burning plants near the Kona and Hilo airports are the primary plants which need to be replaced in order to achieve 100% renewable electricity on the Big Island, corresponding to 50.9 MWe out of a total Big Island generation from oil of 57.3 MWe (2010-2020). The other two large plants can both be classified as at least partially renewable. Increasing their output to demonstrated (Honoka'a 45 MWe) and proposed (PGV 60 MW) capacity would provide enough generation to allow the closure of all oil plants on the island. And this is without including the two 30 MW (~15 MWe total) grid scale solar projects about to come online near Waikoloa, or other emerging alternatives. The Honoka'a plant deserves further mention. The plant opened in 2000 and was designed as a peaking power plant, able to respond quickly to demand fluctuations. With this in mind, it was sited about halfway between the two main demand centers on the island, Hilo and Kona. By the time the plant was built there was already a recognition that the island should move toward renewable energy as quickly as possible. So an ability to respond to the fluctuations inherent in solar and wind energy was also incorporated in the design. In a further move toward sustainability the plant was designed to burn naphtha, a byproduct of the distillation of crude oil, which has traditionally been used primarily as a solvent. Another improvement occurred in late 2019 when a contract was signed with Pacific Biodiesel to provide enough fuel for about 5 MWe of the plant's output. Pacific Biodiesel has a plant in Kea'au, about 50 miles from Honoka'a, which produces "certified sustainable" biodiesel from recycled cooking oil and agricultural waste. A similar amount (~5 MWe) comes from naphtha produced at Hawaii's only refinery on Oahu. So the production of electricity from Honoka'a is all waste, about 20% local, and about 10% sustainable at a production of 50 MW. At its typical production rate with all other plants operating normally (~ 10 MWe), the Honoka'a plant is 50% sustainable and 100% local. The plants listed in Table 1-1 total 406.7MW (nameplate capacity). The amount of electricity generated on the Big Island in 2020 was 1042 Gigawatt hours, corresponding to a total generation of 118.6 MWe (Megawatt equivalent). This makes it clear that Table 1-1 has little to do with actual electricity generated, only nameplate capacity. Actual electricity generated was about one third of the listed capacity.	Table 1-1 has been updated to reflect the current values on Hawaiian Electric's Power Facts site, and the column on the right has been revised to read "Capacity" rather than "Amount Generated" in the Draft EIS. Data from this table is based on information provided by Hawaiian Electric's website (https://www.hawaiianelectric.com/about-us/power-facts). Section 1.3 of the Draft EIS provides an overview of the current energy mix, state energy goals and policies, and the state's and island's renewable energy production.	Project Background
29	8	Pg 15 continued: c) Re Santec Graph 1: PAGE 14 SAYS HAWAII ISLAND WAS GENERATING 60% (under State Renewable Energy Production), while the State of Hawaii was generating 38% renewables. Yet, we are told in Graph 1 that the total percentage of renewable energy generated on the Big Island is not 60% as listed above, but only 38%. On Page 14 the EIS states that Hawaii Island had the highest percentage of energy generated by renewable resources, which was listed at 60%. On Page 15 of the EIS it is stated that Hawaii Island was able to increase the amount of renewable energy to approximately 38% in 2021. Maybe I'm naive but I find these statements confusing. A nice graph of the 38% number is included in the EIS. We have attached as Figure 2 below a very similar graph displaying the source of the 60% quote. Is anyone home? Is there a proof reader or editor? There should at least be an explanation of why the two renewable energy numbers are so different. c) also puzzling in Graph 1(pg 15) is the almost 16% jump in renewables created by PGV's return online. Numbers for the entire year of 2021 indicate a total Big Island production of 130.0 MWe. Based on that total, PGV's average generation during 2021 was 19.5MWe. So while the claim that PGV is already generating 25.7 MW may be technically correct in mid 2022, it was less than 20 MWe for all of 2021. When we attempted to open the link to the citation listed as the source of this graph, we received "the page you requested is no longer available". The data information leading to these conclusions just became available on DBEDT.	Text and an additional graph were added to Section 1.3 of the Draft EIS to clarify the current production percentages for Hawai'i Island, and the text has been revised to explain the difference between system renewable energy and renewable energy portfolio, which accounts for the differences in calculations in the EISPN. The graphs have been replaced with a more current graph that illustrates renewable portfolio standard compliance.	Project Background
29	9	Pg 16 a) Begins with the sentence "Hawaiian electric also identifies additional solar, biomass, and energy projects in development on Hawaii Island, which would add approximately 184.5MW if they come online (Hawaii Electric 2021b). THE ENTIRE POWER CONSUMPTION OF THE BIG ISLAND HAS STEADILY GONE DOWN SINCE 2007. WE DON'T NEED air polluting and ground destabilizing geothermal power any longer.	Comment noted. The definition of firm generation is included in Section 1.3 of the Draft EIS and states that firm generation means sources of power generation that are controllable and reliable in that they are not episodic or reliant on environmental variables such as the wind and sun to produce electricity.	Project Background, Purpose

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		b) Project Purpose - Puna Geothermal Venture is not a firm source of power generation and should be listed in the Variable (As-Available) Generation. See Figure 3 below. All electricity graphs were made using State of Hawaii DBEDT data and/or EIA (Energy Information Administration) data. THERE IS NOTHING FIRM ABOUT PGV EXCEPT THAT IT FLUCTUATES REGULARLY. Figure 4 above is designed to show how HELCO managed output from their individual plants before and after the 2018 eruption. In May 2018 PGV's production decreased immediately from about 38MW to zero. Meanwhile, the Honokaa plant output jumped from 6.0 MWe in April to 38.6 in May and 45.3 MWe in June, fully covering the 38 MW loss created by the eruption. The Honokaa plant continued to provide an average of 45 MWe of generation until October 2019. Most of the other plants had only minor changes in their activity. Once again, this demonstrates the ability of the Honokaa plant to preserve system stability by increasing output in response to disruptions at other plants. It actually does what PGV promised but has failed to deliver throughout its 30 year history.	Comment noted. Part of the reason energy costs rose when PGV was offline following the eruption is because HELCO had to increase use of fossil fuels (e.g., from the Honokaa plant) for power generation. Section 1.3 of the Draft EIS explains how increasing renewable energy production is necessary to meet Hawai'i's renewable energy goals and policies.	
29	10	Pg 16 - 1.4 Alternatives: a)The 1987 EIS said the life of the PGV plant was 35 years. A great alternative is PGV decommissions their the plant as envisioned in the 1987 EIS. 35 years from 1987 is 2022! It is time for PGV to pack up and go and stop harming the environment and residents. PGV was shut down for over 2 years after the 2018 eruption and we didn't experience one brownout or electrical shortage. The State has mandated we use less power and so we don't even need PGV to meet our projected power usage as it keeps declining. PGV can decommission as anticipated in the 1987 EIS and pack it up and restore the land to its former beauty. The community would benefit from the property being acquired by the County of Hawaii Open Space Fund and returned as a park to the people who lost so much in 2018. b) Shut down the PGV plant and move toward more biodiesel and solar, improve battery storage, and also implement the virtual power plant concept now being experimented with on Maui, Big Island and Oahu. It is called VPP, Virtual Power Project, Swell Energy (6000 batteries and 25MW on 3 islands) and you can find more about it at: https://www.swellenergy.com Pg 16 cont. c) As part of its goal to become self-sufficient, the State of Hawaii initiated a program to reduce State electric utility sales by 40% from 2007 levels by 2030. According to this scenario shown in Figure 5 above , total Big Island electric utility sales would fall off to 85MWe by 2030. That is, the State has mandated a steady shrinkage of electric utility sales in Hawaii. Even with no additional projects, the island would achieve 100% renewable energy by 2030 under this scenario, assuming a full 38MW contribution from PGV. Continuation of the roughly 2MW per year downward trend mandated by the 2008 Act would entirely remove the need for any energy from PGV before the expiration of any new RPPA (lasting until at least 2052) that would result from the approval of PGV's EIS, and this is without any addition of new renewable energy projects on the island. d) 1.5 Geothermal Resource Subzones. Greedy speculators and government officials enacted the geothermal resource subzones in the 1980's WITHOUT PERFORMING ANY ENVIRONMENTAL REVIEW WHICH WOULD DISCLOSE THE CUMULATIVE EFFECTS OF INJECTION WELLS WITH ADDED CHEMICALS DESIGNED TO PREVENT SILICA BUILDUP AND HOW THOSE INJECTION WELL FRACTURES PROPAGATE AND/OR DISSOLVE ROCK IN ACTIVE VOLCANOES UNDER EXTREME PRESSURE. Our illustrious legislators in Oahu condemned Puna residents to the last 35 years of hell from PGV and then on top of it PGV injects cold water and salt water underground while lava is erupting less than 200 yards away from their property line during the 2018 flow trying to save their wells. The entire world knows about phreatomagmatic explosions at Halema'uma'u when the lava hits the water and the entire world knows that lava explodes on contact with the ocean - so why PGV didn't think pumping cold water and salt water into an erupting volcano wouldn't explode. WE SAW EXACTLY HOW IT EXPLODED OUT FISSURE 17. Then PGV didn't stop pumping water for 2 weeks while they waited for the State of Hawaii to organize and pay for emergency equipment to cement wells. PGV SHOULD HAVE JUST CALLED FOR THE CEMENT TRUCKS ON MAY 4 AFTER THE 6.9 EARTHQUAKE AND NOT BLOWN THE RIFT ZONE OPEN FOR 2 WEEKS. I made a UIPA request to the State of Hawaii Emergency Management Agency about the details of the "Governor's Expert Task Force" and what actually transpired during those several weeks in May 2018. Who was pushing for cement to fill the wells and who was pushing to inject water and salt water to try and save the wells. I will provide the information upon receipt.	Comment noted. Please note that the 1987 EIS identified an *approximate* term of 35 years for the operation of the PGV facility but recognized that the facility could operate for a longer term. Because this is an Applicant action, closing the plant at this time is not proposed by the Applicant and is not a reasonable alternative. Neverless, decommissioning of the PGV facility at the end of the current PPA (in 2027) is discussed in Section 1.5 of the Draft EIS, and the impacts of such alternative are discussed throughout Chapter 3 of the Draft EIS. It is also noted that the land where the PGV facility is sited is private land. To the Applicant's knowledge, the land is not proposed to be sold by the owner, and the County of Hawai'i has not indicated that it would try to acquire the land. No other energy-generating project was proposed in the ARPPA, which has been approved by the PUC. The Draft EIS acknowledges that under the No Action Alternative, if the PGV facility were to decommission, Hawai'i Island's energy needs would need to be met by other sources. Section 1.3 of the Draft EIS discusses the state's energy goals and policies, in particular the reduction of fossil fuel energy generation to zero by 2045. No policies have been identified that mandate a reduction of electric utility sales in Hawaii. Comment noted. Please note that the state's clean energy initiatives are aimed at reducing electricity produced using fossil fuels, not to limit overall energy consumption. Regarding demands for energy, HELCO anticipates that Hawai'i Island's energy demands will increase by 28.4 percent over the life of the Project or approximately one percent per year. Comment noted.	Alternatives, Project Background
29	11	Pg 17 - Project Location. As you can see by the maps attached to the end of the EISPN, PGV is trying to downplay that they are located in the middle of several subdivisions, including lava covered areas WHERE PEOPLE STILL OWN LAND AND PLAN TO REBUILD. NOT EVERYONE IS TAKING THE BUYOUTS! SANTEC NEEDS TO DISCLOSE THAT INSTEAD OF PUSHING THE BUYOUTS. Why did Santec or PGV cut off most of the right-hand sides of their maps in Figures 2-6? TO HIDE THE FACT THERE ARE HOMES AND PEOPLE AND ANIMALS LIVING THERE!	The figures included in the EISPN focused on informing the public of the scope of the Proposed Action and resources present within the footprint of the Project Area. Potential impacts from the proposed Project are discussed throughout Chapter 3 of the Draft EIS. Figure 1 and Figures 4–10 in the Draft EIS show the location of the PGV facility in relation to the surrounding neighborhoods.	General Analysis
29	12	Pg 18 - Existing Operations: Geothermal Wells and Wellfield Facilities. a) PGV IS NOT A RENEWABLE RESOURCE. PGV IS NOT FIRM. PGV HAS TO CONSTANTLY RE-DRILL WELLS AND GET NEW EQUIPMENT IN AN ATTEMPT TO MEET THEIR CONTRACT. Drilling new wells involves massive drill rigs, diesel engines and miles of special strength steel pipes, drilling muds and oils and chemicals, all brought in overseas. b) PGV uses many hundreds of thousands of gallons of petroleum products (diesel, pentane) plus tens of thousands of gallons of liquid nitrogen and who knows how many gallons of highly corrosive acids to keep the silica and corrosion from fouling their systems.	According to the U.S. government and State of Hawai'i, geothermal energy production is categorized as renewable. Drilling at the site is conducted in accordance with approved state and federal permits and is not part of the proposed Project. See the response to comment 9 above.	Hazardous Material and Waste, Hydrology

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		c) THE INFORMATION IN TABLE 2-1 CONTRADICTS THE INFORMATION IN PGV'S POO (PLAN OF OPERATION) APPROVED BY HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES AND SUBMITTED TO THE HAWAII PUC AS BEING CURRENT IN 2020 as shown in Figure 6 below, which clearly shows well pads I, G, J and even K. What is going on at PGV? Why are their diagrams of operations and wellpads different for DLNR than what is provided elsewhere?	Potential impacts from hazardous materials and waste including use and storage locations associated with the Project are analyzed in Section 3.10 of the Draft EIS. Potential impacts to hydrology are discussed in Section 3.2.	
29	13	Pg 18 - c) THIS EIS NEEDS TO DISCLOSE THE ACTUAL WELLS PGV HAS CREATED - ALL OF THEM - WITH TOP AND BOTTOM GPS COORDINATES, AS WELL AS THE REDRILLS AND SPUDS FOR EACH. Also answer the burning questions why PGV needs so many wells, why they need rock catchers and why wells fail. The people need to realize PGV is drilling down and then sideways into an active volcano. We also need to know the status of all the production wells listed in 2-1 which do not say plugged or covered but say "out of service" anyway, and if that counts as a proper plug and abandonment.	A description of the existing environment, including permitted and constructed wells, is included in Section 2.2 of the Draft EIS. Potential impacts to hydrology are discussed in Section 3.2 of the Draft EIS.	Hydrology
29	14	Pg 20 - 2.1.6 Existing Operations. a) PGV got in trouble in 2016 with the EPA for using and losing an inordinate amount of the petrochemical pentane. The 2015 USGS Water report clearly states PGV injects Pentane into their wells. THIS EIS NEEDS TO CLARIFY WHY PGV INJECTS PENTANE UNDERGROUND.	Potential impacts from hazardous materials and waste from the Project are analyzed in Section 3.10 of the Draft EIS. As discussed in Sections 2.1, 2.2, 3.2, 3.3, 3.10, and 3.11, PGV does not inject pentane into the injection wells.	Hazardous Material and Waste
29	15	Pg 23- I reviewed the reports to the Legislature from the Hawaii Emergency Response Commission from 2019-present and I can find no mention of working on PGV's Emergency Response Plan or Hawaii County Civil Defense's ERP. I made a UIPA request to Hawaii County Civil Defense, they know nothing about how the public was informed of PGV's Emergency Response Plan or how the public was notified and given a chance to comment. According to the UIPA answers, Hawaii County Civil Defense does not even know the location of PGV's H2S perimeter monitors since they were moved after the lava and they only have a 2016 Emergency Response Plan which shows all the roads to be used in an emergency THAT HAVEN'T EXISTED SINCE 2018. The HAZMAT response team that is supposed to protect the people from PGV is an hour away. WE COULD ALL BE DEAD BY THE TIME THE HAZMAT TEAM IS DRESSED AND GETTING ON THE ROAD - IT ONLY TAKES A FEW SECONDS OF A HIGH CONCENTRATION TO KILL. H2S gas follows the lowest topography and does not flow upwind and uphill to where PGV moved the monitors after 2018. We had a prime example of the lack of emergency response during the 2014 Hurricane Iselle, where PGV did not shut down ahead of the advancing storm and instead stayed operating until winds knocked trees out all over the community, bringing down electrical poles, and the plant tripped off and gassed the neighbors trapped in their homes by fallen trees.	Potential impacts from hazardous materials and waste associated with the Project are analyzed in Section 3.10 of the Draft EIS; potential impacts to air quality from the Project are also discussed in Sections 3.3 and 3.11. Sections 3.10 and 3.11 of the DEIS include a description of the facility's procedures for identifying, reporting, and responding to any exceedances and how to respond in the case of natural disasters as required in permit requirements for public health and safety.	Hazardous Material and Waste, Air Quality
29	16	Pg 24 - a) Proposed Power Operations - In 2018 PGV was pumping about 6 million gallons-a-day. According to the specifications listed in the EISPN, PGV would be pumping about 10.8 million gallons per day in order to generate the full capacity of 60 MW (678+226=904 kph, 904*24=21,696 kpd, 21,696*1000=21,696,000 pd, 21,696,000/8=2,712,000 gpd per unit, 2,712,000*4=10,848,000 total gpd). This corresponds to an increase of 80% over 2018 pumping rates into the fractured rift zone. b) What type of propants does PGV use to keep the fractures open? How do the chemicals PGV injects into their wells to keep silica, mold and scale from forming react with the rock formation fractures? If you are injecting and producing from "the same resource" "in a closed loop system" then we need to know why you have to keep adding more chemicals.	The Project description includes the amount of current and proposed water use in Section 2.2 of the Draft EIS. Potential impacts to hydrology from the Project are analyzed in Section 3.2 of the Draft EIS. PGV does not actively keep the fractures open. Use of all chemicals in the operations are covered by permits as described in Sections 3.2, 3.3, 3.10, and 3.11 of the Draft EIS.	Hydrology, Geology
29	17	Pg 25 - a) Proposed Monitoring and Maintenance - WHERE IS THE SEISMIC MONITORING? Geothermal plants in the US mainland have to perform seismicity studies and have seismic arrays around them and hook up to the local USGS monitoring site SO WE CAN SEE WHAT THE HECK IS GOING ON UNDERGROUND. Mike Keleikini clearly stated that PGV has their own seismic monitoring program at his public meeting in July 2022. LET'S SEE THE SEISMIC RESULTS NOW! Perhaps that is how Ormat was able to warn their stockholders 17 times in 2017 that lava flows were imminent, because they knew they had turned the ground to rubble in their injection zones… (see Blindsided with Advance Warning 6/14/2018 attached as an exhibit below). b) How often do the 3 Department of Health Hydrogen Sulfide Monitors have wind blowing their direction? Maybe 10% of the time, if at all. Does Hydrogen Sulfide travel uphil? NO, SO THEN WHY ARE THOSE DOH MONITORS LOCATED UPWIND AND UPHILL? See Figure 7 below which shows the wind direction roses and elevations for the 3 DOH monitors as they are in August 2022. c) How does averaging out the leaking hydrogen sulfide into rolling minutes or hour or day averages protect the residents? Why can't we have monitoring at the Source = The Production Wells?	Potential impacts from geologic hazards associated with the Project are discussed in Section 3.1 of the Draft EIS. While PGV monitors seismicity in the area for internal purposes, the official agencies primarily responsible for monitoring seismicity and informing the public of such events are the USGS Hawaiʻi Volcanoes Observatory, with support by the Hawaiʻi County Civil Defense Agency.	Geologic Hazards
29	18	Pg 27 - Geology. a) I find it incredible that the EIS draft discussion of geology is only a little over one page long. The geology of the area is what enables the existence of the plant and the geology also creates the greatest dangers. Not only is the discussion very brief, it is also highly generalized and largely deals with the Big Island as a whole and not with the specific area of the plant. I believe this is a conscious effort to broad brush the events of 2018, because a detailed examination of the area and events during the eruption will lead to completely different conclusions regarding PGV's influence upon it. b) There is not a single map or diagram in the geology discussion, so I provide a map in Figure 8 below showing the events which transformed the 2018 eruption from an event "within the range of normal behavior of Kilauea Volcano" (EISPN, p 3-2) into the by far the largest eruption of Kilauea since the arrival of the haole. c) One of the most amazing "coincidences" of the 2018 eruption was the close correspondence between the fissure line and the PGV boundary for a distance of about 1 km on the southeast boundary of the lease area. Part of the reason for this is that the former Pu'u	The EISPN is intended to be a scoping document. Further analysis of the Proposed Action is set forth in the Draft EIS. Potential impacts from geologic hazards associated with the Project (including seismicity, subsidence, volcanic activity, geologic process for geothermal power production) are discussed in Section 3.1 of the Draft EIS. Please refer to the figures in the Draft EIS that show the location of the PGV facility in relation to the 2018 lava flows. Potential impacts to hydrology are discussed in Section 3.2 of the Draft EIS.	Geologic Hazards, Hydrology, Public Health and Safety

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		Pilau was used as a survey marker for PGV's boundary. This point became Fissure 22 in 2018. Preexisting faults continued in this direction all the way to the end of Fissure 18, an additional kilometer. Fissure 22 became the major eruptive center for a period of about 4 days beginning on May 18. It is directly connected via another unmapped fault to the bottom of well KS-14. The existence of this fault was shown in the initial advance of lava from Pu'u O'o on May 3 which passes directly along a line containing KS-14 and Fissure 22, the former Pu'u Pilau. c) On May 13, 2018 the most explosive fissure (Fissure 17) of the eruption opened around 4 am. The small circles (primarily red, orange, and yellow) show earthquake epicenters for an 82 hour interval which ended just before the opening of Fissure 17. 2018 fissures are shown in heavy white lines. There is a rectangle outlined in faint white lines which contains the earthquakes of the cluster. Fissure 17 lies almost exactly in its center, as shown by the diagonals. Also shown on the map are faults with throw (heavy black lines), 1955 fissures (heavy lime green), and previous known fissures (heavy blue lines). The rectangle outlined in dark blue shows the fault mapped by Kennedi et al. The rectangular area shaded with orange shows a structural graben defined by the known faults shown on the map. Grabens are known to be frequent locations of volcanic eruptions. Kennedi described her mapped fault as the main fault exploited by PGV. Explosions produced by water injection would have been directed by this structure directly downrift to Fissure 17. There had been no earthquakes in the rectangle during the 2018 eruption until this time - 6:20 pm, May 9. There had only been 93 earthquakes within the rectangle during the previous 50 years, one less than the number which occurred in less than 4 days during 2018. The southwest corner of the rectangle is the focal point of the cluster and lies near the southwest corner of the PGV well field. What a coincidence. Not only was Fissure 17 the most explosive fissure of the eruption, it also erupted lava which was unique for the 2018 eruption and rarely seen in Hawaii before. Large pieces of pre-existing rock were thrown hundreds of feet into the air. When this rock was analyzed, it was found to be dacite with a silica content of ~67%. With the exception of a small deposit on Oahu, the only other sample of this type of rock found in the Hawaiian Islands occurred when PGV encountered lava while re-drilling KS-13. Another amazing coincidence. After the opening of Fissure 17, lava eruption moved systematically uprift, with major outpourings from Fissures 22, 13, and 7 before activity became centered at Fissure 8 on May 28. PGV was injecting water into their production wells throughout this period. d) NO MENTION OF THE HILINA SLUMP. The EIS needs to disclose the entire southeast flank of Kilauea Volcano is breaking apart along the rift zones and is sliding into the ocean, including the area where PGV wants to withdraw up to 10.8 million gallons a day which is then cooled and then injected deeper into the hot ground with added chemicals to prevent silica buildup and corrosion. The Hilina Slump is sliding at an accelerated pace since 2018. The Draft EISPN talks all about earthquakes on the surface and how PGV is built to withstand them but fails to mention the worldwide problem of induced seismicity impacts underground and what that is and how it is safe to locate multiple wells in the middle of antithetic faults and grabens which are producing and injecting into a rift zone experiencing "active tectonic dilation" See attached pages from PGV's application to the EPA. Look how PGV names the fractures they create after the well numbers. Look at the side views of PGV's multiple wells criss-crossing faults and TELL US HOW PGV IS NOT AN ENHANCED ENGINEERED GEOTHERMAL PLANT. e) PER THE EISPN "The location of the Proposed Action is somewhat topographically protected from potential flows; however, several wells were damaged in the 2018 Lower Puna eruption." PGV IS NOT SOMEWHAT PROTECTED NOW, THEY ARE SURROUNDED ON 3 SIDES BY LAVA NOW AND NOT ON A HILL ANYMORE EXCEPT FOR ON ONE SIDE BY CINDER CONES FROM PAST ERUPTIONS. We need a current map with current elevations. f) The ground at PGV has uplifted several feet at PGV wellpad E as discussed in Damage and Repair of KS-14 (1034260.pdf) attached as an exhibit below. That report doesn't conform with the frenzied media reports from May 2018 about how 10 of 11 wells were quenched and plugged by May 21. Where are the other well repair reports? What wells were plugged and what wells were not? PGV's "Quench Log" (see attached as exhibit) doesn't list 10 or 11 wells. l) How intelligent is that to locate a plant in a Lava Zone 1? HAWAII VOLCANO OBSERVATORY HAS NO SEISMOMETERS BELOW PGV SINCE 2018, even before that (Cooper & Dustman 1995 available at https://evols.library.manoa.hawaii.edu/handle/10524/62941), Catherine Kenedi (2010 available at: https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/3111/D_ Kenedi_Catherine_a_2010.pdf?sequence=1) and 2011 available at: PDF Microseismicity and 3-D Mapping of an Active Geothermal Field, Kilauea ...) WE NEED A THOROUGH SEISMIC STUDY OF THE PGV AREA, INCLUDING THE MICRO-EARTHQUAKES GENERATED BY PGV. I just received the "Geothermal Induced Seismicity National Environmental Policy Act Review at: 1423753-geothermal-induced-seismicity-national-environmental-policy-act-review. This Induced Seismicity Report discloses results of 4	It is also noted that the Project is sited in its location due to the presence and availability of geothermal resources. Those who site homes in Lava Zone 1 assume the risk that seismic activity and other volcanic hazards may damage the residences. PGV's updated ERP is discussed throughout the Draft EIS (Sections 2.1.8, 2.2.9, 3.4.1, 3.10, 3.11, and 3.13). Potential impacts to public health and safety are discussed in Section 3.11 of the Draft EIS. PGV (and its parent company, Ormat) is well aware of the inherent risks associated with geothermal development. Ormat has many power plants at or near geothermal resources that are derived from volcanic activity, similar to Hawai'i. Some of these locations are in the Philippines, Indonesia, New Zealand, Africa, and South America.	

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		geothermal plant monitoring schemes and concludes that more research needs to be done on induced seismicity. I will attach it as an exhibit for your ease of viewing. m) PGV was questioned by the PUC last year about Protocol for locating geothermal injection wells. Of course back then I was mistaken and thought it was USGS protocol, but it actually was EPA and USBLM protocols. Of course PGV said "they wern't aware of any protocols and I should ask USGS". Interestingly, in the Reference section of the above document, there is a citation to an Ormat Brady Geothermal Plant Protocol - WHICH MEANS PGV HAS KNOWN SINCE AT LEAST 2013 OF PROTOCOL WHERE NOT TO LOCATE INJECTION WELLS. See Ormat. 2013. Brady's EGS Project PROTOCOL FOR INDUCED SEISMICITY ASSOCIATED WITH ENHANCED GEOTHERMAL SYSTEMS DOE Award: DE-FG36-08GO18200. Ormat Nevada Inc. pg. 1 – 38. (no link provided). PGV knows exactly that their wells create fractures -fractures in the same place for 30 years make the ground weak. Weak ground lets the lava out from an active volcano. This EIS gets to discuss that problem. n) The draft EISPN states "In the event of a volcanic hazard with the potential to threaten the facility or block a well, all production and injection wells would be shut-in (i.e., pumps stopped and injection ceased) and PGV would implement the ERP. Your Precious PGV DID NOTHING AFTER MAY 3 AS THE LAVA APPROACHED. PGV did not follow that relic 1992 Emergency Response Plan, did not remove 60K+ gallons of explosive pentane, they did not disassemble or remove any sensitive equipment, did not cement their wells shut to prevent explosions or blowouts of Hydrogen Sulfide, like common sense would dictate. UNTIL THE GOVERNOR ORDERED A STATE OF EMERGENCY AND THREATENED TO TAKE OVER THE PLANT. o) The State of Hawaii had to find a team of "experts" during the 2018 lava flows to manage PGV's operations because nobody at PGV had a clue. Instead of putting cement in their wells immediately they caused phreatomagmatic explosions underground for weeks pumping cold water and salt water into their wells while they waited for the State to ship in their emergency supplies (See Damage and Repair well KS-14). PGV'S 1992 EMERGENCY RESPONSE PLAN IN EFFECT DURING 2018 SAID NOTHING ABOUT "COOLING THE RESOURCE" OR "QUENCHING ANY WELLS" The explosivity of Fissure 17 is easy to understand - water and lava and hot rocks don't mix... p) PGV's 2021 ERP states that PGV will start circulating water in the wells in the event of a lava flow. I DEMAND THIS EIS DISCLOSE WHAT PHREATOMAGMATIC EXPLOSIONS AND ERUPTIONS ARE AND THAT THEY OCCUR WHEN LAVA AND WATER MEET UNDERGROUND. This EIS needs to tell the permitting authorities how lava and water explode up at Halema'uma'u and how lava explodes when it touches the ocean - this EIS needs to explain how PGV think this does not happen when decided to inject water into hot dry 2000 degree wells with lava erupting less than 200 yards away. 1 GALLON OF WATER EXPLODES TO STEAM WITH THE FORCE OF 8 STICKS OF DYNAMITE - THIS NEEDS TO BE EXPLAINED IN THE ENVIORNMENTAL IMPACT STATMENT BECAUSE PGV INJECTED WELL OVER 1,342,194 GALLONS OF COLD WATER AND SALT WATER INTO AN ERUPTING VOLCANO DURING THE 2018 ERUPTION. What PGV did during the eruption (injecting cold water into 2000 degree that caused the underground explosions is clearly stated in "Lava Eruption Disrupts Puna Geothermal Venture - The Background" available at: https://www.higp.hawaii.edu/hggrc/lava-eruption-disrupts-the-puna-geothermal-venture/ NOTE: the links to the actual document have recently been removed from the internet, I suspect to hide the evidence, but don't worry, I will attach a copy to the August 22, 2022 filing of this comment paper so all government agencies involved can see the extent of the intentional negligence in 2018. Here is a brief comment to support our position: "Usually a geothermal well can be quenched by pumping cold water; however, the intrusion of the 2000+°F magma nearby and on the surface changed the wells' behavior and [the water] didn't work well at first on some of the wells." According to Wardlow, the operators of PGV were able to collect downhole temperature and pressure measurements before the lava had entered the facility. One of the wells had measured temperatures of 100°F greater than normal, even at 2500 ft depth. In addition to salt water, this well had to be quenched with a mud-barite mixture, which is intended to generate a ceramic seal upon exposure to high temperature conditions. The team also encountered problems due to delays in equipment delivery (especially bridge plugs) to the islands. Overnight mail doesn't exist [on Hawaii] noted Wardlow. q)The 2022 Emergency Response Plan released by PGV has so many deficiencies that it is difficult to know where to begin criticizing it. It is largely unchanged from earlier versions of the plan dating back to 1992 before the opening of the plant. While aspects of the plan dealing with hydrogen sulfide have received a great deal of attention, problems related to safely shutting wells have been scarcely addressed. The few sentences dealing with this subject are scattered and contradictory as well. Chapter 8 deals with shut down procedures in the event of eight kinds of emergencies. The first two relate to lava and magma intrusion. Both cases reference "layup/recirculation per PGV procedures" of all production wells. Layup/recirculation is not defined anywhere in the document. The term layup as used with reference to boilers and other furnace related equipment means filling with water before a time of disuse. Evidently this is a new term to describe what was described as "quenching"		

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		during the 2018 eruption. Recirculation is an added term, perhaps to acknowledge that water would surely boil/explode if not changed frequently. Certainly, a clear definition of the procedure referred to as layup/recirculation should be required. r) Another glaring deficiency in PGV's Emergency Response Plan is its failure to address the possibility of lava erupting directly beneath the plant, not in the sense of lava seeping up one of the well bores, but massively exploding through the ground as a new fissure. There are frequent examples of lava erupting from the same fissure many times. That is how pu'us, craters, and the great maunas form. Evidently, this possibility did not occur to the builders of the PGV plant. Figure 9 below shows the location of one of the original 1955 fissures (in lime) superimposed over an image of the main plant. The 10 original OEC units are shown as well as the turbines. There are literally dozens of pipes filled with pentane suspended directly over the former fissure while the plant is operating. This is another way in which PGV shows that it always has the safety of their employees and nearby residents as top priority. s) PGV paints a very simplistic picture of the procedure described in 2018 as "quenching". Quenching is a common procedure in any kind of well. It is used to stabilize a well which has a problem until it can be repaired. The well is filled with water the weight of which is sufficient to prevent any gas leakage or other instabilities. The idea is that the well is filled with water and remains full until repairs can be completed. While this process works very well in most situations, doing it in the presence of nearby lava changes the situation drastically. Figure 10 below is based on documents provided by PGV regardings its Underground Injection Permit with the EPA and shows the daily volume of water (gallons) injected into its production wells from May 15-27, 2018. PGV injected a total of over 1.3 million gallons of water into 4 wells over a period of 12 days. The heavy black line shows the maximum volume of a typical PGV well. The total injected would have been enough to fill the 4 wells 8 times each. Between May 23 and May 27, enough water was pumped to fill KS-9 25 times, including 7 times on May 23. What happened to all that water? Well KS-14 was heavily damaged during the eruption but has since been repaired. Enough water to fill it 7 times was pumped into KS-14 from May 15 to May 21. Well head pressure and temperature increased abruptly at KS-14 from 323 psi, 428o F on May 1, 2018 to 1295 psi, 577o F on May 3. A narrative of the repair (Spielman et al, 2020) states that pressures rose as high as 2000 psi during the injections during 2018. A fault crossing the well bore is believed to have moved a meter and the well casing was damaged severely. Thus it is hard not to imagine major leakage from the well as it was pumped full of water. Given the temperature and pressure conditions, explosions would seem inevitable. This massive excess pumping renders the very idea of "recirculation" absurd. So much for the lessons learned from the 2018 eruption. It also shows that pumping any water into any well with lava nearby is criminal. t) A much more sensible emergency plan would be to require immediate cementing of all production wells at the first appearance of any fissures within a mile. Ideally, this would have occurred on May 3, 2018, but nothing had been done with the wells until Governor Ige intervened on May 9.		
29	19	Pg 28 - a) PGV is using the 2020 USGS/Hawaii Volcano Observatory report "Have humans influenced volcanic activity on the Lower East Rift Zone of Kilauea Volcano" as authoritative proof that PGV did nothing to influence the 2018 eruption. That "scientific" report did not: discuss the world-wide known impacts of geothermal injection wells, b) did not discuss the "cumulative impacts of 30 years of multiple injection wells 6000-8000+ feet below the surface of the ocean" and did not mention world-wide known fact that PGV was "cooling and quenching" its "resource" with cold water and salt water for 2 weeks while PGV waited for the State of Hawaii have their emergency pumps, well plugs and bentonite clay flown in on the taxpayer dime. PGV was unprepared and did nothing until the Governor ordered them to and brought in a group of 'experts'. The head of the Hawaii Volcano Observatory was on the Governor's Task Force of "experts". I guess he didn't know that putting cold water into hot rock while a volcano was erupting a few feet away was going to create underground explosions! b) Hydrology - reservoir is separated from the groundwater aquifer in the LERZ by a semi-permeable confining layer (or "cap rock") that is located at depth of between approximately 2,750 and 4,000 feet below the ground surface (EPA 2021). The EIS needs to detail how PGV will prove the "semi-permeable" cap rock is not fractured since the lava from the 2018 eruption came from magma chambers below 2,700-4000 feet in a Fissure Line which broke all along PGV's property line. "Semi-permeable" means is not a sealed formation, it leaks, so NO, it does not protect the groundwater from PGV's injections of chemicals, including pentane and isopropanol What is Royal Purple? The PGV injects that and we want to know what it is! c) "the EPA's UIC permit includes injection pressure limits which are based on formation testing to reduce the potential for the creation of fractures". RIGHT THERE YOU ARE ADMITTING PGV INJECTIONS HAVE THE PROPENSITY TO CREATE FRACTURES, including test injection into new wells until the fracture point is established. It is safe to assume that 30 years of microfractures will turn the injection zone into a mass of rubble unable to support an earthquake and also unable to keep back the pressurized lava in the Kilauea magma system. This EIS can use the data from both Cooper & Dustman (1995) and Catherine Kenedi (2010, 2011) to show their is seismicity associated with Puna Geothermal Venture operations and how the microfractures were occupying the rift zone in the same	Potential impacts from geologic hazards (including seismicity) associated with the Project are analyzed in Section 3.1 of the Draft EIS; also, potential impacts to hydrology from the Project are analyzed in Section 3.2. The anticipated cumulative impacts of the Proposed Action are discussed in Section 3.13 of the Draft EIS. The EIS documents for Casa Diablo and Bottle Rock are beyond the scope of this EIS. As mentioned above, potential impacts to hydrology from the Project are discussed in Section 3.2 of the Draft EIS, as well as a description of approved drilling operations. Section 3.2 of the Draft EIS includes an overview of the hydrogeology at the site.	Geologic Hazards, Hydrology

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		area as the 2018 fissure line broke out of. WHY ISN'T PGV BE REQUIRED TO HAVE A SEISMIC ARRAY AND A SEISMIC MONITORING PROGRAM AVAILABLE TO THE PUBLIC REALTIME? d) Here are links to other geothermal plant EIS's with comments. The best comment came from the EPA in relation to Ormat's new Casa Diablo IV geothermal plant: Appx C of the Diablo EIS contains the EPA comments and also a recommendation that induced seismicity be disclosed and the cumulative effects of seismicity and how induced seismicity is monitored and mitigated: https://gbuapcd.org/Docs/PermittingAndRules/CD4/cd4_final_eir_volume_2_appendices_a-f.pdf e) The Casa Diablo EIS available at https://gbuapcd.org/Docs/PermittingAndRules/CD4/cd4_final_eir_volume_1.pdf The word "seismic" only shows up 3 times in this EIS, no mention of cumulative effects of geothermal-well induced seismicity. It is the same as the 1987 PGV EIS, says the area already seismically active and "does not expect induced seismicity to be a problem". How is covering up induced seismicity in an EIS protecting the environment? f) The technology exists to monitor PGV's microfractures and project the cumulative effects of multiple wells removing and injecting 6-10 million gallons a day. When are we going to move into the new century and admit geothernal operations induce seismicity and that it is not intelligent to locate fracturing technologies in unstable areas where the island is falling into the ocean naturally and we have potential hidden faults that are unknown because PGV and HVO and USGS refuse to study it, in direct opposition to the rest of the world? https://today.tamu.edu/2021/03/30/underground-noise-reveals-fracture-pathways-needed-for-energy-production/ g) BOTTLE ROCK EIS available at https://www.osti.gov/servlets/purl/6887368 Recent seismologic studies (Hamilton and Muffler, 1972, Bufe, et al., 1978) show that a large number of "micro-earthquakes" (an earthquake having a magnitude of 2 or less on teh Richter scale) occur continously in the Geysers steam field. This type of activity is common in both developed and undeveloped geotheral areas throughout the world. While some of these events appear to be realted to regional geologic forces, others may be related to natural changes in the geothermal system. Preliminary results presented by Marks, et al., (1978) indicate the micro seismic activity is increasing as a result of development of the steam resource. h) THIS EIS MUST DISCLOSE THE CUMULATIVE EFFECT OF UP TO 30 GEOTHERMAL WELLS (with all the added redrills and spuds listed for each well) withdrawing and injecting 6-10.8 million gallons of acidic effluent with added chemicals per day as indicated by PGV's intention to increase to a 60 mw plant. the EIS must disclose the cumulative amount of chemicals which will be dumped into the ground over the next 35 years in plain English and also the impact of the chemicals that prevent silica buildup in pipes and how they react underground with the rock formation they are injected into. i) This EIS will disclose how the "impermeable cap rock" that is supposed to protect the water table isn't really impermeable because, besides PGV's constant drilling into it, the island is actively experiencing tectonic dilation, lava dike intrusions and slumping into the ocean exactly at the spot where PGV is located, and the cap rock was fractured in the 2018 eruption all along the fissure line, that is how the lava got to the surface.		
29	20	Pg 29 - Air Quality and Climate Change. Since reopening in 2020, PGV has moved their 3 DOH Air Pollution Monitors to areas that the wind does not blow and uphill where the heavy Hydrogen Sulfide gas does not flow. The EISPN states PGV has prepared new air dispersion modeling report. The EIS needs to disclose which way the winds actually blow and how and where PGV will place DOH monitors to actually pick up Hydrogen Sulfide, downwind and low to the ground. It seems like the H2S will pool around PGV during the normal trades and then flow downhill at night, the heavier-than-air gas flowing down through the areas that were not covered by lava. b) the imaginary 3500' circle around PGV does not prevent toxic gasses from travelling into the neighborhood. During the 2014 Huricane Iselle the toxic gasses passed 3500' and knocked out people all around PGV. PGV paid money to make the lawsuits go away. Explain how an arbitrary circle drawn on a map protects the residents.	Potential impacts to air quality from the Project are analyzed in Sections 3.3 and 3.11 of the Draft EIS. Impacts anticipated from climate change are discussed in Section 3.3.	Air Quality
29	21	Pg 30 - a) Noise - The noise in upper Leilani Estates is unbearable since the foliage is gone. Make sure you go up there and survey the residents. PGV IS CONTROLLING FOR "COQUIS" in their noise studies so we need to know all about that and also realize that is being done to show PGV is operating below permitted noise levels. b) Biological Resources - make sure you talk about the endangered Newell Shearwaters which have been documented nesting in Pu'ulena Crater next to PGV. In the past, PGV was ordered to dim their lights because of the birds. Obviously, they arn't dimming their lights anymore since the eruption. Has anyone checked to see if there are still Newell Shearwaters at Pu'ulena?	Potential impacts from noise associated with the Project are analyzed in Section 3.6 of the Draft EIS, and the potential impacts of the Proposed Action on biological resources in the area are discussed in Section 3.5 and Appendix G (biological survey).	Noise
29	22	Pg 34/35 a) RELATING TO CENSUS There are a bunch of 10 acre lots that are located in that acreage above and to the left where the word "Pohoiki" is superimposed on the map on Page 48 of th EISPN. They all have Bureau of Conveyance activity in 2022, it appears to be a subdivision "Onipa'a II" but without obvious infrastructure. This EIS should disclose the fact that Hawaii is a hot real estate market and address how many more substandard lots and vacant land surrounding PGV could potentially be on the market and open to development within several miles from PGV where there are no roads and no escape routes are being provided, and how those people will be protected from gasses travelling downhill from PGV.	Potential impacts to socioeconomic and environmental justice considerations from the Project are discussed in Section 3.6 of the Draft EIS. It is noted that the Project is sited in its location due to the presence of geothermal resources. Those siting homes in Lava Zone 1 assume the risk that seismic activity and other volcanic hazards may damage or adversely impact the residences.	Socioeconomics, Environmental Justice

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		b) Community Development - Geothermal Relocation Fund We need to be assured the lava-covered land bought with government funds is not re-sold like the County of Hawaii resold the homes purchased by the Geothermal Relocation to PGV employees for a very low price over the years, including my ex-home on Mohala Street in Leilani Estates, where Fissure 1 broke out. c) Explain what "Environmental Justice" is and explain how PGV giving money for pet projects for County and State governments protects the environment in the area surrounding PGV from negative and irreversible effects of PGV's cumulative operations. THE RESIDENTS ARE SICK AND TIRED OF BEING GUINEA PIGS FOR PGV'S EXPERIMENTS IN LAVA ZONE 1 while PGV pays royalties to the government for the privilege to harm us. d) Many people arn't selling out to FEMA and want to keep their lava lots. This EIS should detail a map showing the lots people have applied to be bought out of versus the lots that still remain in the areas surrounding PGV that are still owned by people. e) Cultural Practices - This EIS needs to take notice of the local customs and beliefs. We have seen that come front and center with the TMT (Thirty Meter Telescope). There is a long history of opposition to geothermal in Puna. We are in Hawaii and should give deference to the Hawaiian culture of living in harmony with the land. See	Section 3.6 of the Draft EIS acknowledges that although populations in the area dropped following the 2018 eruption, they have since made modest recoveries. An individual's decision to keep their private property rather than sell is beyond the scope of this EIS. This EIS is intended to disclose the anticipated environmental impacts from the Proposed Action. The Draft EIS includes figures that show the locations of residential subdivisions surrounding the PGV facility. Cultural resources and practices are discussed in Section 3.8 of the Draft EIS and Appendix I (Cultural Impact Assessment).	
29	23	Pg 36 - a) Hazardous Materials and Solid Waste. How many gallons of Pentane TOTAL does PGV use and have onsite at all times? How much liquid Nitrogen? How much of that is used in the Operating Systems versus how much being stored in tanks. Make sure we have the total amounts of petrochemicals onsite and the blast radius' diagrams for all hazardous chemicals and petroleum products stored at PGV. b) Hydrogen Sulfide "...H2S which is emitted as a gas from volcanic activity"... Clarify that H2S is produced and located very deep underground and as it rises it mixes with groundwater and turns into Sulfer Dioxide. H2S is not a normal product of volcano emissions. This EIS should detail the strength of the concentration of H2S in Puna versus the rest of the world's geothermal	Potential impacts from hazardous materials are analyzed in Section 3.10 and to air quality from the Project Area are analyzed in Sections 3.3 and 3.11 of the Draft EIS.	Hazardous Materials, Air Quality
29	24	Pg 37 - a) Transportation and Access. When evaluating transportation of dangerous chemicals, we need to be advised of how many trucks of and quantities of each kind of chemical (pentane, nitrogen, etc) that will be driving each month right next to and past public schools during school time and neighborhoods for the next 35 years. b) Evaluate how Civil Defense will get to Pohoiki Road in the case of emergency, including the time and miles. c) Detail how the 1000+ residents living to the south and east will escape PGV blowout and gassing if Highway 130 is blocked between Leilani Estates and Pahoa.	Potential impacts to traffic from the Project are analyzed in Section 3.12 of the Draft EIS. As discussed in Section 3.10 of the Draft EIS, the storage, transportation, and disposal of hazardous materials used at the PGV facility are in accordance with applicable federal, state, and local regulations and permit conditions.	Traffic
29	25	Pg 42 - a) We need to notify both the State of Hawaii Civil Defense Agency and the Hawaii County Civil Defense Agency of this EISPN and all further drafts, neither of those agencies are on your list. I just received a UIPA request from the County of Hawaii Civil Defense Agency and they don't even know where PGV's Department of Health Perimeter Hydrogen Sulfide meters are located in July 2022. Hawaii County Civil Defense plans on evacuating residents in 2022 look like they will follow their HCDA 2016 Emergency Response Plan which is outdated and shows images of public roads that don't exist since 2018. See notes on Page 48 below. b) The United States Bureau of Land Management has protocol where not to locate injection wells - located at: https://www.blm.gov/sites/blm.gov/files/policies/Attachment%203%20Induced%20Seismicity%20Screening%20Worksheet%20Guidance%20Document.pdf This decision tree should have been included in the decision-making of on how intelligent it would be to locate a geothermal plant on an active volcano within 5 miles of schools, within 1000' of residental homes and with no seismic background or even a sesimic monitoring program.	These agencies have been added to the list of parties consulted for the EIS. The Hawai'i County Civil Defense Agency was provided a copy of the EISPN. An updated ERP is located on PGV's website: https://punageothermalproject.com/wp-content/uploads/2023/02/PGV-Emergency-Response-Plan-230101.pdf%22. The location of the Project is consistent with zoning, and the facility is operated consistent with permit requirements. Regarding the site's location, siting of a geothermal facility is dependent on the idendification of the following three key elements: heat, water, and natural geological permeability. At the PGV facility, heat is supplied from the Kīlauea volcano, water is supplied primarily from the nearby ocean (and some rain), and the relatively young geology of the Lower East Rift Zone is naturally permeable in numerous locations. PGV and Ormat are aware of and understand the hazards associated with developing a geothermal facility near volcanic areas such as the Lower East Rift Zone. The risks associated can result in having to shut the plant down for extended periods, such as the case of the 2018 Kīlauea eruption. However, these are risks that PGV and Ormat address through the development and implementation of Emergency Response Plans and other operating procedures and by close coordination with county and state officials.	Agencies and Parties Consulted

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			Globally, there are many geothermal facilities physically located near shopping malls, schools, and residents. Ormat's Steamboat Complex is just one example. There is a shopping mall across the street from the facility boundary, and Galena High School and the University of Nevada, Reno, are located adjacent to the facility.	
29	26	Pg 43 - Neighbors and Concerned Citizens. This is a request to add Sara Steiner/Larry Wood as persons to be notified and consulted on this EIS. Our emails are listed above. Puna Geothermal Venture and the State and County of Hawaii are aware of us and know we have been trying to protect Puna from PGV since the eruption.	You have been added to the list of neighbors and concerned citizens to be contacted.	Agencies and Parties Consulted
29	27	Pg. 48 to 53 - There is no title or any identifying mark on each page (49-53) so how do we know what image we are looking at? Additionally, each image on Pages 48-53 is only a partial image of the surrounding area and cut off on the right-hand side of the document's legend. We need to see the entire document in the EISPN Figures 1-6, including the Author and Title of document and we want to see the surrounding area east of PGV where people live right in close proximity downwind from PGV.	The EISPN figures were focused on the Project Area; additional figures have been added to support the analysis in the Draft EIS.	Figures
29	28	Pg. 48 - a) What is the Blue Outline Parcel TMK 140010010000? That is not part of PGV's known Lease Area unless they are expanding on it and then we need to know now as PGV claims to have no interest in expanding beyond their 815 acres.. b) WE HAVE NO ROADS ON THE LAVA LIKE the Figure on page 48 shows. This EIS needs to show the general public and (government agencies tasked with our safety) exactly what roads the surrounding residents are going to use to escape PGV's constant gassings (70 times in 30 years). Pg 48 is FALSE INFORMATION AND MAKES IT LOOK LIKE THE RESIDENTS HAVE ESCAPE ROUTES FROM PGV! This EIS needs to take off the lava covered roads and only show the roads if they are open and usable by the public.	The figure shows the correct lease area, and PGV is not proposing to locate the facility area beyond the 815-acre lease site. As noted in Section 1.6 of the Draft EIS, the Proposed Action is located on approximately 16.4 acres of the existing PGV facility's 815-acre lease site. A note has been added to the legend of Figure 1 to clarify that the map reflects the layout of county roads prior to the 2018 eruption. A discussion of road reconstruction in the vicinity of the facility is discussed in Section 3.12 of the Draft EIS.	Figures
29	29	Pg 49. a) Where are wellpads "G" "I" and "J" detailed in PGV's POO at Figure 6 above? (PGV's "POO" is their Plan Of Operation approved by the State of Hawaii Department of Land and Natural Resources. The POO (updated in 2020 to the PUC) shows KS-13 and KS-14 located somewhere up in the area covered with lava, and shows future wells KS -15, 16, 17, 18, 19 and 20 on some nonexistent well pads named "G", "I" and "J" and "K"(see below graph). HOW CAN WE BELIEVE ANYTHING PGV SAYS??? What documents are true, the documents approved by the State of Hawaii Department of Land and Natural Resources and submitted by HELCO to PUC or some documents submitted to the EPA and the Health Department? HOW MANY WELLS ARE ALLOWED ON A WELLPAD? HOW CLOSE ARE PGV'S WELLS? HOW MANY REDRILLS AND SPUDS ON EACH WELL? The cumulative effectsl of the wells that PGV is anticipating using for their 60MW expansion need to be disclosed now! ////////ADDITIONAL COMMENT REGARDING EIS PREPARATION/////// NOTE: PURSUANT TO HAR 11-200.1-13 THIS EIS MUST CONSIDER AND EVALUATE THE SUM OF EFFECTS OF THE PROPOSED ACTION ON THE QUALITY OF THE ENVIRONMENT, including: HAR 11-200.1-13(b)(4) PGV has a substantial adverse effect on the social, welfare and cultural practices of the Community and State - Hawaiians don't want you drilling into Pele, the residents of the State & County do not want you to spend innumerable funds responding to constant emergencies at PGV, including having the Governor declare a state of emergency specifically because PGV refused to do anything to follow their Emergency Response Plan during the 2018 eruption. The State had to threaten to take over the plant so finally PGV evacuated the 67,000 gallons of pentane and then because there was nobody at all who could take charge of the emergency, the State had to fly in an "expert" from California (who conveniently used to be an Ormat Vice President) who only cared to save PGV's wells. In order to do that, the State of Hawaii paid to ship in quench pumps, metal plugs and clay to plug wells BECAUSE PGV DID NOT HAVE ANY EMERGENCY EQUIPMENT ON SITE. Besides the above, the County of Hawaii Hazmat team has had to suit up in Hilo and drive 40 miles from Downtown Hilo to respond to minimum of 70 toxic gassings in 30 years. The State and County also have to have public shelter available to escape PGV blow-outs, etc… The State and County have paid for studies for Hydrogen Sulfide harm to residents - let this EIS discuss those studies and what happened to the results. HAR 11-200.1-13(b)(5) PGV has a substantial adverse effect on public health, no reliable monitoring of toxic substances (monitors located upwind and uphill), 24/7/365 Noise, drilling, banging, clanging, vibrations, lights. PGV's Geothermal resource is a toxic deadly chemical soup which PGV adds more chemicals to every day and the quantitiy totals for the next 35 years need to be stated. What about psychological harm to people who are exposed to constant danger from a known polluter and the government does nothing for 35 years but make excuses and give permit shields instead of permits and call for emergency declarations to bypass regulatory environmental rules? HAR 11-200.1-13(b)(6) PGV involves adverse secondary impacts, besides fear and loathing from being gassed 70 times in the last 30 years and Ormat Nevada criminals lying and stealing money from the federal government to pay for upgrades to Ormat Puna, we have no underground monitoring of expanding fracture zone caused my multiple production and injection wells thousands of feet underground. USGS/HVO monitors ERZ3, ERZ4, PO7, 2816 are broken or don't exist or don't work since 2018, actually it has been "fruitless" to rely on	Drilling at the site is conducted in accordance with approved state and federal permits. Well pads and well locations are approved under existing permits as described in the Draft EIS. Over time, and in coordination with permitting agencies, PGV adjusts the locations of well pads and wells in response to results of drilling. Cumulative impacts from the proposed Project are analyzed in Section 3.13 of the Draft EIS. Socioeconomic considerations are discussed in Section 3.6 of the Draft EIS. Potential impacts to public health are discussed in Section 3.12, and impacts from noise are discussed in Section 3.4. The potential impacts to hydrological resources are discussed in Section 3.2, potential impacts to air quality are discussed in Sections 3.3 and 3.11, and greenhouse gas emissions are discussed in Section 3.3. The potential impacts to aesthetics (i.e., visual resources) are discussed in Section 3.9 of the Draft EIS.	Figures, EIS Contents

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		any UGSG/HVO monitoring of PGV since 1991 (see 1995 Cooper & Dustman) NOTHING HAS CHANGED SINCE 1995 EXCEPT WE HAVE LESS USGS SEISMIC MONITORS IN PUNA. HAR 11-200.1-13(b)(7) DISCLOSE THE DEGRADATION OF THE ENVIRONMENT BY PRODUCING AND INJECTING 6 MILLION GALLONS OF ACIDIC EFFLUENT AND CHEMICALS INTO THE ROCK FORMATION - PGV CREATES INDUCED SEISMICITY AND IT FRACTURES THE GROUND INTO RUBBLE AFTER 35 YEARS. PGV's 1987 EIS failed to even mention degradation of the underground environment. HAR 11-200.1-13(b)(8) We need the cumulative effects of fracturing the unstable rift zone with 20 or 30 or more wells (however many wells PGV needs to reach 60 MW), including multiple re-drills and spuds off of wells and how the chemicals to remove silica and corrosion and biofouling agents don't dissolve the rock formation they are injected into and why geothermal wells fail - they fill with rock from all the fracturing. HAR 11-200.1-13(b)(10) PGV has substantial NEGATIVE effects on AIR and WATER and AMBIENT NOISE LEVELS, also the 2015 USGS water survey stated PGV injects Pentane and Isopropanol into their wells and it has showed up in the monitoring wells. HELLO, it is just a matter of time before it leaches down to the ocean. PGV creates 24/7/365 noise, drilling, banging, clanging, vibrations, lights and now there is no foliage to buffer the neighbors, only new lava which enhances the noise and smells and vibrations also come out of all the open fissures in Leilani Estates. The County enacted a night-time drilling ban demanded by the residents surrounding PGV way back in 2015 or so - but PGV never obeyed and the people had to sue. HAR 11-200.1-13(b)(11) have a substantial adverse effect on or be likely to suffer damage by being located in an environmentally sensitive LERZ. PGV fits both of these problems. First off they are located in the middle of an active volcanic rift zone which is experiencing tectonic dilation, which means it is pulling apart at the LERZ and south flank of Kilauea is falling into the ocean naturally without help from PGV! During the 2018 Kilauea eruption, lava flowed from out of their property line WHILE PGV MADE SUBSTANTIAL ADVERSE EFFECT ON PUNA BY INJECTING COLD WATER AND SALT WATER INTO AN ERUPTING VOLCANO. AR 11-200.1-13(b)(12) Since 2018 PGV is viewable now from all sides except the cinder-cone side (at the north) , sticks out like a sore thumb. All the foliage is gone and the lava surrounds the plant and it is louder and more bright since the eruption. Fissures on their property line are still smoking and noise from the plants emits from the fissures.. HAR 11-200.1-13(b)(13) Require Substantial Energy Consumption and emit substantial greenhouse gas. AND ANOTHER POWER PLANT HAS TO BE KEPT MAINTAINED FOR EVERY TIME PGV GOES OFFLINE, including 2 21/2 years while PGV tried to get it together after the eruption. PGV IS NOT FIRM RELIABLE POWER. PGV IS NOT RENEWABLE - THEY USE AND LOSE AN INORDINATE AMOUNT OF PENTANE, HAS TO CONTINUALLY DRILL NEW WELLS AS THE OLD ONES FAIL (JUST LIKE OIL AND GAS)		

APPENDIX E

AIR QUALITY TECHNICAL STUDY

Prepared for
Stantec, Inc.

Prepared by
Ramboll US Consulting, Inc.
San Francisco, California

Project Number
1690029388

Date
March 2023

AIR QUALITY AND GREENHOUSE GAS TECHNICAL REPORT – PUNA GEOTHERMAL VENTURE REPOWER PROJECT

PUNA GEOTHERMAL VENTURE (PGV) PĀHOA, HAWAI'I

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APPENDICES

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ACRONYMS AND ABBREVIATIONS

AQ	Air Quality
AQS	Air Quality Standards
BOP	Balance of Plant
CAA	Clean Air Act
CAP	Criteria Air Pollutant
CDP	Census Designated Place
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DOH	Department of Health
GCCU	Geothermal Combined Cycle Units
GHG	Greenhouse Gas
HELCO	Hawai'i Electric Light Company, Inc.
HI	Hawai'i
H_2S	Hydrogen Sulfide
MOVES	Motor Vehicle Emission Simulator
NAAQS	National Ambient Air Quality Standards
N_2O	Nitrous Oxide
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NSP	Noncovered Source Permit
O_3	Ozone
OECs	Ormat Energy Converters
PGV	Puna Geothermal Venture
$PM_{2.5}$	Fine Particulate Matter Less than 2.5 Micrometers in Aerodynamic Diameter
PM_{10}	Respirable Particulate Matter Less than 10 Micrometers in Aerodynamic Diameter
PUC	Hawai'i Public Utilities Commission
SO_2	Sulfur Dioxide
SOx	Oxides of Sulfur
USEPA	United States Environmental Protection Agency
UIC	Underground Injection Control

VOCs	Volatile Organic Compounds
VRMU	Vapor Recovery Maintenance Unit
VRU	Vapor Recovery Unit

Units

g	Gram	ppm	parts per million
lb/day	Pounds per day	ppb	parts per billion
m	Meter	s	Second
MT	Metric Ton	TPY	US Tons per Year
MW	Megawatts	yr	Year
MWh	Megawatts Hour		
$\mu g/m^3$	Micrograms per cubic meter		

EXECUTIVE SUMMARY

Puna Geothermal Venture (PGV), a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant in the Puna District on Hawai'i Island. Originally completed in 1993, PGV has been supplying power to Hawai'i Electric Light Company, Inc. (HELCO) for nearly thirty years. The power plant is located on an 815-acre site in the Kapoho section of the Kilauea Lower East Rift Geothermal Resource Subzone, an area that has produced geothermal heat for hundreds of years and is expected to continue producing geothermal heat for hundreds of years to come. The PGV site is an active geothermal power plant with production wells, injection wells, a steam plant, a brine plant, and associated infrastructure.

When initial construction of the PGV plant was completed in 1993, the power-generating capacity for the facility was 25 MW. In 1995, power output was increased to 30 MW without the addition of any equipment or wells via the increased utilization of existing steam. In 2012, additional power generating equipment was installed, resulting in 38 MW total output. The equipment added in 2012 again utilized the existing geothermal fluids and did not require any further drilling for the expansion.[1]

The aim of the PGV Repower Project (Project) is to increase the power-generating capacity of the facility to 60 MW by replacing the 12 existing Ormat Energy Converters (OECs) with four (4) new units. The reconstruction would take place in two phases: Phase 1 would increase the generating capacity by 8 MW (from 38 to 46 MW), or about 21 percent. Phase 2 would result in an increase of 14 MW (from 46 to 60 MW), or about 30 percent compared to the post-Phase 1 capacity. It is estimated that there would be a 20 percent increase in balance of plant (BOP) as part of Phase 2 due to piping infrastructure required to connect the fourth new OEC. Most of the existing buildings and infrastructure would remain for the project, including administration buildings, the control room, maintenance areas, well pads, and the gathering system. The new OECs are planned to be installed at a new location on-site and will have a smaller land footprint compared to the existing energy converters.

This report evaluates the air quality (AQ) and greenhouse gas (GHG) impacts associated with the construction and operational activities of the proposed Project.

The Criteria Air Pollutants (CAP) and GHG Emissions from construction equipment and operational mobile sources were estimated using the U.S. Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) version 3.2. MOVES is an emission modeling system that is widely used and available from USEPA. Modeling inputs were collected from information provided by PGV, including the equipment inventory and specifications, construction and operation schedules, and phasing inventory.

[1] Puna Geothermal Venture Repower Project Environmental Impact Statement Preparation Notice (EISPN). July 2022.

[2] USEPA Motor Vehicle Emission Simulator version 3. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.

1. INTRODUCTION

At the request of Stantec, Ramboll US Consulting, Inc. (Ramboll) has prepared this technical report documenting emissions impacts from construction and operational activities of the PGV Repower Project, which includes the removal of 12 existing energy converters and the installation of 4 OECs in two phases. The total design capacity with the new OECs will be 60 MW, which constitutes a 22 MW increase above the existing capacity. Based on the definition of "Land" as interpreted by the Hawaii Public Utilities Commission (PUC), the heat extracted from the geothermal fluid at the PGV site is state "land," so the proposed Project's continued use of the geothermal site triggers environmental review.[3] This report evaluates the AQ and GHG impacts of the proposed Project as part of a broader Environmental Impact Statement (EIS).

1.1 Project Description

The aim of the proposed Project is to increase the power-generating capacity to 60 MW by replacing 12 existing energy converters with 4 new Ormat Energy Converters (OECs). The reconstruction would take place in two phases: Phase 1 would increase the generating capacity by 8 MW (from 38 to 46 MW), or about 21 percent. Phase 2 would result in an increase of 14 MW (from 46 to 60 MW), or about 30 percent compared to the post-Phase 1 capacity. It is estimated that there would be a 20 percent increase in balance of plant (BOP) as part of Phase 2. Most of the existing buildings and infrastructure would remain for the project, including administration buildings, the control room, maintenance areas, well pads, and the gathering system. The new OECs are planned to be installed at a new location on site and will have a smaller land footprint compared to the existing energy converters.

1.2 Report Organization

This technical report is divided into four sections as follows:

Section 1.0 – Introduction: describes the purpose and scope of this technical report, the objectives and methodology used in this technical report, and the report organization;

Section 2.0 – Affected Environment: describes the national and state level AQ and GHG standards considered in this report, aside from existing ambient conditions at the Project location;

Section 3.0 – Environmental Consequences and Mitigation: describes the methods used to estimate the emissions of criteria air pollutants (CAPs) and GHGs, and mitigation requirements;

Section 4.0 – References: includes a listing of all references cited in this report.

[3] Puna Geothermal Venture Repower Project Environmental Impact Statement Preparation Notice (EISPN). July 2022.

2. AFFECTED ENVIRONMENT

The Project is located in Pāhoa, Hawaii County, on the island of Hawai'i. The Project site consists of approximately 815 acres in the Kapoho Section of the Kīlauea Lower East Rift Geothermal Resource Subzone. The PGV property boundary is enclosed primarily by agricultural land use. The area of the Project does not lie within a Census Designated Place (CDP), though Leilani Estates, Nanawale Estates, and Pāhoa CDP are nearby. Leilani Estates is within 0.5 mi of the PGV Property Boundary, Nanawale Estates is within 1 mi, and Pāhoa Preschool is about 4 miles away. The Lava Tree State Monument is also within 0.5 mi of the PGV Property Boundary. The state of Hawaii owns all mineral rights, including geothermal resources, in the state and has issued a Geothermal Resources Mining Lease for the existing PGV facility. An aerial image of the Project site is shown in Appendix B Figure 1.

2.1 General Discussion of Air Quality Pollutants

2.1.1 Criteria Air Pollutants

Criteria air pollutants (CAPs) are defined as pollutants for which the federal and state governments have established ambient air quality standards, or criteria, for outdoor concentrations to protect public health. The federal and state standards have been set, with an adequate margin of safety, at levels above which concentrations could be harmful to human health and welfare. These standards are designed to protect the most sensitive people from illness or discomfort. Pollutants of concern include O_3, NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. There are no large sources of lead (Pb) emissions associated with the construction or operation of the Project; hence Pb emissions were not evaluated.

2.1.1.1 Ozone

Ozone (or O_3) is a colorless gas that is formed in the atmosphere when volatile organic compounds (VOCs), sometimes referred to as reactive organic gases, and oxides of nitrogen (NO_X) react in the presence of ultraviolet sunlight. O_3 is not a primary pollutant; it is a secondary pollutant formed by complex interactions of two pollutants directly emitted into the atmosphere. The primary sources of VOCs and NO_X, the precursors of O_3, are automobile exhaust and industrial sources. Meteorology and terrain play major roles in O_3 formation, and ideal conditions occur during summer and early autumn on days with low wind speeds or stagnant air, warm temperatures, and cloudless skies. Short-term exposures (lasting for a few hours) to O_3 can result in breathing pattern changes, reduction of breathing capacity, increased susceptibility to infections, inflammation of the lung tissue, and some immunological.

2.1.1.2 Nitrogen Dioxide

Most NO_2, like O_3, is not directly emitted into the atmosphere but is formed by an atmospheric chemical reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as NO_X and are major contributors to O_3 formation. The primary sources of NO, the precursor to NO_2, include automobile exhaust and industrial sources. High concentrations of NO_2 can cause breathing difficulties and result in a brownish-red cast to the atmosphere, causing reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis, and some increase in bronchitis in children (2 and 3 years old) has also been observed at concentrations below 0.3 parts per million by volume (ppm).

2.1.1.3 Carbon Monoxide

Carbon Monoxide (CO) is a colorless and odorless gas formed by the incomplete combustion of fossil fuels. CO is emitted almost exclusively from motor vehicles, power plants, refineries, industrial boilers, ships, aircraft, and trains. In urban areas, automobile exhaust accounts for the majority of CO emissions. CO is a non-reactive air pollutant that dissipates relatively quickly; therefore, ambient CO concentrations generally follow the spatial and temporal distributions of vehicular traffic. CO concentrations are influenced by local meteorological conditions, primarily wind speed, topography, and atmospheric stability. CO from motor vehicle exhaust can become locally concentrated when surface-based temperature inversions are combined with calm atmospheric conditions, a typical situation at dusk in urban areas between November and February. The highest levels of CO typically occur during the colder months of the year when inversion conditions, where a layer of warm air sits atop cool air, are more frequent and can trap pollutants close to the ground. In terms of health, CO competes with oxygen, often replacing it in the blood, thus reducing the blood's ability to transport oxygen to vital organs. The results of excess CO exposure can be dizziness, fatigue, and impairment of central nervous system functions.

2.1.1.4 Sulfur Dioxide

Sulfur Dioxide (SO_2) is a colorless, pungent gas formed primarily by the combustion of sulfur-containing fossil fuels. The main sources of SO_2 are coal and oil used in power plants and industries; as such, the highest levels of SO_2 are generally found near large industrial complexes. In recent years, SO_2 concentrations have been reduced by the increasingly stringent controls placed on stationary source emissions of SO_2 and limits placed on the sulfur content of fuels. SO_2 is an irritant gas that attacks the throat and lungs and can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also yellow plant leaves and erode iron and steel.

2.1.1.5 Particulate Matter

Particulate Matter (PM) pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter can form when gases emitted from industries and motor vehicles undergo chemical reactions in the atmosphere. $PM_{2.5}$ and PM_{10} represent fractions of particulate matter. Fine particulate matter, or $PM_{2.5}$, is roughly 1/28 the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (e.g., motor vehicles, power generation, and industrial facilities), residential fireplaces, and woodstoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as SO_X, NO_X, and VOCs. Inhalable or coarse particulate matter, or PM_{10}, is about one-seventh the thickness of a human hair. Major sources of PM_{10} include crushing or grinding operations; dust stirred up by vehicles traveling on roads; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions.

$PM_{2.5}$ and PM_{10} pose a greater health risk than larger-size particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. $PM_{2.5}$ and PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. Very small particles of substances such as lead, sulfates, and nitrates can cause lung damage directly or be absorbed into the bloodstream, causing damage elsewhere in the body. Additionally, these substances can transport absorbed gases, such as chlorides or ammonium, into the lungs, also causing injury. Whereas PM_{10} tends to collect in the upper portion of the respiratory system, $PM_{2.5}$ is so tiny that it can penetrate deeper into the lungs and damage lung tissues. Suspended particulates also damage and discolor surfaces on which they settle, as well as produce haze and reduce regional visibility

2.1.2 Greenhouse Gases

There is a general scientific consensus that global climate change is occurring, caused in whole or in part by increased emissions of GHGs that keep the Earth's surface warm by trapping heat in the Earth's atmosphere, in much the same way as glass traps heat in a greenhouse.[4] The Earth's climate is changing because human activities, primarily the combustion of fossil fuels, are altering the chemical composition of the atmosphere through the buildup of GHGs.

GHGs allow the sun's radiation to penetrate the atmosphere and warm the Earth's surface, but do not let the infrared radiation emitted from the Earth escape back into outer space. As a result, global temperatures are predicted to increase over the century. In particular, if climate change remains unabated, surface temperatures in Hawaii are expected to increase anywhere from 5 to 7.5 degrees Fahrenheit by the end of the century.[5] Not only would higher temperatures directly affect the health of individuals through greater risk of dehydration, heat stroke, and respiratory distress, the higher temperatures may increase ozone formation, thereby worsening air quality. Higher temperatures along with reduced water supplies could reduce the quantity and quality of agricultural products. In addition, there could be an increase in wildfires and a shift in distribution of natural vegetation throughout the Island. Global warming could also increase sea levels and coastal storms resulting in greater risk of flooding.

Emissions of carbon dioxide (CO_2) are the leading cause of global warming, with other pollutants such as methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) also contributing. The magnitude of each GHG's impact on global warming differs because each GHG has a different global warming potential (GWP), which indicates, on a pound for pound basis, how much the pollutant will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O, for example, are substantially more potent than CO_2, with GWPs of 27.9 and 273, respectively.

2.2 National and State Ambient Air Quality Standards

As required by the Clean Air Act (CAA) Amendments of 1970[6], the USEPA has established National Ambient Air Quality Standards (NAAQS) for the following air pollutants: CO, ozone, nitrogen dioxide (NO_2), particulates (PM_{10} and $PM_{2.5}$), oxides of sulfur (SO_X), and lead (Pb). Hawaii State Department of Health (DOH) has also established standards for these pollutants

[4] Intergovernmental Panel on Climate Change (IPCC). 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

[5] Fourth National Climate Assessment. Chapter 2: Our Changing Climate. 2018. Available online at: https://nca2018.globalchange.gov/chapter/2/. Accessed Feb. 2023.

[6] 42 United States Code (USC) §7401 et seq. 1970.

for Hawaii.[7] The federal and state governments have both adopted health-based standards for pollutants. Per the CAA, the USEPA periodically (every five years) reviews the science upon which the NAAQS are based and undertakes a process for revising the standards if it is deemed necessary.[8]

Table 2-1 lists the federal and Hawaii standards. The federal primary standards are intended to protect the public health with an adequate margin of safety. The federal secondary standards are intended to protect the nation's welfare and account for air pollutant impacts on soil, water, visibility, vegetation, and other aspects of the general welfare. Areas that violate these standards are designated nonattainment areas. Areas that once violated the standards but now meet the standards are classified as maintenance areas. Classification of each area under the federal standards is done by USEPA based on state recommendations and after an extensive review of monitored data.

Hawaii County, Hawai'i, where the project is located, has not been classified as a nonattainment area for any criteria pollutants under NAAQS.

Table 2-1. National and State Air Quality Standards

Pollutant	Averaging Time	NAAQS[1]		Hawaii AQS[1]
		Primary	Secondary	
Ozone (O_3)	1-Hour	-	-	
	8-Hour	0.070 ppm	0.070 ppm	0.080 ppm
Carbon Monoxide (CO)	1-Hour	35 ppm	-	9 ppm
	8-Hour	9 ppm	-	4.4 ppm
Nitrogen Dioxide (NO_2)	1-Hour	0.100 ppm	-	-
	Annual	0.053 ppm	0.053 ppm	0.04 ppm
Sulfur Dioxide (SO_2)	1-Hour	0.075 ppm	-	-
	3-Hour	-	0.5 ppm	0.5 ppm
	24-Hour	0.14 ppm	-	0.14 ppm
	Annual	0.03 ppm	-	0.03 ppm
Inhalable Particulate Matter (PM_{10})	24-Hour	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$
	Annual	-	-	50 $\mu g/m^3$
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	35 $\mu g/m^3$	35 $\mu g/m^3$	-
	Annual	12 $\mu g/m^3$	15 $\mu g/m^3$	-
Lead (Pb)	30-day	-	-	-
	Calendar Quarter	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	-
	Rolling 3-Month Average	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$	1.5 $\mu g/m^3$

Note:

1. The NAAQS and Hawaii AAQS, other than O_3 and those based on annual averages, are not to be exceeded more than once a year. Pb shows not to exceed numbers.

[7] Hawaii State Department of Health (DOH). 2011. Hawaii Administrative Rule (HAR) §11-59.

[8] U.S. Environmental Protection Agency (USEPA). n.d. Process of Reviewing the National Ambient Air Quality Standards.

2.3 Air Quality Setting

2.3.1 Ambient Air Monitoring Data

The Hawaii DOH Clean Air Branch operates AQ monitoring sites which measure ground-level concentrations of criteria pollutants. The monitoring data shown in Tables 2-2 through 2-4 was sourced from the Hawaii DOH website.[9] Tables 2-2 through 2-4 present the data that was available for 2020-2022 for the three monitoring sites on the Island of Hawai'i that are closest to the PGV plant: Leilani, KS Hawai'i, and Mountain View. No exceedances of NAAQS or HI AQS were observed during the three-year period.

Table 2-2. Ambient Air Quality Monitoring Data, Leilani Site

AQS Site Leilani							
Pollutant	Averaging Time	Form	2020	2021	2022	HI AQS	NAAQS
Hydrogen Sulfide (H_2S) [ppb]	1-Hour	Annual Average	10	2.3	0.94	25	NA
Sulfur Dioxide (SO_2) [ppb]	1-Hour	99th Percentile	2.0	2.0	2.0	NA	75
		3-Year Average	2.0				

Table 2-3. Ambient Air Quality Monitoring Data, KS Hawai'i Site

AQS Site KS Hawai'i							
Pollutant	Averaging Time	Form	2020	2021	2022	HI AQS	NAAQS
Fine Particulate ($PM_{2.5}$) [μg/m3]	24-Hour	98th Percentile	6.2	5.7	6.9	NA	35
		3-Year Average	6.3				
Fine Particulate ($PM_{2.5}$) [μg/m3]	Annual	Annual Average	3.1	3.0	3.1	NA	12
		3-Year Average	3.1				

[9] Hawaii Department of Health. Hawaii Air Quality Data. Available at: https://air.doh.hawaii.gov/Report/stationreport

Table 2-4. Ambient Air Quality Monitoring Data, Mountain View Site

AQS Site Mountain View							
Pollutant	Averaging Time	Form	2020	2021	2022	HI AQS	NAAQS
Fine Particulate ($PM_{2.5}$) [μg/m3]	24-Hour	98th Percentile	4.7	4.9	6.9	NA	35
		3-Year Average	5.5				
Fine Particulate ($PM_{2.5}$) [μg/m3]	Annual	Annual Average	2.6	2.5	2.9	NA	12
		3-Year Average	2.6				
Sulfur Dioxide (SO_2) [ppb]	1-Hour	99th Percentile	3.0	8.0	10	NA	75
		3-Year Average	7.0				

3. ENVIRONMENTAL CONSEQUENCES AND MITIGATION

3.1 The Proposed Action Alternative

Construction activities from the Project would temporarily generate emissions. The construction schedule includes two phases: Phase 1 involves removal of existing equipment and upgrades that will reduce steel structures, piping, mechanical components, and associated flange connections. It includes the installation of three new OECs and supporting electrical equipment. Phase 2 includes an expected 20 percent increase in BOP and one additional OEC unit. The existing infrastructure associated with the facility, including office buildings, control room, electrical substation, distribution lines, and maintenance areas will remain unchanged with the Project. The property boundary will also remain the same after the Project's completion, and most of the 815-acre property will not be altered.

Ramboll estimated CAPs and GHG emissions from construction activities in Phase 1 and Phase 2. The methodologies used by Ramboll to calculate emissions are summarized in the next section.

Normal operational emissions consist of n-pentane releases from the vapor recovery unit (VRU) and vapor recovery maintenance unit (VRMU), and H_2S emissions from the Sulfa-Treat System, which collects fugitive leaks at the steam turbine seals. Because the upgraded OECs will utilize the same geothermal resource, no increase in operational power plant emissions is expected as a result of the Project.

In addition to power plant emissions, mobile operational emissions occur as result of work trips for the existing 31 employees and periodic truck trips for maintenance activities. Operation of the post-Project PGV Plant will not require additional employees; thus, the mobile operational emission sources represent a continuation of existing travel patterns and activities that currently occur at the project site. Any existing infrastructure associated with the facility are also expected to remain the same with the Project. Therefore, under the Proposed Action Alternative, there will not be an increase in operational emissions compared to the No Action Alternative.

3.1.1 Calculation Methodologies for Construction Emissions

Emissions from construction activities were estimated using EPA's MOVES software.[10] MOVES is an emissions modeling system that estimates air pollution emissions for CAPs, GHGs, and air toxics. It covers on-road vehicles such as cars and trucks, and nonroad equipment such as bulldozers and cranes. MOVES was developed by the EPA and is suitable to develop emissions inventories for a variety of regulatory purposes outside of California. Emissions associated with construction include exhaust emissions from offroad construction equipment and worker commuting to and from the project site. It also includes fugitive dust emissions from paved road dust generation. It is assumed no hauling activities are in scope for this Project.

3.1.1.1 Emissions from Off-road Equipment

CAP and GHG emissions from off-road equipment were based on the equipment inventory, equipment specifications, their daily usage and construction phasing schedule provided by

[10] USEPA Motor Vehicle Emission Simulator version 3. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.

PGV. Appendix Table A-1 presents the construction schedule for Phase 1 and Phase 2 of construction, and Appendix Table A-2 presents the construction equipment list for both construction phases.

3.1.1.2 Emissions from On-road Vehicles

MOVES estimates CAP and GHG emissions from on-road worker trips based on vehicle type, emission factor, distance travelled, and number of trips. The number of truck and construction worker trips were provided by PGV. The construction trip generation rate for the Project is shown in Appendix Table A-3. Emission factors for each vehicle type were developed using MOVES and default values for age distribution, fuel, meteorology, and vehicle type distribution for each respective year. The trip length for workers was conservatively determined by PGV to be 10 miles.

3.1.1.3 Emissions from Fugitive Dust

Fugitive dust emissions are typically generated during construction phases, and fugitive dust contributes to both PM_{10} and $PM_{2.5}$ emissions. Fugitive dust is generated by various activities during construction such as material handling, bulldozing, scraping, and grading. Because there are no hauling trips scoped for this project, fugitive dust emissions from material handling are assumed minimal due to no significant material movement. On-road fugitive dust is also associated with vehicles traveling on paved and unpaved roads. Fugitive dust emissions associated with bulldozing, scraping, and grading of materials and on-road sources are estimated based on guidance from the Mojave Desert Air Quality Management District (MDAQMD).[11]

The fugitive dust emissions for the Project are estimated from the bulldozing, scraping and grading of topsoil, overburden, waste material, and ore through the use of heavy equipment such as bulldozers, graders, scrapers, roller, excavator, etc. Portable equipment such as crane, lifts, and concrete mixer are assumed to have no fugitive emissions, as they are either portable sources that would be towed when moved, travel at such a low speed that no emissions would be generated, or are stationary. Thus, emissions would either be accounted for in the vehicle that transports the equipment or are de minimis.

Airborne, visible fugitive dust during construction will be controlled at the project site by the contractor in accordance with the Air Pollution Control standards stated in HAR § 11-60. 1-33. Acceptable methods of control include the use of water or appropriate chemicals to control fugitive dust; application of asphalt, water, or appropriate chemicals on roads and material stockpiles; installation of hoods, fans, and fabric filters where appropriate; covering all moving, open-bodied trucks which may result in fugitive dust; and the maintenance of clean roadways. [12] The fugitive dust emissions from construction off-road equipment are calculated in Table A-4.

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[11] Mojave Desert Air Quality Management District (MDAQMD). 1999. Emissions Inventory Guidance Section VI.L. Wind Erosion from Unpaved Operational Areas and Roads. Available at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

[12] Hawaii State Department of Health, Hawaii Administrative Rules § 11-60.1-33. 2011. Available at: https://health.hawaii.gov/cab/files/2014/06/har_11-60_1.pdf.

The on-road fugitive dust emissions from worker trips are calculated based on paved surface silt loading, vehicle weight, and annual vehicular activity in miles traveled. Fugitive dust emissions from construction paved roads are shown in Table A-5.

3.1.1.4 Summarized Construction Emissions

The uncontrolled CAP and GHG emissions from on- and off-road construction sources for both construction phases are presented in Table A-7. The controlled emissions are shown in Table 3-1 below.

Table 3-1: Controlled Construction Emissions by Construction Year and Phase

Year	CAP Emissions						GHG Emissions
	ROG	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
	tpy						MT/yr
2023	0.0085	0.11	0.070	2.9E-04	0.71	0.22	96
2024	0.047	0.52	0.36	0.0014	2.9	0.90	470
2025	0.036	0.42	0.28	0.0012	2.7	0.83	388
2026	0.014	0.15	0.095	4.9E-04	0.60	0.19	164
Phase 1 Total	0.059	0.67	0.45	0.0018	3.6	1.1	588
Phase 2 Total	0.046	0.54	0.36	0.0016	3.3	1.0	530
Total Construction Emissions	0.11	1.2	0.81	0.0034	6.9	2.1	1,118

Note:
Controlled emissions assume 74% control efficiency for fugitive dust from construction equipment.

3.1.2 Calculation Methodologies for Operational Emissions

The upgraded OECs will utilize existing geothermal wells, and PGV may drill additional injection and/or production wells, as needed, in accordance with their state and federal Underground Injection Control (UIC) permits;[13] mobile emissions for current and future drilling are covered in the HDOH's Noncovered Source Permits (NSPs) for the Project.[14] The existing infrastructure, including administration buildings, control rooms, and maintenance areas, is expected to remain unchanged with the installation of the new OECs, so no operational emission increases from land uses are anticipated. Finally, the total number of employees will not increase with the proposed OEC upgrades, so no increase in mobile source operational emissions from worker trips is anticipated as a result of the Project.

[13] Existing UIC permits include one federal permit (No. HI596002), and two state permits (No. H-1529 and Authority to Construct 7 Geothermal Wells).

[14] Existing NSPs include permits No. 0008-13-N and No. 0008-02-N.

3.1.2.1 Existing Emissions Sources

The existing OECs onsite consist of both geothermal combined cycle units (GCCU) and binary units. In the case of the GCCUs, hot geothermal steam leaves the wellhead and expands through a turbine, resulting in a pressure drop. The turbine then turns a shaft which powers a generator. After exiting the turbine, the low-pressure steam leaves the turbine and passes through two heat exchangers where it transfers both sensible and latent heat to pentane, which is a low boiling point motive fluid. The transference of energy vaporizes the pentane, which expands across a second turbine, resulting in further power transfer to the same generator.

Binary units are similar to GCCUs but exclude the steam turbine. In the case of a binary OEC, steam exits the wellhead and passes through a pair of heat exchangers, which results in the evaporation of the motive fluid. The motive fluid then expands through a turbine and conveys mechanical work to the generator.

Regardless of OEC configuration, the steam is ultimately condensed to liquid in the second heat exchanger (the motive fluid preheater) and is reinjected into the earth to maintain constant aquifer pressure.

Emission sources from existing, normal operation of the geothermal power plant come from three sources: the VRMU, VRU, and Sulfa-Treat System. Each source is described in more detail below.

Vapor Recovery Maintenance Unit (VRMU): The VRMU is used to evacuate and recover pentane before venting non-condensable gases from the pentane system. The VRMU consists of a 4-step recovery and carbon filtering system.

Vapor Recovery Unit (VRU): The VRU is normally used to remove pentane before venting non-condensable gases from the pentane system. The VRU uses a 2-stage refrigeration cycle to recover the pentane and return it to the pentane storage tanks.

Sulfa-Treat System: The Sulfa-Treat System captures fugitive H_2S emissions from the turbine seals. The system uses negative pressure to capture the fugitive emissions, which then pass through a series of two reactors for chemical abatement. The abatement reactor configuration changes occasionally but maintains a consistent control efficiency.

Both the VRMU and VRU produce n-pentane emissions, while the Sulfa-Treat System leads to H_2S emissions.

In addition to the above-mentioned sources, operational emissions for the site also include mobile source emissions that occur as the result of worker trips. The PGV Plant currently has 31 employees.[15] Mobile source operational emissions were estimated based on the existing workforce of 31 personnel, assuming a five-day workweek, two (2) trips per day, and a ten (10) mile trip length, as specified by PGV. Operational on-road fugitive dust emissions from worker and maintenance truck trips are estimated in Table A-6. Operational emissions are presented in Table 3-2.

[15] Puna Geothermal Venture Repower Project Environmental Impact Statement Preparation Notice (EISPN). July 2022.

3.1.2.2 Summary of Project Operational GHG Emissions

No GHG emissions are emitted during normal PGV plant operations. Electricity generated onsite is used to power the compressors, pumps, and cooling fans.

The CAP and GHG emissions from controlled operational sources are presented in Table 3-2 below.

Table 3-2. Operational Emissions Summary

Source	CAP Emissions[1]								GHG Emissions[2]
	ROG	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	n-Pentane	H_2S	CO_2e
	tpy								MT/yr
Worker Commute	0.037	0.027	0.63	4.53E-04	0.0076	1.75E-03	--	--	62
Maintenance Truck Trips	1.26E-05	9.55E-05	1.20E-04	1.61E-07	8.21E-06	4.29E-06	--	--	0.04
Power Plant	--	--	--	--	--	--	3.44	0.03	--
Total Operational Emissions	0.04	0.03	0.63	4.54E-04	0.01	1.75E-03	**3.44**	0.03	62

Notes:

1. Operational mobile emissions were estimated with US EPA's Motor Vehicle Emission Simulator (MOVES) Emissions Estimator Model version 3.1. Operational sources include workers travelling to and from the project site and quarterly maintenance truck trips. For PM, the operational emissions of fugitive dust include the entrained roadway dust and tire/brake wear from operational vehicles.
2. The mitigated and unmitigated scenarios for operational emissions are the same because no control measures are applied for fugitive dust emissions and the power plant emissions were supplied in the 2022 Noncovered Source Permit (No. 0008-02-N) Request for Renewal and Modification Application and are estimated post-control.

3.2 No Action Alternative

The No Action Alternative is the only practical alternative to the Proposed Action. Under this alternative, Ormat would not upgrade equipment at the PGV facility. This alternative assumes current operation of the existing geothermal energy production facility through 2027 (or an extended term of the PPA) under the status quo conditions.

The No Action Alternative does not include any construction and, therefore, would result in no impacts related to construction. Please refer to Section 3.1.2 above for details on the operational emissions from this alternative, as they are not expected to change with the proposed Project.

4. REFERENCES

1. Puna Geothermal Venture Repower Project Environmental Impact Statement Preparation Notice (EISPN). July 2022.
2. U.S. Environmental Protection Agency (USEPA). Motor Vehicle Emission Simulator version 3. https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.
3. Intergovernmental Panel on Climate Change (IPCC). 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
4. Hayhoe, K., D.J. Wuebbles, D.R. Easterling, D.W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner, 2018: Our Changing Climate. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. doi: 10.7930/NCA4.2018.CH2
5. 42 United States Code (USC) §7401 et seq. 1970.
6. Hawaii State Department of Health (DOH). 2011. Hawaii Administrative Rule (HAR) §11-59.
7. U.S. Environmental Protection Agency (USEPA). n.d. Process of Reviewing the National Ambient Air Quality Standards.
8. Hawaii Department of Health DOH) Website Air Monitoring Data. https://air.doh.hawaii.gov/Report/stationreport.

TABLES

Table A-1
Construction Schedule
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase[1]	Subphase[1]	Construction Activity	Start Date	End Date	Number of Work Days[2]	Days per Week[2]	Hours per Day[2]
Phase 1	Removal of existing equipment	Removal of Existing Equipment	10/1/2023	10/27/2023	20	5	8
	Site Development	Rock Crushing	10/28/2023	12/22/2023	40	5	8
		Grade Site	12/23/2023	2/18/2024	40	5	8
	Power Plant Construction	Foundation	2/19/2024	6/23/2024	90	5	8
		Pipeline Installation	6/24/2024	10/25/2024	90	5	8
		Mechanical/Electrical Installation	10/26/2024	2/28/2025	90	5	8
Phase 2	Site Development	Rock Crushing	3/1/2025	4/27/2025	40	5	8
		Grade Site	4/28/2025	6/22/2025	40	5	8
	Power Plant Construction	Foundation	6/23/2025	10/26/2025	90	5	8
		Pipeline Installation	10/27/2025	2/27/2026	90	5	8
		Mechanical/Electrical Installation	2/28/2026	6/30/2026	87	5	8

Notes:

1. The construction schedule for Phase 1 was provided by the Project Developer in the lifecycle greenhouse gas analysis submitted to the Public Utilities Commission (PUC) under Docket 2019-0333 for the Amended and Restated Power Purchase Agreement (ARPPA) between HELCO and PGV. Construction activities for Phase 2 were conservatively assumed to be the same as Phase 1 (except for Removal of Existing Equipment, which is expected to be completed in Phase 1).

2. Construction is generally expected to occur between 7am-6pm Monday-Friday and 9am-6pm on Saturdays in accordance with the Hawaii Noise Order.

References:

Hawaii Public Utilities Commission (PUC). 2019. Docket 2019-0333. Application for Approval on an Amended and Restated Power Purchase Agreement between Hawaii Electric Light Company, Inc. and Puna Geothermal Venture. Available at: https://dms.puc.hawaii.gov/dms/dockets?action=details&docketNumber=2019-0333.

Table A-2
Construction Equipment List
Puna Geothermal Venture (PGV)
Pāhoa, HI

Anticipated Construction Start Date:	**10/1/2023**

Phase	Subphase	Construction Activity	Equipment Type[1]	Modeled Equipment Type[2]	Fuel[3]	Quantity[1]	Horsepower[1]	Daily Usage (hours/day)[1]	Utilization[1]
Phase 1	Removal of existing equipment	Removal of existing equipment	Excavator	Dsl - Excavators	Diesel	3	158	8	100%
			Rubber Tired Dozer	Dsl - Crawler Tractor/Dozers	Diesel	2	247	8	100%
			Concrete/Industrial Saw	Dsl - Concrete/Industrial Saws	Diesel	1	81	8	100%
	Site Development	Rock Crushing	Rock Crusher	Dsl - Crushing/Proc. Equipment	Diesel	1	85	8	100%
			Rock Screen	Dsl - Other General Industrial Eqp	Diesel	1	172	8	100%
		Grade Site	Excavators	Dsl - Excavators	Diesel	2	158	8	100%
			Roller	Dsl - Rollers	Diesel	1	80	8	100%
			Compactor	Dsl - Crushing/Proc. Equipment	Diesel	1	85	8	100%
			Tractors/Loaders/Backhoes	Dsl - Tractors/Loaders/Backhoes	Diesel	3	97	8	100%
			Graders	Dsl - Graders	Diesel	1	187	8	100%
			Truck	Dsl - Off-highway Trucks	Diesel	1	402	8	100%
	Power Plant Construction	Foundation	Excavators	Dsl - Excavators	Diesel	1	158	8	100%
			Trencher	Dsl - Trenchers	Diesel	1	78	8	100%
			Concrete Mixer	Dsl - Cement & Mortar Mixers	Diesel	1	9	8	100%
			Roller	Dsl - Rollers	Diesel	1	80	8	100%
		Pipeline Installation	Welding Machine	Dsl - Welders	Diesel	3	46	8	100%
			Forklift	Dsl - Forklifts	Diesel	2	89	8	100%
			Truck	Dsl - Off-highway Trucks	Diesel	2	402	8	100%
		Mechanical/Electrical Installation	Man Lift	Dsl - Aerial Lifts	Diesel	1	63	8	100%
			120T Crane	Dsl - Cranes	Diesel	1	231	8	100%
Phase 2	Site Development	Rock Crushing	Rock Crusher	Dsl - Crushing/Proc. Equipment	Diesel	1	85	8	100%
			Rock Screen	Dsl - Other General Industrial Eqp	Diesel	1	172	8	100%
		Grade Site	Excavators	Dsl - Excavators	Diesel	2	158	8	100%
			Roller	Dsl - Rollers	Diesel	1	80	8	100%
			Compactor	Dsl - Crushing/Proc. Equipment	Diesel	1	85	8	100%
			Tractors/Loaders/Backhoes	Dsl - Tractors/Loaders/Backhoes	Diesel	3	97	8	100%
			Graders	Dsl - Graders	Diesel	1	187	8	100%
			Truck	Dsl - Off-highway Trucks	Diesel	1	402	8	100%
	Power Plant Construction	Foundation	Excavators	Dsl - Excavators	Diesel	1	158	8	100%
			Trencher	Dsl - Trenchers	Diesel	1	78	8	100%
			Concrete Mixer	Dsl - Cement & Mortar Mixers	Diesel	1	9	8	100%
			Roller	Dsl - Rollers	Diesel	1	80	8	100%
		Pipeline Installation	Welding Machine	Dsl - Welders	Diesel	3	46	8	100%
			Forklift	Dsl - Forklifts	Diesel	2	89	8	100%
			Truck	Dsl - Off-highway Trucks	Diesel	2	402	8	100%
		Mechanical/Electrical Installation	Man Lift	Dsl - Aerial Lifts	Diesel	1	63	8	100%
			120T Crane	Dsl - Cranes	Diesel	1	231	8	100%

Notes:

1. The construction equipment information for Phase 1 was provided by the Project Developer in the lifecycle greenhouse gas analysis submitted to the Public Utilities Commission (PUC) under Docket 2019-0333 for the Amended and Restated Power Purchase Agreement (ARPPA) between HELCO and PGV. The construction equipment for Phase 2 were conservatively assumed to be the same as Phase 1 (except for Removal of Existing Equipment, which is expected to be completed in Phase 1).

2. Modeled equipment types were assigned using US EPA's Motor Vehicle Emission Simulator (MOVES) Emissions Estimator Model version 3.1.
3. All equipment were conservatively assumed to be diesel-fueled.

References:

Hawaii Public Utilities Commission (PUC). 2019. Docket 2019-0333. Application for Approval on an Amended and Restated Power Purchase Agreement between Hawaii Electric Light Company, Inc. and Puna Geothermal Venture. Available at: https://dms.puc.hawaii.gov/dms/dockets?action=details&docketNumber=2019-0333.
U.S. Environmental Protection Agency (USEPA). 2020. Motor Vehicle Emission Simulator: MOVES3. Office of Transportation and Air Quality. US Environmental Protection Agency. Ann Arbor, MI. Available at: https://www.epa.gov/moves.

Table A-3
Construction Trip Generation Rate
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase	Subphase	Construction Activity	Construction Days	Trip Rates[1] (trips/day)	Trip Length[2] (miles/ trip)
				Worker Trips	Worker Trips
Phase 1	Removal of Existing Equipment	Removal of Existing Equipment	20	15	10
	Site Development	Rock Crushing	40	5	10
		Grade Site	40	23	10
	Power Plant Construction	Foundation	90	10	10
		Pipeline Installation	90	18	10
		Mechanical/Electrical Installation	90	5	10
Phase 2	Site Development	Rock Crushing	40	5	10
		Grade Site	40	23	10
	Power Plant Construction	Foundation	90	10	10
		Pipeline Installation	90	18	10
		Mechanical/Electrical Installation	87	5	10

Notes:

1. Worker trip rates were estimated assuming 1.25 workers per piece of equipment, per California Emissions Estimator Model (CalEEMod) v2022.1 Appendix C guidance.
2. Worker trip length was provided by the Project Developer in the lifecycle greenhouse gas analysis submitted to the Public Utilities Commission (PUC) under Docket 2019-0333 for the Amended and Restated Power Purchase Agreement (ARPPA) between HELCO and PGV.

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix C. Available at: https://www.caleemod.com/documents/user-guide/04_Appendix%20C.pdf

Hawaii Public Utilities Commission (PUC). 2019. Docket 2019-0333. Application for Approval on an Amended and Restated Power Purchase Agreement between Hawaii Electric Light Company, Inc. and Puna Geothermal Venture. Available at: https://dms.puc.hawaii.gov/dms/dockets?action=details&docketNumber=2019-0333.

Table A-4
Fugitive Dust - Construction Off-road Equipment
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase	Construction Activity	Construction Equipment	Quantity[2]	Years of Activity	Operating Days per Year[2]	Operating Hours per Equipment[2]	Operating Hours per Year	Maximum Total Equipment Hours per Day	Control Efficiency (%)	PM_{10} EF[3,4] (lb/hr)	$PM_{2.5}$ EF[3,4] (lb/hr)	Uncontrolled Emissions: PM_{10} Emissions (tpy)	Uncontrolled Emissions: $PM_{2.5}$ Emissions (tpy)	Controlled Emissions[5]: PM_{10} Emissions (tpy)	Controlled Emissions[5]: $PM_{2.5}$ Emissions (tpy)
Phase 1	Removal of existing equipment	Excavator	3	2023	20	8	480	24	74%	2.6	0.81	0.64	0.19	0.17	0.05
		Rubber Tired Dozer	2		20	8	320	16	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Concrete/Industrial Saw	1		20	8	160	8	74%	2.6	0.81	0.21	0.06	0.06	0.02
	Rock Crushing	Rock Crusher	1	2023	40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Rock Screen	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
	Grade Site	Excavators	2	2023	6	8	96	16	74%	2.6	0.81	0.13	0.04	0.03	0.01
		Roller	1		6	8	48	8	74%	2.6	0.81	0.06	0.02	0.02	0.01
		Compactor	1		6	8	48	8	74%	2.6	0.81	0.06	0.02	0.02	0.01
		Tractors/Loaders/Backhoes	3		6	8	144	24	74%	2.6	0.81	0.19	0.06	0.05	0.02
		Graders	1		6	8	48	8	74%	2.6	0.81	0.06	0.02	0.02	0.01
		Truck	1		6	8	48	8	74%	2.6	0.81	0.06	0.02	0.02	0.01
		Excavators	2	2024	34	8	544	16	74%	2.6	0.81	0.72	0.22	0.19	0.06
		Roller	1		34	8	272	8	74%	2.6	0.81	0.36	0.11	0.09	0.03
		Compactor	1		34	8	272	8	74%	2.6	0.81	0.36	0.11	0.09	0.03
		Tractors/Loaders/Backhoes	3		34	8	816	24	74%	2.6	0.81	1.1	0.33	0.28	0.09
		Graders	1		34	8	272	8	74%	2.6	0.81	0.36	0.11	0.09	0.03
		Truck	1		34	8	272	8	74%	2.6	0.81	0.36	0.11	0.09	0.03
	Foundation	Excavators	1	2024	90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
		Trencher	1		90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
		Concrete Mixer[1]	1		90	8	720	8	74%	--	--	--	--	--	--
		Roller	1		90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
	Pipeline Installation	Welding Machine	3	2024	90	8	2,160	24	74%	2.6	0.81	2.9	0.87	0.74	0.23
		Forklift[1]	2		90	8	1,440	16	74%	--	--	--	--	--	--
		Truck	2		90	8	1,440	16	74%	2.6	0.81	1.9	0.58	0.50	0.15
	Mechanical/Electrical Installation	Man Lift[1]	1	2024	48	8	384	8	74%	--	--	--	--	--	--
		120T Crane[1]	1		48	8	384	8	74%	--	--	--	--	--	--
		Man Lift[1]	1	2025	42	8	336	8	74%	--	--	--	--	--	--
		120T Crane[1]	1		42	8	336	8	74%	--	--	--	--	--	--
Phase 2	Rock Crushing	Rock Crusher	1	2025	40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Rock Screen	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
	Grade Site	Excavators	2	2025	40	8	640	16	74%	2.6	0.81	0.85	0.26	0.22	0.07
		Roller	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Compactor	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Tractors/Loaders/Backhoes	3		40	8	960	24	74%	2.6	0.81	1.3	0.39	0.33	0.10
		Graders	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
		Truck	1		40	8	320	8	74%	2.6	0.81	0.42	0.13	0.11	0.03
	Foundation	Excavators	1	2025	90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
		Trencher	1		90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
		Concrete Mixer[1]	1		90	8	720	8	74%	--	--	--	--	--	--
		Roller	1		90	8	720	8	74%	2.6	0.81	1.0	0.29	0.25	0.08
	Pipeline Installation	Welding Machine	3	2025	48	8	1,152	24	74%	2.6	0.81	1.5	0.47	0.40	0.12
		Forklift[1]	2		48	8	768	16	74%	--	--	--	--	--	--
		Truck	2		48	8	768	16	74%	2.6	0.81	1.0	0.31	0.26	0.08
		Welding Machine	3	2026	42	8	1,008	24	74%	2.6	0.81	1.3	0.41	0.35	0.11
		Forklift[1]	2		42	8	672	16	74%	--	--	--	--	--	--
		Truck	2		42	8	672	16	74%	2.6	0.81	0.89	0.27	0.23	0.07
	Mechanical/Electrical Installation	Man Lift[1]	1	2026	87	8	696	8	74%	--	--	--	--	--	--
		120T Crane[1]	1		87	8	696	8	74%	--	--	--	--	--	--
2023 Emissions (tpy)												2.7	0.82	0.70	0.21
2024 Emissions (tpy)												11	3.3	2.8	0.86
2025 Emissions (tpy)												10	3.1	2.6	0.80
2026 Emissions (tpy)												2.2	0.68	0.58	0.18

Notes:

1. Portable crane, lifts, and concrete mixer are assumed to have no fugitive emissions, as they are either portable sources that would be towed when moved, travel at such a low speed that no emissions would be generated, or are stationary. Thus, emissions would either be accounted for in the vehicle that transports the equipment, or are de minimis.
2. Equipment quantity, operating hours per day, and operating days per year for Phase 1 were provided by the Project Developer in the lifecycle greenhouse gas analysis submitted to the Public Utilities Commission (PUC) under Docket 2019-0333 for the Amended and Restated Power Purchase Agreement (ARPPA) between HELCO and PGV. Phase 2 conservatively assumes the same equipment information as Phase 1 (except for Removal of Existing Equipment, which is expected to be completed in Phase 1).
3. Moisture content assumed to be equal to the most conservative moisture content (19%) according to Yamamoto et al. (1963). Silt content assumed to be 30%, consistent with default from the Mojave Desert Air Quality Management District (MDAQMD) guidance.
4. Fugitive dust emission factors for off-road equipment were calculated using Mojave Desert Air Quality Management District (MDAQMD) Bulldozing, Scraping and Grading of Materials "most complex" methodology from the Emissions Inventory Guidance for Mineral Handling and Processing Industries document Section VI.D.
5. According to Hawaii Administrative Rules (HAR) § 11-60.1-33, watering is one of the recommended mitigation measures during construction to minimize dust generation. Construction activities for PGV assume a 74% control efficiency, consistent with California Emissions Estimator Model (CalEEMod) guidance assuming watering three times per day.

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix C. Available at: https://www.caleemod.com/documents/user-guide/04_Appendix%20C.pdf.

Hawaii Public Utilities Commission (PUC). 2019. Docket 2019-0333. Application for Approval on an Amended and Restated Power Purchase Agreement between Hawaii Electric Light Company, Inc. and Puna Geothermal Venture. Available at: https://dms.puc.hawaii.gov/dms/dockets?action=details&docketNumber=2019-0333.

Hawaii State Department of Health, Hawaii Administrative Rules § 11-60.1-33. 2011. Available at: https://health.hawaii.gov/cab/files/2014/06/har_11-60_1.pdf.

Mojave Desert Air Quality Management District (MDAQMD). 1999. Emissions Inventory Guidance Mineral Handling and Processing Industries. Available at: http://www.mdaqmd.ca.gov/home/showdocument?id=768.

Tamamoto et al. 1963. Soil Moisture Constants and Physical Properties of Selected Soils in Hawaii. Available at: https://www.fs.usda.gov/psw/publications/documents/psw_rp002/psw_rp002.pdf.

Table A-5
Fugitive Dust - Construction Paved Roads
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase	Construction Activity	Year	Paved Road Silt Loading[1] (g/m^2)	Average Vehicle Weight[2] (tons)	Number of Days with >0.01 Inches Precipitation[3] (day/yr)	Uncontrolled PM_{10} Emission Factor[4] (lb/VMT)	Uncontrolled $PM_{2.5}$ Emission Factor[4] (lb/VMT)	Trip Distance[5] (miles)	Number of Trips per Day[5]	Number of Trips per Year	Control Efficiency[6] (%)	Uncontrolled Emissions		Controlled Emissions[6]	
												Annual PM_{10} Emissions (tpy)	**Annual $PM_{2.5}$ Emissions (tpy)**	**Annual PM_{10} Emissions (tpy)**	**Annual $PM_{2.5}$ Emissions (tpy)**
Phase 1	Removal of Existing Equipment	2023	0.4	2.4	182.6	0.0020	5.0E-04	10	15	300	0%	0.0031	7.5E-04	0.0031	7.5E-04
	Rock Crushing	2023						10	5	200	0%	0.0020	5.0E-04	0.0020	5.0E-04
	Grade Site	2023						10	23	113	0%	0.0011	2.8E-04	0.0011	2.8E-04
	Grade Site	2024						10	23	788	0%	0.0080	0.0020	0.0080	0.0020
	Foundation	2024						10	10	900	0%	0.0092	0.0023	0.0092	0.0023
	Pipeline Installation	2024						10	18	1,575	0%	0.016	0.0039	0.016	0.0039
	Mechanical/Electrical Installation	2024						10	5	235	0%	0.0024	5.9E-04	0.0024	5.9E-04
	Mechanical/Electrical Installation	2025						10	5	215	0%	0.0022	5.4E-04	0.0022	5.4E-04
Phase 2	Rock Crushing	2025						10	5	200	0%	0.0020	5.0E-04	0.0020	5.0E-04
	Grade Site	2025						10	23	900	0%	0.0092	0.0023	0.0092	0.0023
	Foundation	2025						10	10	900	0%	0.0092	0.0023	0.0092	0.0023
	Pipeline Installation	2025						10	18	840	0%	0.0086	0.0021	0.0086	0.0021
	Pipeline Installation	2026						10	18	735	0%	0.0075	0.0018	0.0075	0.0018
	Mechanical/Electrical Installation	2026						10	5	435	0%	0.0044	0.0011	0.0044	0.0011
2023 Total Emissions (tpy)												**0.0063**	**0.0015**	**0.0063**	**0.0015**
2024 Total Emissions (tpy)												**0.036**	**0.0088**	**0.036**	**0.0088**
2025 Total Emissions (tpy)												**0.031**	**0.0077**	**0.031**	**0.0077**
2026 Total Emissions (tpy)												**0.012**	**0.0029**	**0.012**	**0.0029**

Notes:

1. Paved road silt loading estimate is based on Mojave Desert Air Quality Management District (MDAQMD) guidance for low traffic roads.
2. Average on-road vehicle weight assumed to be 2.4 tons consistent with California Emissions Estimator Model (CalEEMod) default average vehicle weight for paved roads.
3. Number of days with greater than 0.01 inches precipitation per year based on meteorological data collected at Hawaii County, Hawaii (https://www.bestplaces.net/climate/county/hawaii/hawaii).
4. Paved road fugitive dust emission factors were calculated based on guidance from U.S. EPA AP-42, Section 13.2.1 paved roads methodology and account for reduction in emissions due to precipitation.
5. Only worker trips are included because there are no vendor or haul trips associated with this Project. The worker trip length and trip rates were provided by the Project Developer in the lifecycle greenhouse gas analysis submitted to the Public Utilities Commission (PUC) under Docket 2019-0333 for the Amended and Restated Power Purchase Agreement (ARPPA) between HELCO and PGV.
6. All paved roads considered in this analysis are public roadways. Thus, it is assumed that no fugitive dust controls are applied, as Hawaii County would be unable to verify or mandate controls.

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix G. Available at: https://www.caleemod.com/documents/user-guide/08_Appendix%20G.xlsx
U.S. Environmental Protection Agency (EPA). 2011. AP-42, Section 13.2.1, Paved Roads. Available at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0201.pdf.

Hawaii Public Utilities Commission (PUC). 2019. Docket 2019-0333. Application for Approval on an Amended and Restated Power Purchase Agreement between Hawaii Electric Light Company, Inc. and Puna Geothermal Venture. Available at: https://dms.puc.hawaii.gov/dms/dockets?action=details&docketNumber=2019-0333.

Mojave Desert Air Quality Management District (MDAQMD). 1999. Emissions Inventory Guidance Section VI.L. Wind Erosion from Unpaved Operational Areas and Roads. Available at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Table A-6
Fugitive Dust - Operational Paved Roads
Puna Geothermal Venture (PGV)
Pāhoa, HI

Activity Description[1]	Paved Road Silt Loading[2] (g/m^2)	Average Vehicle Weight[3] (tons)	Number of Days with >0.01 Inches Precipitation[4] (day/yr)	Uncontrolled PM_{10} Emission Factor[5] (lb/VMT)	Uncontrolled $PM_{2.5}$ Emission Factor[5] (lb/VMT)	Trip Distance (miles)[6]	Number of One-way Trips per Year[7]	Control Efficiency[8] (%)	Uncontrolled Emissions: Annual PM_{10} Emissions (tpy)	Uncontrolled Emissions: Annual $PM_{2.5}$ Emissions (tpy)	Controlled Emissions[8]: Annual PM_{10} Emissions (tpy)	Controlled Emissions[8]: Annual $PM_{2.5}$ Emissions (tpy)
Worker Commute	0.4	2.4	183	0.0020	5.0E-04	10	16,120	0%	0.16	0.040	0.16	0.040
Maintenance Truck Trips	0.4	2.4	183	0.0020	5.0E-04	10	8	0%	8.2E-05	2.0E-05	8.2E-05	2.0E-05
								Total Emissions	**0.16**	**0.040**	**0.16**	**0.040**

Notes:

1. Emissions for public paved road fugitive dust generation from vehicle trips from/to the facility.
2. Paved road silt loading estimate is based on Mojave Desert Air Quality Management District (MDAQMD) guidance for low traffic roads.
3. Average on-road vehicle weight assumed to be 2.4 tons consistent with California Emissions Estimator Model (CalEEMod) default average vehicle weight for paved roads.
4. Number of days with greater than 0.01 inches precipitation per year based on meteorological data collected at Hawaii County, Hawaii (https://www.bestplaces.net/climate/county/hawaii/hawaii).
5. Paved road fugitive dust emission factors were calculated based on guidance from U.S. EPA AP-42, Section 13.2.1 paved roads methodology and account for reduction in emissions due to precipitation.
6. Worker commute and maintenance truck trip distance to and from the facility is assumed to be 10 miles/trip, as provided by the Project Developer.
7. Annual Truck Trips assume a quarterly truck trip required per year for maintenance purposes. Annual Worker Trips assume employees are commuting to the site 5 days per week, 52 weeks per year (round trips). This analysis is based on a workforce of 31 employees, as specified in the Environmental Impact Statement Preparation Notice (EISPN) for the proposed Project.
8. All paved roads considered in this analysis are public roadways. Thus, it is assumed that no fugitive dust controls are applied.

References:

California Emissions Estimator Model (CalEEMod®) v2022.1 Appendix G. Available at: https://www.caleemod.com/documents/user-guide/08_Appendix%20G.xlsx

U.S. Environmental Protection Agency (USEPA). 2011. AP-42, Section 13.2.1, Paved Roads. Available at: https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0201.pdf.

Mojave Desert Air Quality Management District (MDAQMD). 1999. Emissions Inventory Guidance Section VI.L. Wind Erosion from Unpaved Operational Areas and Roads. Available at: http://www.mdaqmd.ca.gov/home/showdocument?id=768

Table A-7
Uncontrolled Construction Emissions
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase	Subphase	Construction Activity	Year	Source	CAP Emissions[1]						**GHG Emissions**[2]
					ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
					ROG	NOx	CO	SO2	PM10	PM2.5	CO2e
					lb/yr						MT/yr
Phase 1	Removal of existing equipment	Removal of existing equipment	2023	On-Site Exhaust	4.9	91	31	0.32	5.8	5.6	55
				Mobile Exhaust	1.8	1.7	28	0.018	0.039	0.034	1.2
				Roadway Dust	--	--	--	--	2,547	778	--
	Site Development	Rock Crushing	2023	On-Site Exhaust	3.9	82	22	0.12	4.3	4.2	20
				Mobile Exhaust	1.2	1.1	19	0.012	0.026	0.023	0.82
				Roadway Dust	--	--	--	--	1,698	519	--
		Grade Site	2023	On-Site Exhaust	4.4	48	27	0.11	4.1	4.0	19
				Mobile Exhaust	0.81	0.75	13	0.0081	0.017	0.015	0.56
				Roadway Dust	--	--	--	--	1,146	350	--
			2024	On-Site Exhaust	20	232	122	0.61	19	18	105
				Mobile Exhaust	4.2	3.6	69	0.045	0.10	0.086	3.1
				Roadway Dust	--	--	--	--	6,495	1,983	--
	Power Plant Construction	Foundation	2024	On-Site Exhaust	14	274	109	0.47	17	16	80
				Mobile Exhaust	5.0	4.2	81	0.053	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	5,735	1,751	--
		Pipeline Installation	2024	On-Site Exhaust	31	447	134	1.4	23	23	247
				Mobile Exhaust	8.7	7.4	141	0.092	0.20	0.18	6.3
				Roadway Dust	--	--	--	--	9,560	2,919	--
		Mechanical/Electrical Installation	2024	On-Site Exhaust	8.8	81	39	0.15	5.6	5.4	24
				Mobile Exhaust	1.3	1.1	22	0.014	0.031	0.027	1.0
				Roadway Dust	--	--	--	--	5.0	1.2	--
			2025	On-Site Exhaust	6.7	62	30	0.13	4.2	4.1	21
				Mobile Exhaust	1.1	0.87	18	0.012	0.026	0.023	0.83
				Roadway Dust	--	--	--	--	4.6	1.1	--
Phase 2	Site Development	Rock Crushing	2025	On-Site Exhaust	2.6	62	15	0.12	3.0	2.9	20
				Mobile Exhaust	1.0	0.83	17	0.011	0.025	0.022	0.79
				Roadway Dust	--	--	--	--	1,698	519	--
		Grade Site	2025	On-Site Exhaust	19	236	113	0.72	18	17	124
				Mobile Exhaust	4.7	3.7	76	0.052	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	7,640	2,333	--
	Power Plant Construction	Foundation	2025	On-Site Exhaust	13	251	95	0.46	15	14	80
				Mobile Exhaust	4.7	3.7	76	0.052	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	5,735	1,751	--
		Pipeline Installation	2025	On-Site Exhaust	14	220	58	0.76	10	10	132
				Mobile Exhaust	4.4	3.5	71	0.048	0.10	0.092	3.3
				Roadway Dust	--	--	--	--	5,099	1,557	--
			2026	On-Site Exhaust	11	183	43	0.66	7.4	7.2	115
				Mobile Exhaust	3.4	2.5	58	0.041	0.089	0.079	2.8
				Roadway Dust	--	--	--	--	4,461	1,362	--
		Mechanical/Electrical Installation	2026	On-Site Exhaust	12	114	55	0.26	7.5	7.3	44
				Mobile Exhaust	2.0	1.5	34	0.024	0.053	0.047	1.7
				Roadway Dust	--	--	--	--	9.2	2.2	--

Table A-7
Uncontrolled Construction Emissions
Puna Geothermal Venture (PGV)
Pāhoa, HI

Uncontrolled Construction Emissions by Year

Year	Uncontrolled Construction CAP Emissions						**Uncontrolled Construction GHG** Emissions
	ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
	lb/yr						MT/yr
2023	17	224	140	0.58	5,405	1,660	96
2024	93	1,050	716	2.9	21,860	6,718	470
2025	71	844	570	2.4	20,227	6,209	388
2026	29	301	190	1.0	4,486	1,379	164
Phase 1 Total	118	1,336	904	3.6	27,273	8,383	588
Phase 2 Total	92	1,083	712	3.2	24,703	7,583	530
Total Construction Emissions	210	2,419	1,616	6.8	51,977	15,966	1,118

Year	Uncontrolled Construction CAP Emissions						**Uncontrolled Construction GHG** Emissions
	ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
	tpy						MT/yr
2023	0.0085	0.11	0.070	2.9E-04	2.7	0.83	96
2024	0.047	0.52	0.36	0.0014	11	3.4	470
2025	0.036	0.42	0.28	0.0012	10	3.1	388
2026	0.014	0.15	0.095	4.9E-04	2.2	0.69	164
Phase 1 Total	0.059	0.67	0.45	0.0018	14	4.2	588
Phase 2 Total	0.046	0.54	0.36	0.0016	12	3.8	530
Total Construction Emissions	0.11	1.2	0.81	0.0034	26	8.0	1,118

Notes:

[1.] Construction emissions were estimated with US EPA's Motor Vehicle Emission Simulator (MOVES) Emissions Estimator Model version 3.1. On-Site Exhaust represents emissions from off-road equipment, including onsite truck use, while mobile exhaust includes emissions from workers travelling to and from the project site. For PM, the construction emissions of fugitive dust include the off-road equipment fugitive dust, entrained roadway dust and tire/brake wear from construction vehicles.

[2.] Greenhouse gas emissions from carbon dioxide equivalent (CO_2e) were determined using IPCC 6th Assessment Report Global Warming Potentials for CH_4 and N_2O.

Abbreviations:

CAP - Criteria Air Pollutants
CO - carbon monoxide
CO_2e - carbon dioxide equivalent
EPA- Environmental Protection Agency
GHG - greenhouse gas
IPCC - Intergovernmental Panel on Climate Change
lb - pounds
MOVES - Motor Vehicle Emission Simulator
MT - metric ton
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM_{10} - particulate matter less than 10 microns
$PM_{2.5}$ - particulate matter less than 2.5 microns
ROG - reactive organic gas
SO_2 - sulfur dioxide
tpy - U.S. tons per year

References:

U.S. Environmental Protection Agency (USEPA). 2020. Motor Vehicle Emission Simulator: MOVES3. Office of Transportation and Air Quality. US Environmental Protection Agency. Ann Arbor, MI. Available at: https://www.epa.gov/moves.

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.

Table A-8
Controlled Construction Emissions
Puna Geothermal Venture (PGV)
Pāhoa, HI

Phase	Subphase	Construction Activity	Year	Source	CAP Emissions[1]						**GHG Emissions**[2]
					ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
					ROG	NOx	CO	SO2	PM10	PM2.5	CO2e
					lb/yr						MT/yr
Phase 1	Removal of existing equipment	Removal of existing equipment	2023	On-Site Exhaust	4.9	91	31	0.32	5.8	5.6	55
				Mobile Exhaust	1.8	1.7	28	0.018	0.039	0.034	1.2
				Roadway Dust	--	--	--	--	667	203	--
	Site Development	Rock Crushing		On-Site Exhaust	3.9	82	22	0.12	4.3	4.2	20
				Mobile Exhaust	1.2	1.1	19	0.012	0.026	0.023	0.82
				Roadway Dust	--	--	--	--	445	136	--
		Grade Site		On-Site Exhaust	4.4	48	27	0.11	4.1	4.0	19
				Mobile Exhaust	0.81	0.75	13	0.0081	0.017	0.015	0.56
				Roadway Dust	--	--	--	--	300	91	--
				Total 2023	17	224	140	0.58	**1,425**	444	96
			2024	On-Site Exhaust	20	232	122	0.61	19	18	105
				Mobile Exhaust	4.2	3.6	69	0.045	0.10	0.086	3.1
				Roadway Dust	--	--	--	--	1,701	519	--
	Power Plant Construction	Foundation		On-Site Exhaust	14	274	109	0.47	17	16	80
				Mobile Exhaust	5.0	4.2	81	0.053	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	1,505	459	--
		Pipeline Installation		On-Site Exhaust	31	447	134	1.4	23	23	247
				Mobile Exhaust	8.7	7.4	141	0.092	0.20	0.18	6.3
				Roadway Dust	--	--	--	--	2,510	765	--
		Mechanical/Electrical Installation		On-Site Exhaust	8.8	81	39	0.15	5.6	5.4	24
				Mobile Exhaust	1.3	1.1	22	0.014	0.031	0.027	1.0
				Roadway Dust	--	--	--	--	5.0	1.2	--
				Total 2024	93	**1,050**	716	2.9	**5,787**	**1,806**	470
			2025	On-Site Exhaust	6.7	62	30	0.13	4.2	4.1	21
				Mobile Exhaust	1.1	0.87	18	0.012	0.026	0.023	0.83
				Roadway Dust	--	--	--	--	4.6	1.1	--
				Total 2025	7.7	62	48	0.14	8.8	5.2	22
				Phase 1 Total	118	**1,336**	904	3.6	**7,221**	**2,256**	588
Phase 2	Site Development	Rock Crushing	2025	On-Site Exhaust	2.6	62	15	0.12	3.0	2.9	20
				Mobile Exhaust	1.0	0.83	17	0.011	0.025	0.022	0.79
				Roadway Dust	--	--	--	--	445	136	--
		Grade Site		On-Site Exhaust	19	236	113	0.72	18	17	124
				Mobile Exhaust	4.7	3.7	76	0.052	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	2,001	610	--
	Power Plant Construction	Foundation		On-Site Exhaust	13	251	95	0.46	15	14	80
				Mobile Exhaust	4.7	3.7	76	0.052	0.11	0.10	3.6
				Roadway Dust	--	--	--	--	1,505	459	--
		Pipeline Installation		On-Site Exhaust	14	220	58	0.76	10	10	132
				Mobile Exhaust	4.4	3.5	71	0.048	0.10	0.092	3.3
				Roadway Dust	--	--	--	--	1,339	408	--
				Total 2026	63	782	522	2.2	**5,335**	**1,657**	366
			2026	On-Site Exhaust	11	183	43	0.66	7.4	7.2	115
				Mobile Exhaust	3.4	2.5	58	0.041	0.089	0.079	2.8
				Roadway Dust	--	--	--	--	1,172	357	--
		Mechanical/Electrical Installation		On-Site Exhaust	12	114	55	0.26	7.5	7.3	44
				Mobile Exhaust	2.0	1.5	34	0.024	0.053	0.047	1.7
				Roadway Dust	--	--	--	--	9.2	2.2	--
				Phase 2 Total	92	**1,083**	712	3.2	**6,531**	**2,030**	530

Table A-8
Controlled Construction Emissions
Puna Geothermal Venture (PGV)
Pāhoa, HI

Mitigated Construction Emissions by Year

Year	Controlled Construction CAP Emissions						**Controlled Construction GHG** Emissions
	ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
	lb/yr						MT/yr
2023	17	224	140	0.58	1,425	444	96
2024	93	1,050	716	2.9	5,787	1,806	470
2025	71	844	570	2.4	5,344	1,662	388
2026	29	301	190	1.0	1,196	374	164
Phase 1 Total	118	1,336	904	3.6	7,221	2,256	588
Phase 2 Total	92	1,083	712	3.2	6,531	2,030	530
Total Construction Emissions	210	2,419	1,616	6.8	13,752	4,286	1,118

Year	Controlled Construction CAP Emissions						**Controlled Construction GHG** Emissions
	ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2e
	ton/yr						MT/yr
2023	0.0085	0.11	0.070	2.9E-04	0.71	0.22	96
2024	0.047	0.52	0.36	0.0014	2.9	0.90	470
2025	0.036	0.42	0.28	0.0012	2.7	0.83	388
2026	0.014	0.15	0.095	4.9E-04	0.60	0.19	164
Phase 1 Total	0.059	0.67	0.45	0.0018	3.6	1.1	588
Phase 2 Total	0.046	0.54	0.36	0.0016	3.3	1.0	530
Total Construction Emissions	0.11	1.2	0.81	0.0034	6.9	2.1	1,118

Notes:

1. Construction emissions were estimated with US EPA's Motor Vehicle Emission Simulator (MOVES) Emissions Estimator Model version 3.1. On-Site Exhaust represents emissions from off-road equipment, including onsite truck use, while mobile exhaust includes emissions from workers travelling to and from the project site. For PM, the construction emissions of fugitive dust include the entrained roadway dust and tire/brake wear from construction vehicles. Control measures only apply to fugitive dust including watering three times daily during construction.

2. Greenhouse gas emissions from carbon dioxide equivalent (CO_2e) were determined using IPCC 6th Assessment Report Global Warming Potentials for CH_4 and N_2O.

Abbreviations:

CAP - Criteria Air Pollutants
CO - carbon monoxide
CO_2e - carbon dioxide equivalent
EPA- Environmental Protection Agency
GHG - greenhouse gas
IPCC - Intergovernmental Panel on Climate Change
lb - pounds
MOVES - Motor Vehicle Emission Simulator
MT - metric ton
NO_x - nitrogen oxides
N_2O - nitrous oxide
PM_{10} - particulate matter less than 10 microns
$PM_{2.5}$ - particulate matter less than 2.5 microns
ROG - reactive organic gas
SO_2 - sulfur dioxide
tpy - U.S. tons per year

References:

U.S. Environmental Protection Agency (USEPA). 2020. Motor Vehicle Emission Simulator: MOVES3. Office of Transportation and Air Quality. US Environmental Protection Agency. Ann Arbor, MI. Available at: https://www.epa.gov/moves.

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.

Table A-9
Controlled Operational Emissions
Puna Geothermal Venture (PGV)
Pāhoa, HI

Activity Description[1]	Source	Operational CAP Emissions[1,2]								Operational GHG Emissions[4]
		ROG	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$	n-Pentane[3]	H_2S	CO_2e
		lb/yr								MT/yr
Worker Commute	Mobile Exhaust	74	54	1,263	0.91	2.0	1.7	--	--	62
	Roadway Dust	--	--	--	--	13	1.8	--	--	--
Maintenance Truck Trips	Mobile Exhaust	0.025	0.19	0.24	3.2E-04	0.0081	0.0075	--	--	0.043
	Roadway Dust	--	--	--	--	0.0083	0.0011	--	--	--
Power Plant[3]	Vapor Recovery Maintenance Unit (VRMU)	--	--	--	--	--	--	54,750	--	--
	Vapor Recovery Unit (VRU)	--	--	--	--	--	--	54,750	--	--
	Sulfa-Treat System	--	--	--	--	--	--	--	50	--
	Total Emissions	**74**	**54**	**1,263**	**0.91**	**15**	**3.5**	**109,500**	**50**	**62**

Notes:

1. Operational mobile emissions were estimated with US EPA's Motor Vehicle Emission Simulator (MOVES) Emissions Estimator Model version 3.1. Operational sources include workers travelling to and from the project site and quarterly maintenance truck trips. For PM, the operational emissions of fugitive dust include the entrained roadway dust and tire/brake wear from operational vehicles.
2. The mitigated and unmitigated scenarios for operational emissions are the same because no control measures are applied for fugitive dust emissions and the power plant emissions were supplied in the 2014 Noncovered Source Permit (No. 0008-02-N) Request for Renewal and Modification Application and are estimated post-control.
3. Power Plant emissions from VRMU, VRU and Sulfa-Treat System were obtained from PGV Renewal and Modification Permit Application NSP Nos. 0008-13-N and 0008-02-N. Pentane emissions are assumed to be equally distributed between the VRU and VRMU, which is consistent with NSP No. 0008-02-N.
4. Greenhouse gas emissions from carbon dioxide equivalent (CO_2e) were determined using IPCC 6th Assessment Report Global Warming Potentials for CH_4 and N_2O.

Abbreviations:

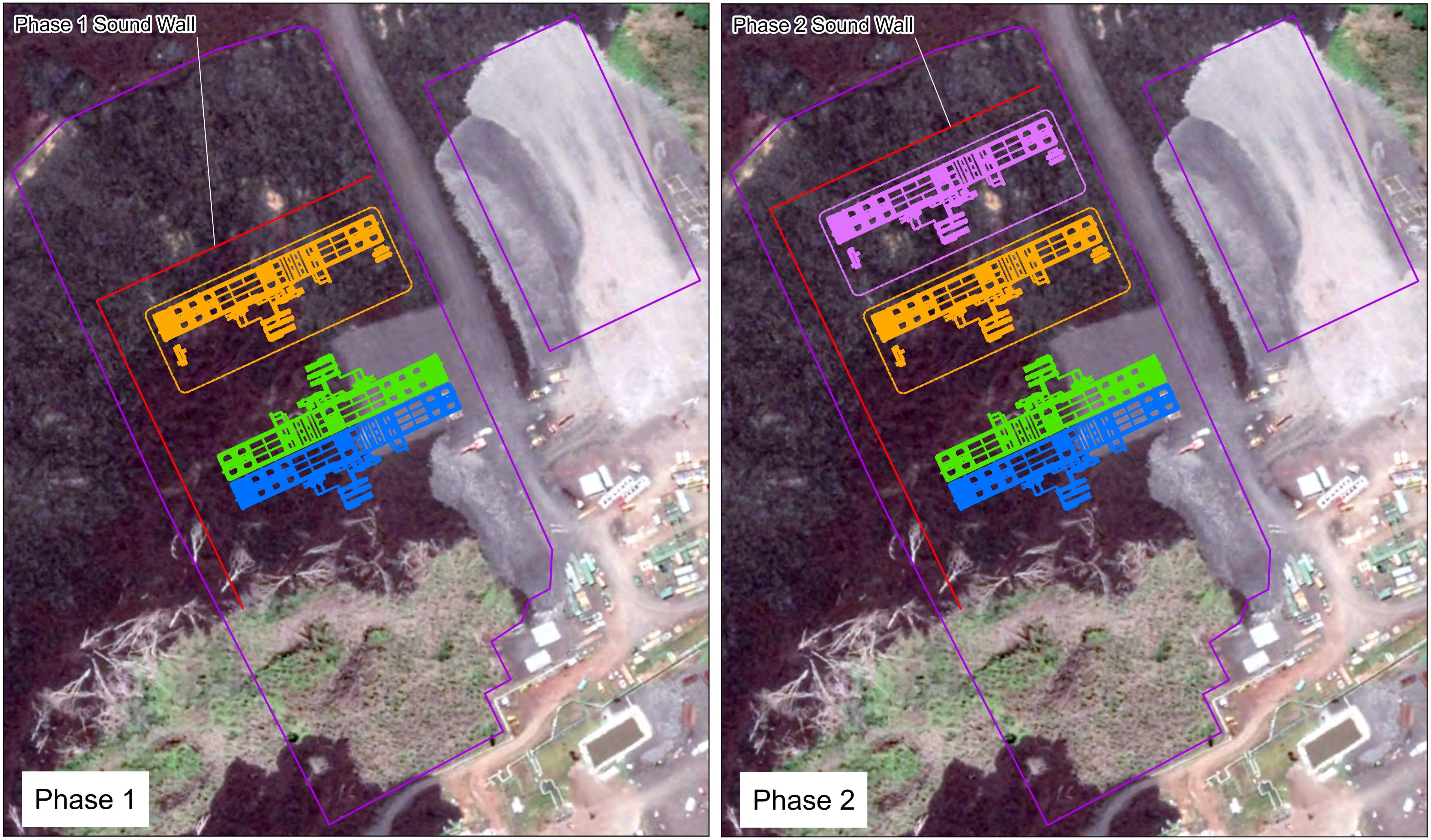
CAP - Criteria Air Pollutants
CH_4 - methane
CO - carbon monoxide
CO2e - carbon dioxide equivalent
EPA- Environmental Protection Agency
GHG - greenhouse gas
H_2S - hydrogen sulfide
IPCC - Intergovernmental Panel on Climate Change
lb - pounds
MOVES - Motor Vehicle Emission Simulator
MT - metric ton
NOx - nitrogen oxides
N_2O - nitrous oxide
PM - Particulate Matter
ROG - reactive organic gas
SO_2 - sulfur dioxide

References:

U.S. Environmental Protection Agency (USEPA). 2020. Motor Vehicle Emission Simulator: MOVES3. Office of Transportation and Air Quality. US Environmental Protection Agency. Ann Arbor, MI. Available at: https://www.epa.gov/moves.

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.

FIGURE



Legend

- Proposed Disturbance Area
- OEC 41
- OEC 42
- OEC 43
- OEC 44
- Sound Wall

N

Stantec

0 125 250 Feet

1 in = 250 feet

Hawaii County, HI
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

DRAWN BY: BT	1ST REVIEW: JT	2ND REVIEW: ML
DATE: 2022-11-08	PROJECT NO: 185805496	

PUNA GEOTHERMAL VENTURE
GEOTHERMAL REPOWER PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Figure 1
Proposed Project

V:\2037\Active\185805496_Puna_EIS\03_data\gis_cad\gis\proj\Puna_EIS_20220502\Puna_EIS_20220509.aprx Revised: 2022-11-08 By: jtrook

Service Layer Credits: World Imagery: Resource Mapping Hawaii
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

APPENDIX F

NOISE IMPACT ANALYSIS

Y. Ebisu & Associates
Acoustical and Electronic Engineers

1126 12th Ave., Room 305
Honolulu, Hawaii 96816
Ph. (808) 735-1634
email: ebisuyassoc@aol.com

YEA Job #60.037
February 1, 2023

Puna Geothermal Venture
P.O. Box 30
Pahoa Hawaii 96778

Attention: Mr. Michael L. Kaleikini
Senior Director, Hawai'i Affairs

Subject: Results of Acoustical Impact Assessment of Proposed Repower Project At Puna Geothermal Venture Generating Station

Dear Mr. Kaleikini:

Purpose. The Puna Geothermal Venture (PGV) Generating Station in Pahoa, Hawaii is planning to upgrade its power generating equipment through replacement of its current 12 operating power-generating units with up to 4 new energy converters located where shown in Figure 1. This acoustical study was performed to predict potential future noise levels from these new energy converters following the Repower Project, and evaluate potential noise impacts associated with those predicted noise levels.

Baseline Background Noise Levels. Baseline background noise levels without the plant in operation were obtained in June 2019 following the 2018 Lower Puna eruption when the plant was not operating. These Baseline background noise levels with the PGV plant quiet were obtained at locations identified in the June 26, 2019 letter report by Y. Ebisu & Associates, and were used to characterize the residual Baseline background noise levels in the entire area surrounding the PGV plant during conditions with only the natural sounds of birds, insects, foliage, and coqui frogs being present. These residual background noise levels were very low and typically below 40 dBA, except during the nighttime when insects and coqui frogs raise the nighttime A-Weighted, and high frequency background noise levels. Low and middle frequency background noise levels are not affected by the sounds of coqui frogs and insects. Table 1 presents the results of these residual background noise levels in the form of A-Weighted sound levels at locations which were not affected by the 2018 eruption and where shown in Figure 2. Measured baseline A-Weighted and Octave Band spectrums of daytime and nighttime background noise levels at these locations with the existing plant off are shown in Figures 3 through 7. Where nighttime measurements included the high frequency sounds of coqui frogs and insects, the A-Weight and Octave Band contributions were eliminated (or parsed) as shown in the figures, to provide estimates of the lowest potential baseline background noise levels without the influence of insects and coqui frogs.

Residual background noise levels during the operation of the existing 30 MW plant in December 2010 and during June 2011 with both the 30 MW and 8 MW plants in operation were also obtained, and the data with both plants operating were used to characterize current background noise levels with the existing power generating plants in operation. These measurements are shown in Tables 2 and 3, and include measurements at community locations which were affected by the 2018 eruption so as to include a broader data base of existing community background noise levels. Residual background noise levels as represented by the Lmin (minimum sound level) and L90 (sound levels exceeded 90 percent of the time) values in the tables are indicative of probable power plant noise levels, particularly where indicated in the tables that the plant was possibly audible at those locations. The Lmax (maximum sound level), Leq (average sound level), and L10 (sound level exceeded 10 percent of the time) values in the tables are probably more attributable to other non-plant noise sources, particularly when the plant was not audible.

At existing residences east of the PGV facility, noise shielding effects behind and/or downslope of Puu Honuaula have resulted in generally lower plant noise levels along the east plant boundary than along the south plant boundary, with existing background noise levels between 40 to 50 dBA. Low frequency noise from the 30 MW plant is present along the east plant boundary at these residences, but mid and high frequency plant noise are not present at these east locations. Residual background noise levels at locations east of the plant are shown in Table 1 and Figures 6 and 7. Background noise measurements obtained in May 2021 with the 30 MW plant operating at approximately 17.5 MW output ranged from 34 to 47 dBA at Sites M1, M, and N, with low frequency plant noise audible at these locations.

At former residences near the south boundary of the PGV plant (Sites 1 and 2), background noise levels were controlled by the PGV plant, and ranged between 45 to 55 dBA, with low frequency noise from the 30 MW plant and mid and high frequency noise from the 8 MW plant being the dominant plant noise sources, particularly during adverse meteorological conditions (northerly winds and with temperature inversion).

At former and existing residences of Leilani Estates to the west which tend to be upslope of the PGV plant, noise shielding effects from terrain features generally do not existing except at certain locations where localized depressions in ground features occur. Due the generally greater distances between residences of Leilani Estates and the existing PGV plant, existing PGV plant noise levels are less than 45 dBA. Because residual background noise levels are less than 40 dBA during the quieter periods, PGV plant noise may also be faintly audible at Leilani Estates. Similar background noise conditions are believed to exist in areas north of the PGV plant which are upslope of the plant. In areas south of the PGV plant, similar background noise conditions may occur primarily during meteorological conditions (downwind sound propagation and thermal inversion) which tend to increase PGV plant noise levels to worse case plant noise levels.

Prior to the 2018 Lower Puna eruption, residences along the south plant boundary experienced the highest plant noise levels, which did not exceed 57 dBA. Overall, existing PGV plant noise levels following the 2018 Lower Puna eruption at current neighboring residences are well below the Not-To-Exceed 57 dBA limit of the Hawaii County Geothermal Resource Permit. The ideal long term goal of not exceeding 55 dBA during the daytime at residences outside the station are also being achieved following full operation of the existing plant at 38 MW. The presence of coqui frog and insect noise during the nighttime has complicated the identification and verification of a nighttime noise limit for plant noise sources, but a level less than 45 to 50 dBA may be possible.

Predictions of Planned 60 MW PGV Plant With Proposed Repower Project. The proposed Repower Project at the PGV power generating station is anticipated to ultimately replace the existing 30 MW and 8 MW power plants with at group of four 15.3 MW modules which are co-located west of the 30 MW plant and on the 2018 lava flow where shown in Figure 1. Phase 1 of the project will consist of the three, southernmost 15.3 MW modules, and Phase 2 of the project will include the fourth northernmost 15.3 MW module (see Figures 7 and 8). The equipment planned to be used at PGV are similar to those previously used on the mainland (McGuinness Hills Phase III Geothermal Plant) project, except that the total number of cooling fans required at PGV will be much lower. Past noise measurements obtained on the mainland by the Saxelby Acoustics consulting firm, after downward adjustments for the lower number of PGV cooling fans, were used to predict the anticipated plant noise levels at the PGV station. As indicated in Figures 1 and 9, the proposed 60 MW PGV plant configuration will consist of 4 each, 15.3 MW power generating modules, with each module including a single turbine/generator unit, 4 each, 400 hp feedwater pumps, and 22 each, cooling fans. The turbine/generator unit, feedwater pumps, and cooling fans will be the primary noise sources of the future power plant, which will be similar to (but quieter than) the primary noise sources at the existing 38 MW power plant.

Within each 15.3 MW module, point noise sources were located and noise-modeled on the project site shown in Figure 1 for the 22 cooling fans, single 15.3 MW turbine generator, and 4 feedwater pumps. Identical point noise sources were grouped within each 15.3 MW module, with each module arranged and modeled as shown in Figure 8. The Third Octave Band Sound Power Levels of the various point sources in each 15.3 MW module and their assumed elevations are shown in Table 4. Figure 9 depicts the planned arrangement of the four 15.3 MW modules to form the

Phase 1 (46 MW) and Phase 2 (60 MW) versions of the Repower Plant. Predictions of the total noise level from the entire 60 MW plant were then made at various community locations where shown in Figure 2 and Table 5. All plant noise predictions are shown without the beneficial effects of attenuation from terrain obstruction features, and are considered to represent worst case predictions. As indicated in Table 5, the predictions at community locations and at the PGV on-site monitoring Stations PGV-A, PGV-B, and PGV-C, were compared to show the differences in plant noise levels between the existing 38 MW and planned 60 MW plants for unobstructed line-of-sight conditions without shielding effects from local terrain features. The values shown in Table 5 for unobstructed line-of-sight conditions should reflect worst case conditions with only distance and molecular absorption effects controlling the power plants' noise levels from the plant to the receptor locations.

As indicated in Table 5, predicted noise levels from the 60 MW plant should not exceed 44 dBA at existing noise sensitive receptors to the east, or 35 dBA at existing noise sensitive receptors to the west. Existing terrain shielding features to the east should normally provide approximately 17 to 19 dBA of noise shielding effects toward receptors to the east, except during adverse meteorological conditions of westerly winds and/or adverse thermal ducting effects which tend to occur during the early morning hours prior to sunrise. Reductions in power plant noise levels at community locations to the east are predicted to be between 12 to 14 dBA following the Repower Project, and between 0 to 2 dBA at Leilani Estates to the west. Increased sound attenuation due to distance effects resulting from the relocation of the power plant noise sources toward the west within the PGV property is the primary cause of the larger noise level reductions expected east of the plant. Reduced buffer distances to the east combined with the reduced Repower plant equipment noise levels are the cause of the near zero reduction in plant noise levels toward Leilani Estates to the west.

Comparisons of the predicted audio frequency content of the noise levels from the 60 MW plant with those of the existing 38 MW plant are shown in Figures 10 through 15 and key community locations west and east of the PGV facility. It should be noted that the background noise contributions from coqui frogs are limited to frequencies between 1,250 Hz and 3,150 Hz, while the background noise contributions from insects tend to be concentrated at 5,000 Hz. The dominating influence of coqui frogs and insects on the nighttime A-Weighted and high frequency background noise levels are shown in Figures 3 through 6. Eliminating (or parsing) these high frequency components result in dramatic reductions of the A-Weighted, nighttime background noise levels as shown in the figures. The contributions of plant noise in the surrounding communities will primarily be associated with low and mid frequency noise components as shown in Figures 10 through 15, which is a condition similar to the existing plant noise. Risks of exceedances of the residual background noise levels by the new

Repower Plant should be similar to existing conditions at Leilani Estates, and should be lower in the communities to the east. These conclusions were based on similarities of the audio frequency content of the existing and Repower Plant at Leilani Estates (see Figures 10 to 13), and the 10+ dB reduction in noise levels to the east with the Repower Plant (see Figures 14 and 15).

Compliance with Hawaii County Geothermal Resource Permit and Long Term Goals. The Not-To-Exceed 57 dBA limit of the Hawaii County Geothermal Resource Permit was not and is currently not being exceeded at residences outside the PGV Generating Station during the operation of the 38 MW power plant. A fixed noise monitoring station (Site A) had been located near the PGV south boundary (where risks of exceeding the 57 dBA limit were highest) prior to the 2018 Lower Puna eruption. As indicated in Table 5, at former Sites 1 and 2 near the south boundary, risks of exceeding 57 dBA will be greatly diminished with implementation of the Repower Plant project.

Table 5 also indicates a potential noise level of 57.2 dBA at the former West Gate of the PGV facility (in the vicinity of Site 12 where shown in Figure 2). Risks of exceeding the 57 dBA limit will increase at that location with implementation of the Repower Plant project. While noise mitigation measures should not be required along the west PGV facility boundary, an examination of the effectiveness of a sound attenuating wall located approximately 92 feet west of the 60 MW plant was performed to determine the possible benefits of such a wall at existing receptors at Leilani Estates.

Table 6 presents the results of calculations of plant noise attenuation at Sites 4A and 6 in Leilani Estates (see Figure 2), which are located approximately 5,000 to 6,000 feet, respectively, from the proposed Repower Plant. Predicted worst case plant noise levels at Sites 6 and 4A are 31.7 and 34.8 dBA (see Table 5), respectively, and well below the 57 dBA limit. Figures 10 and 11 compare existing and proposed plant noise levels, which indicate little or no change in plant noise levels. Figures 3 and 4 indicate residual background noise levels at both locations, which could possibly be less than the existing and worst case plant noise levels if the added noise contributions from coqui frogs and insects are eliminated. Because of all of these considerations plus the need to construct very tall and solid walls to achieve 7 to 11 dBA of plant noise reduction at these two locations (see Table 6), constructing a sound attenuation wall to provide noise shielding and attenuation at Leilani Estates was not considered to be reasonable. If the lands in the vicinity of the former West Gate of the PGV facility become developed with noise sensitive uses in the future, the use of a sound attenuating wall west of the Repower Plant should be reconsidered.

At existing community locations to the east (Sites M, M1, and N) which are at shorter distances (2,600 to 3,500 feet) from the Repower Plant (see Figure 2), predicted worst case plant noise levels are also well below 57 dBA (see Table 5). The noise shielding effects from the higher elevation terrain features of Puu Honuaula and lands east of the existing 30 MW plant have not been included in Table 5, but are estimated at being greater than 10 dBA when thermal ducting and westerly winds do not occur. Figures 14 and 15 indicate that low frequency plant noise (which can be audible under existing conditions) should diminish following transition to the Repower Plant. The final consideration was that the effectiveness of a sound attenuating wall on the east side of the Repower Plant could be reduced by the same unfavorable meteorological conditions (thermal ducting and westerly winds) which reduce the shielding effects from the natural elevated terrain features east of the plant. For these reasons, constructing a sound attenuation wall to provide noise shielding and attenuation at existing communities to the east was not considered to be reasonable.

Summary of Findings. It was determined that the proposed PGV Repower Project replacing the existing 38 MW power plant with an initial 46 MW and ultimate 60 MW plant should not result in adverse noise impacts on neighboring land uses. Plant equipment noise data provided by PGV and based on similar equipment used at other PGV facilities indicate that the proposed plant equipment are sufficiently quieter than the existing plant equipment so as to not increase future background noise levels in the surrounding communities. Existing power plant noise levels in the surrounding communities are very low and well below the 57 dBA Not-To-Exceed limit imposed on the PGV facility, and the proposed 46 MW and 60 MW phased facility should not change these background noise conditions.

Complete replacement of existing power plant equipment with new, quieter equipment which will allow for much higher power plant output without increasing background noise levels in the surrounding communities is a valid characterization of the proposed Repower Project. The noise mitigation measures have been directed at using sufficiently quieter equipment so that the addition of external noise mitigation measures, such as sound attenuating walls, will not be necessary.

Sincerely,

Yoichi Ebisu, P.E.

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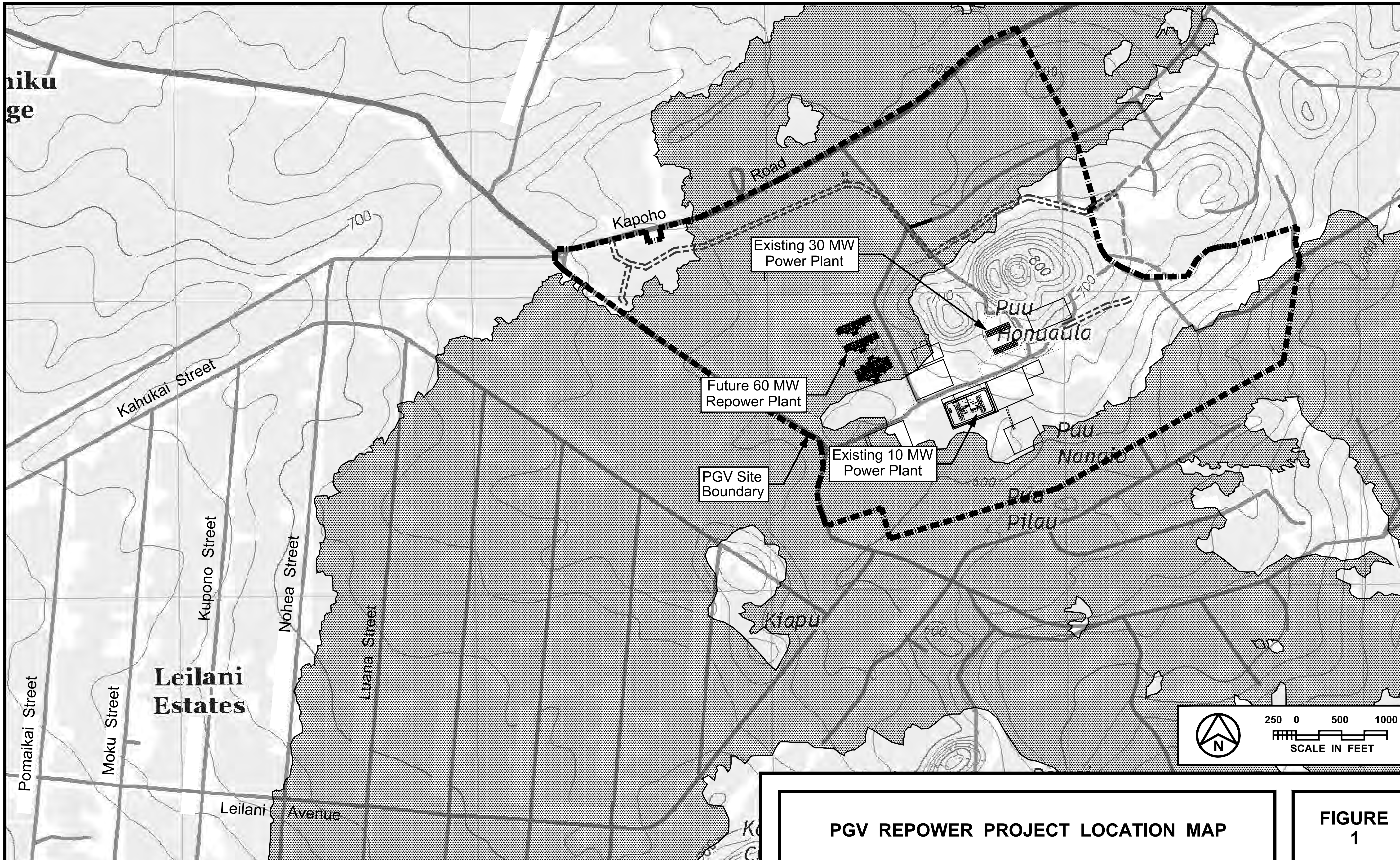
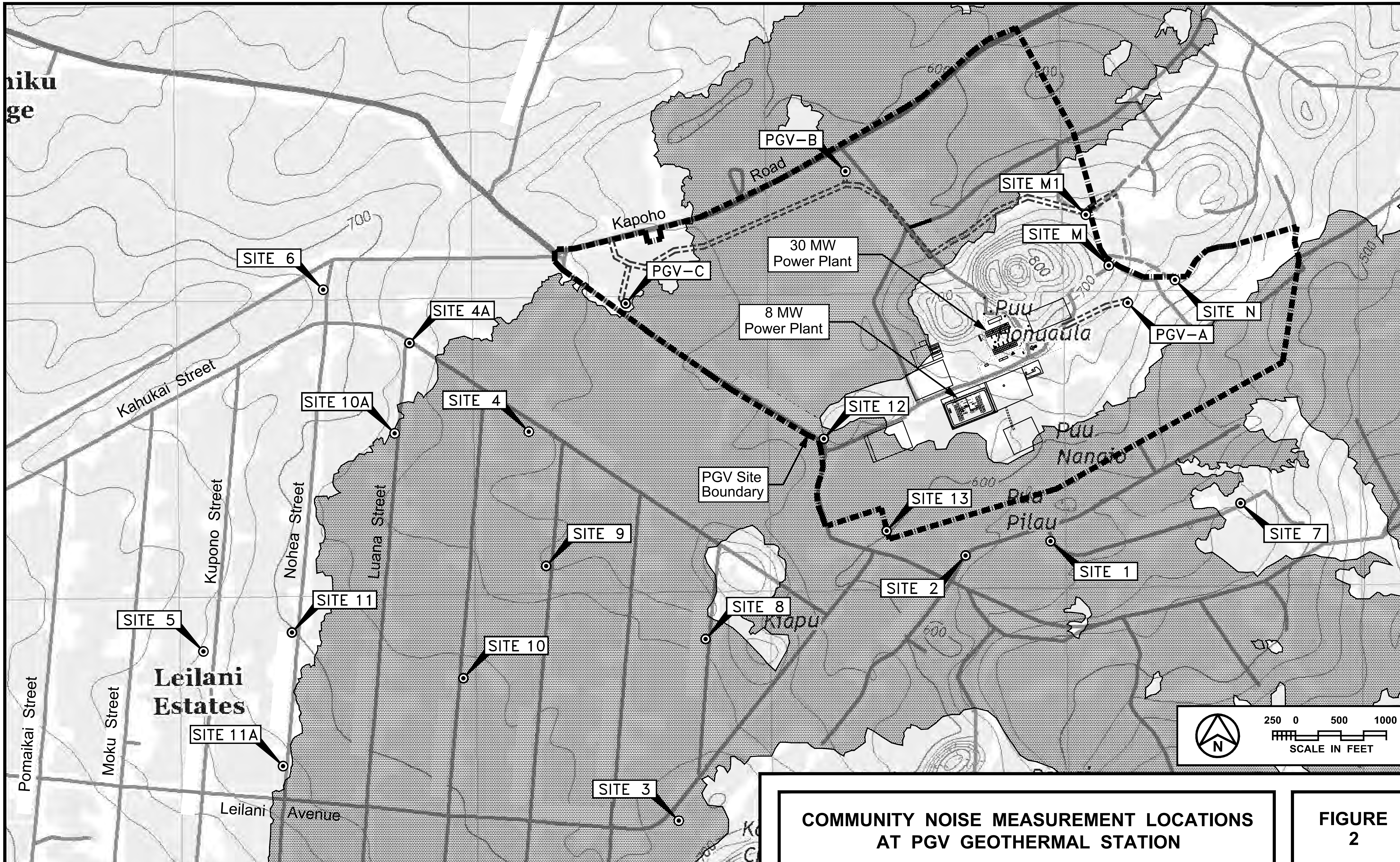


PGV REPOWER PROJECT LOCATION MAP

FIGURE 1



COMMUNITY NOISE MEASUREMENT LOCATIONS AT PGV GEOTHERMAL STATION

FIGURE 2

FIGURE 3. A-WEIGHT AND OCTAVE BAND MEASUREMENTS AT SITE 6 (DAY AND NIGHT) WITH 38 MW PLANT OFF (JUNE 7-8, 2019)

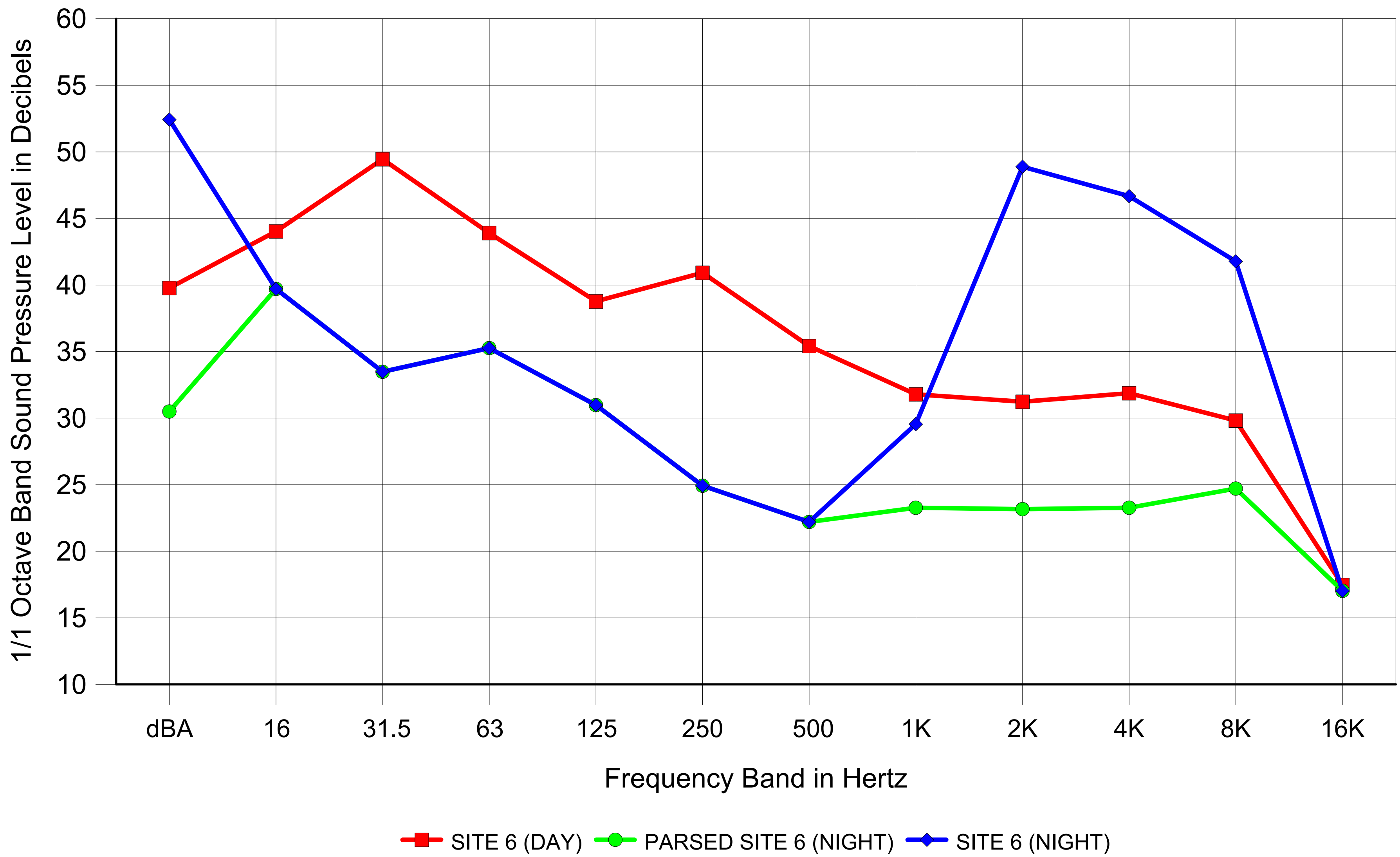


FIGURE 4. A-WEIGHT AND OCTAVE BAND MEASUREMENTS AT SITE 4A (DAY AND NIGHT) WITH 38 MW PLANT OFF (JUNE 7-8, 2019)

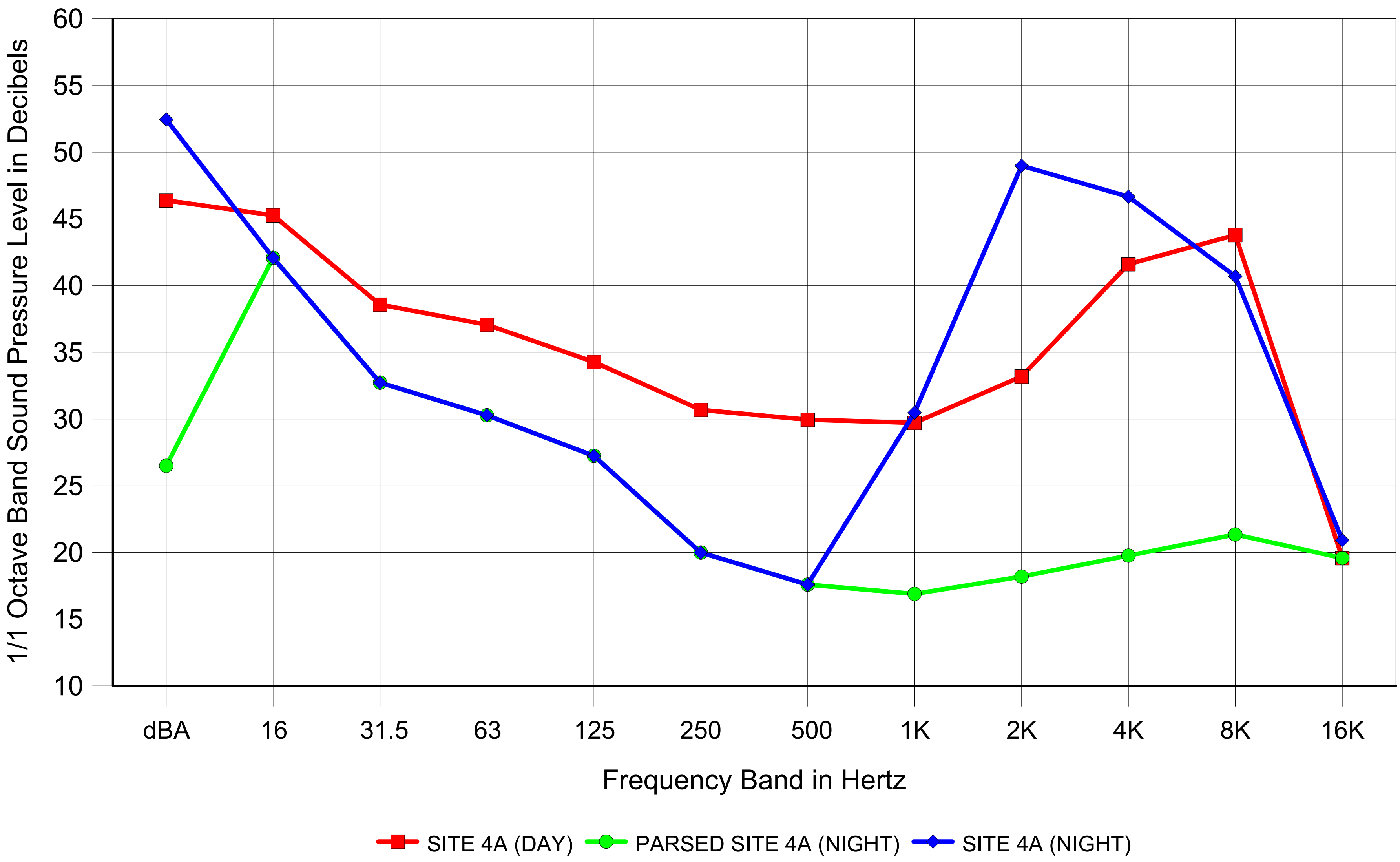


FIGURE 5. A-WEIGHT AND OCTAVE BAND MEASUREMENTS AT SITE 10A (DAY AND NIGHT) WITH 38 MW PLANT OFF (JUNE 7-8, 2019)

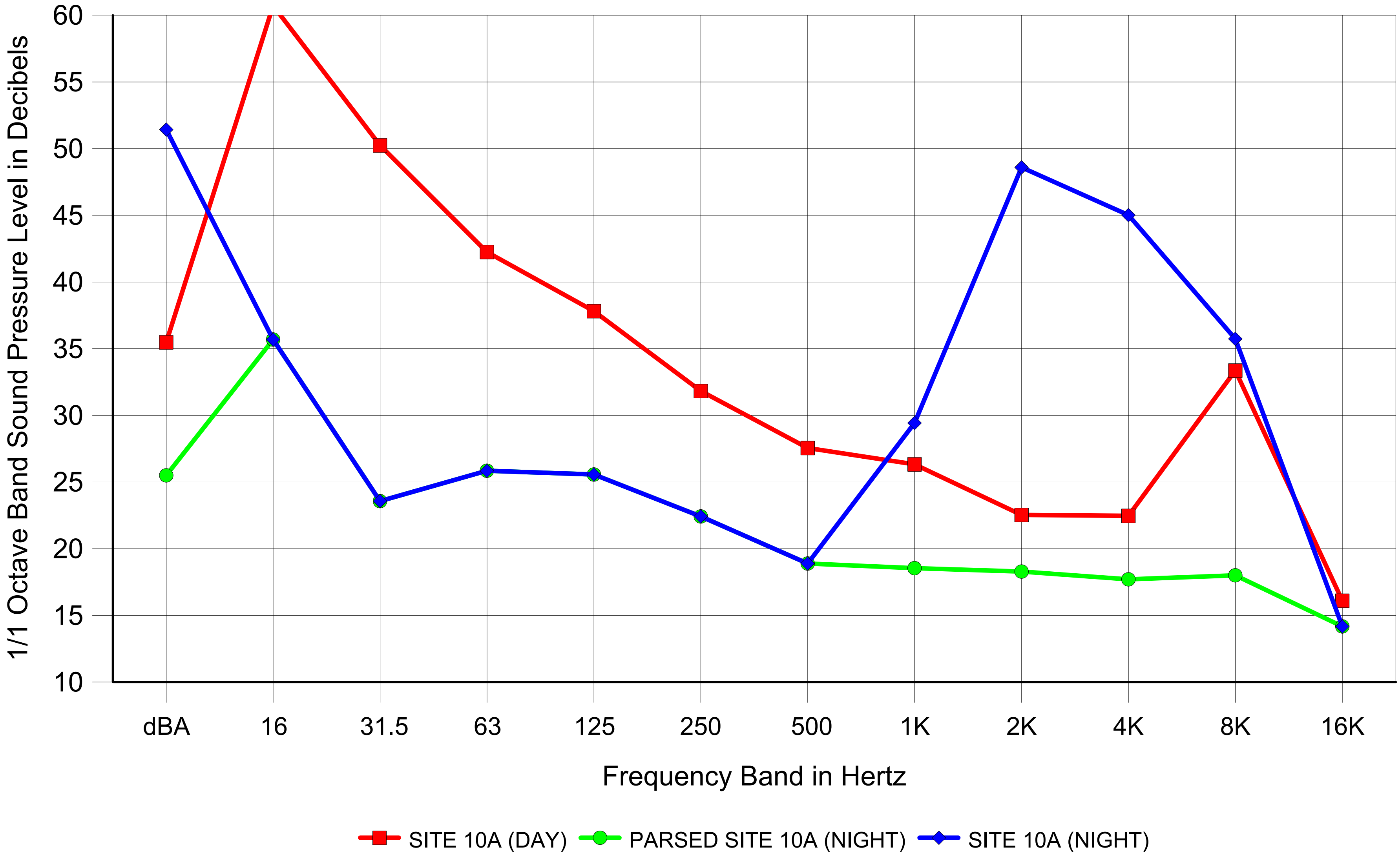


FIGURE 6. A-WEIGHT AND OCTAVE BAND MEASUREMENTS AT SITE M (DAY AND NIGHT) WITH 38 MW PLANT OFF (JUNE 7-8, 2019)

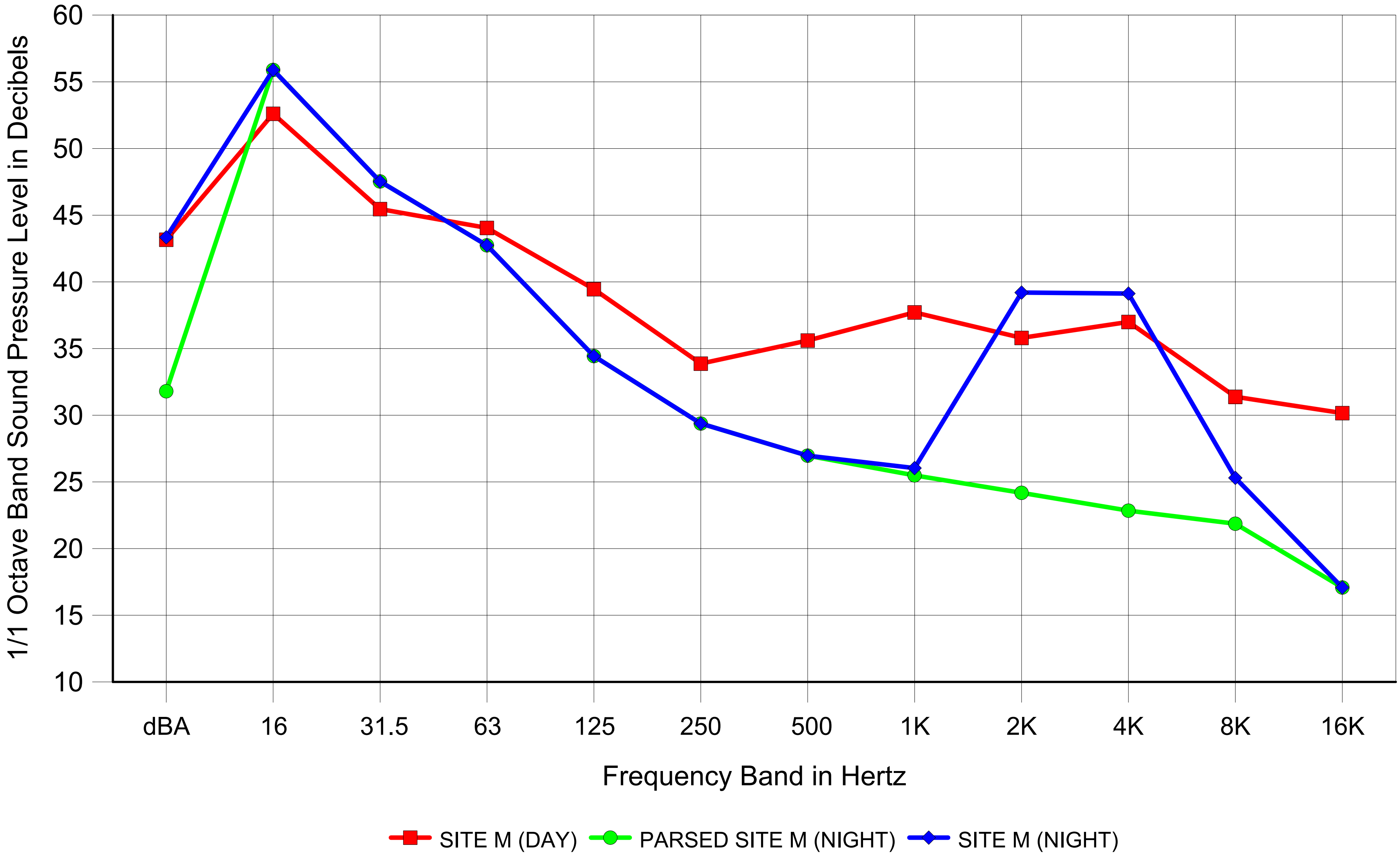
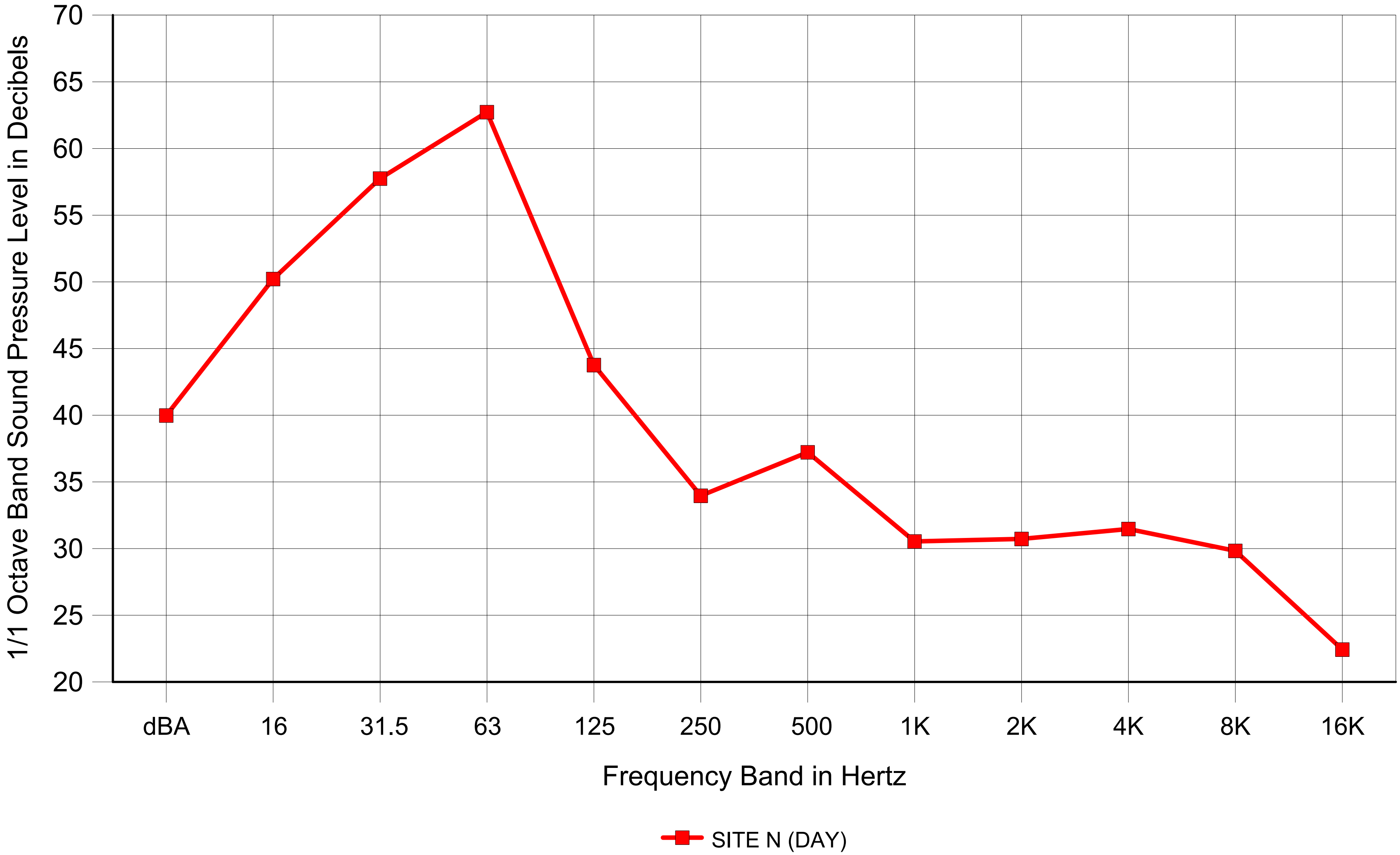
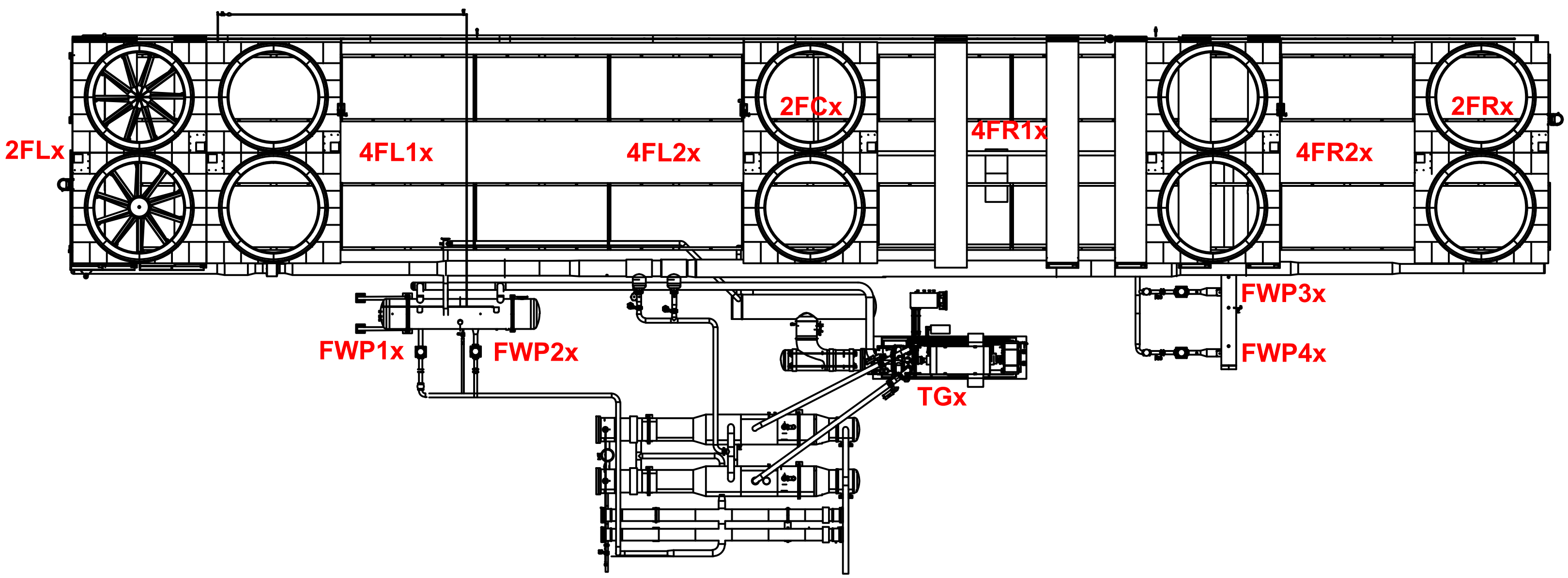


FIGURE 7. A-WEIGHT AND OCTAVE BAND MEASUREMENTS AT SITE N (DAY) WITH 38 MW PLANT OFF (JUNE 7, 2019)





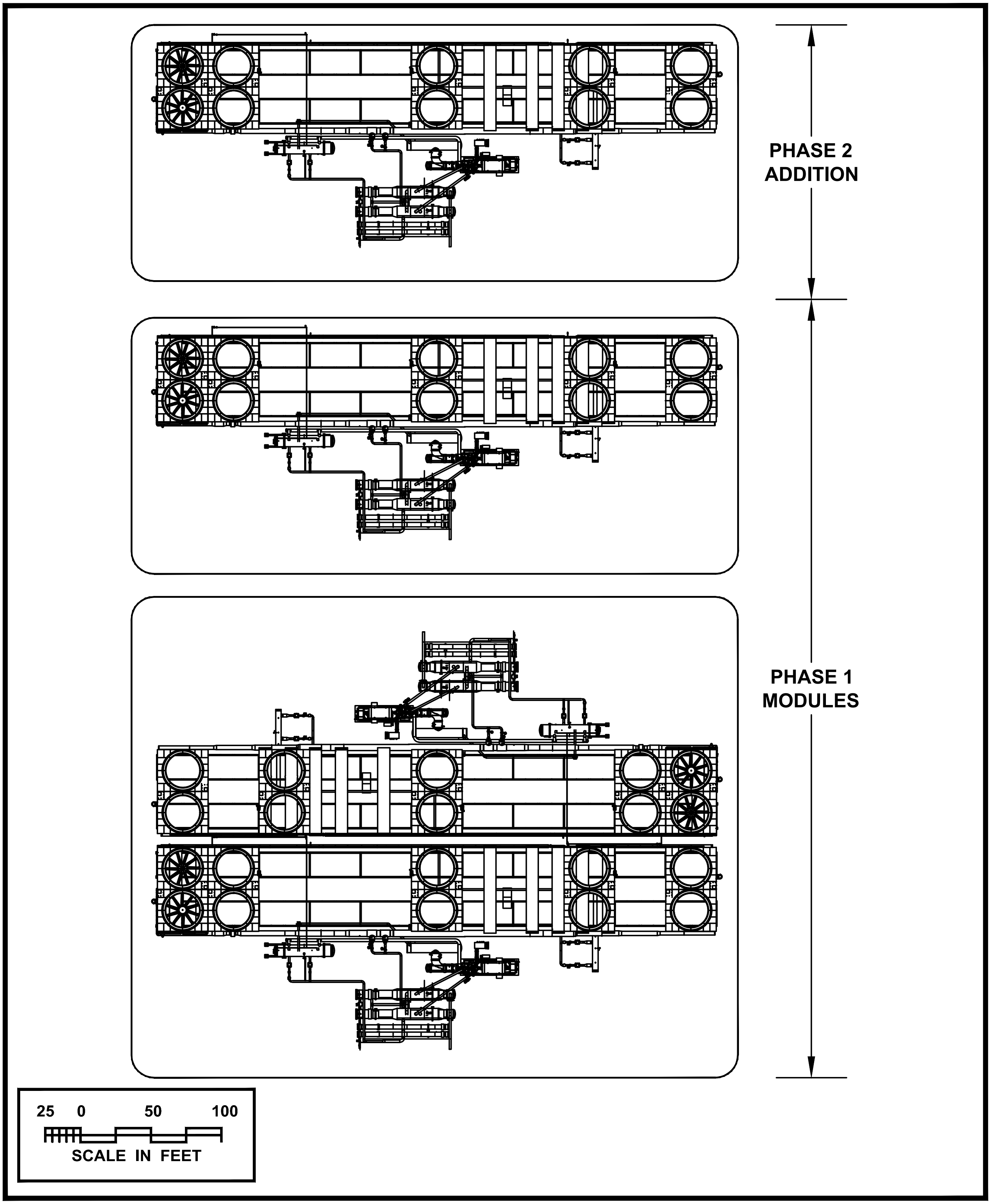
12.5 0 25 50

SCALE IN FEET

NOTE:
x = (a, b, c, and d) INDICATES 1 OF 4 MODULES COMPRISING THE 60 MW PLANT.
(SEE TABLE 5 AND FIGURE 9)

15.3 MW MODULE POINT NOISE SOURCES

FIGURE 8



60 MW REPOWER PLANT CONFIGURATIONS

FIGURE
9

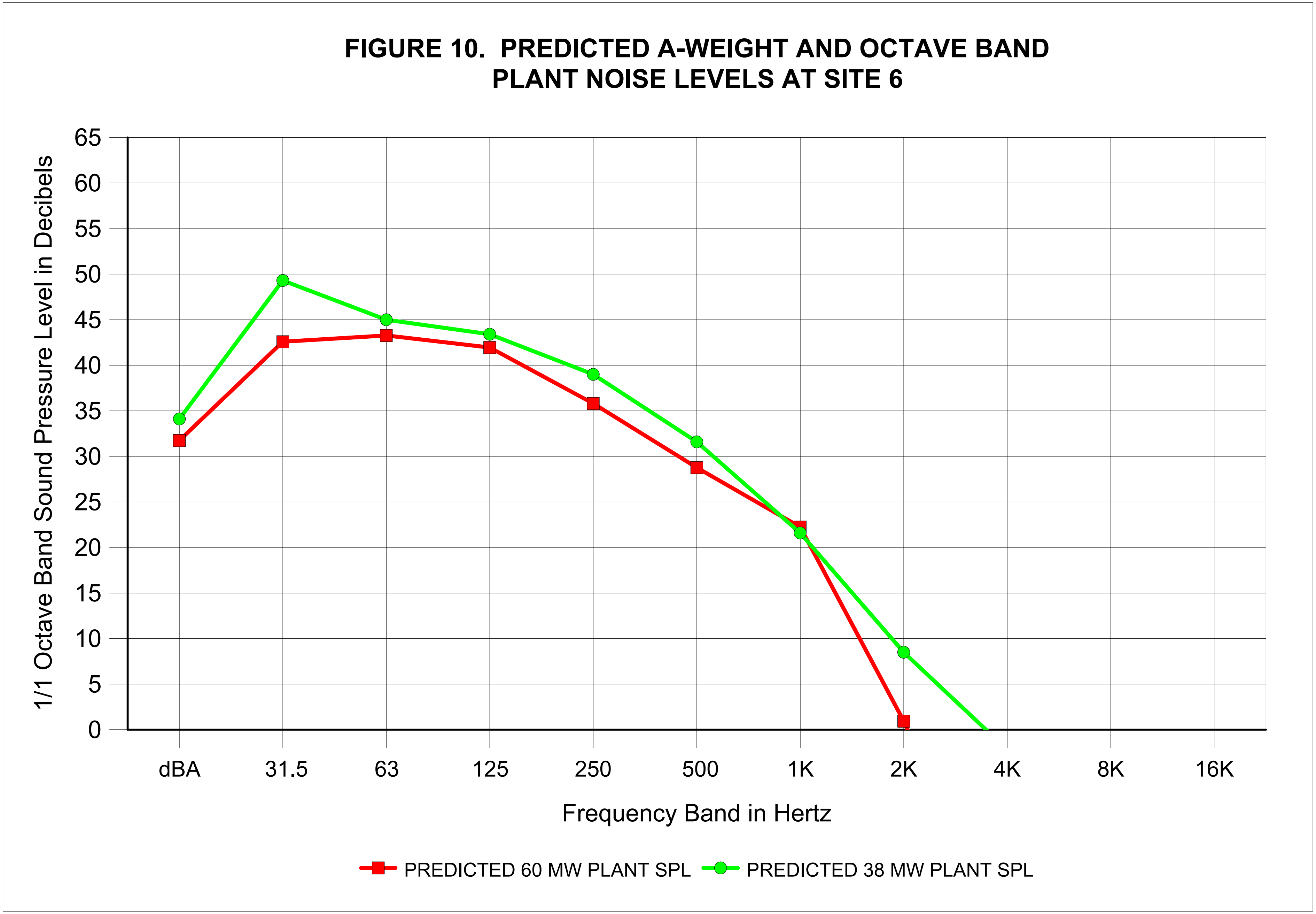


FIGURE 10. PREDICTED A-WEIGHT AND OCTAVE BAND
PLANT NOISE LEVELS AT SITE 6
1/1 Octave Band Sound Pressure Level in Decibels
65
60
55
50
45
40
35
30
25
20
15
10
5
0
dBA
31.5
63
125
250
500
1K
2K
4K
8K
16K
Frequency Band in Hertz
PREDICTED 60 MW PLANT SPL
PREDICTED 38 MW PLANT SPL

FIGURE 11. PREDICTED A-WEIGHT AND OCTAVE BAND PLANT NOISE LEVELS AT SITE 4A

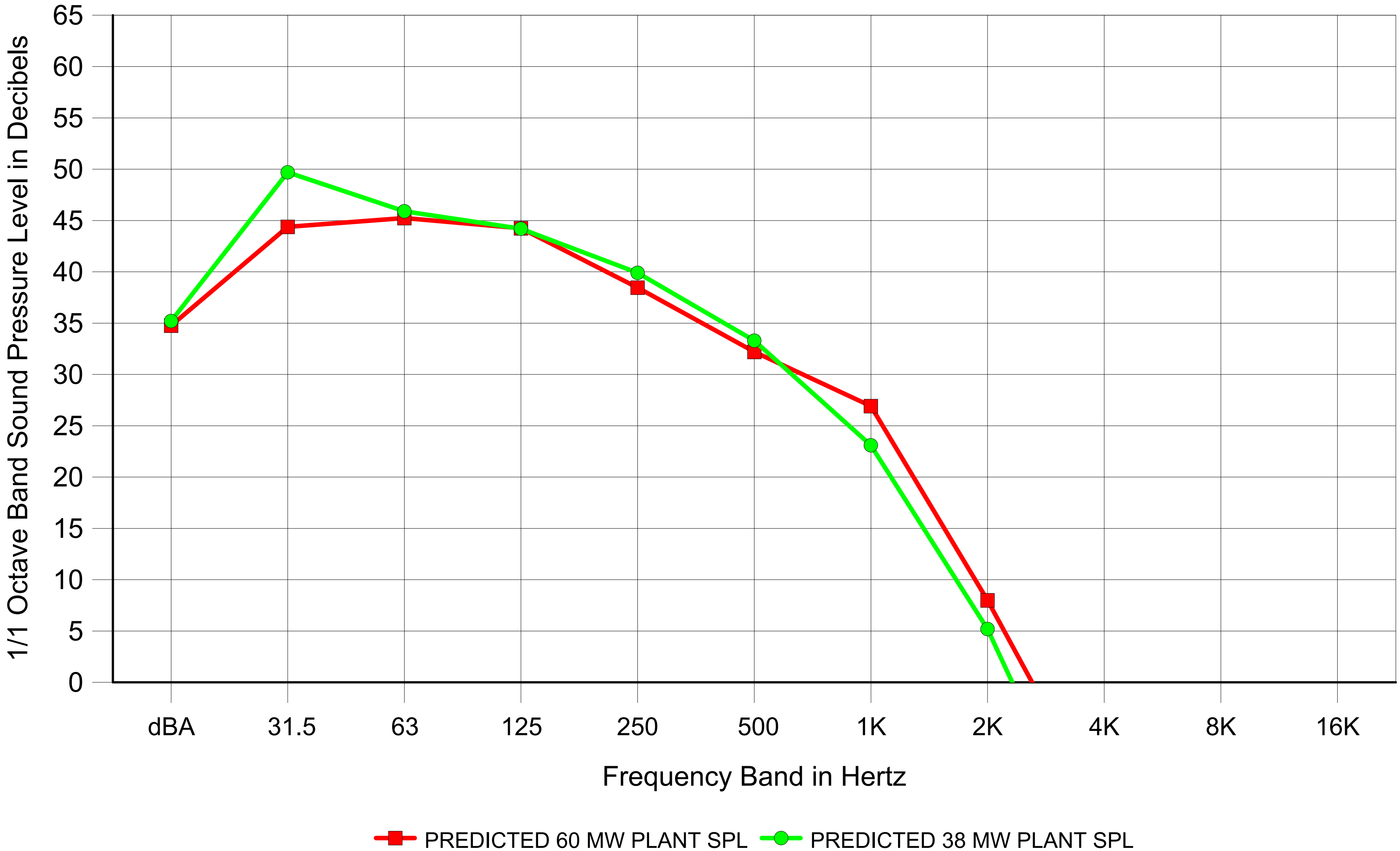
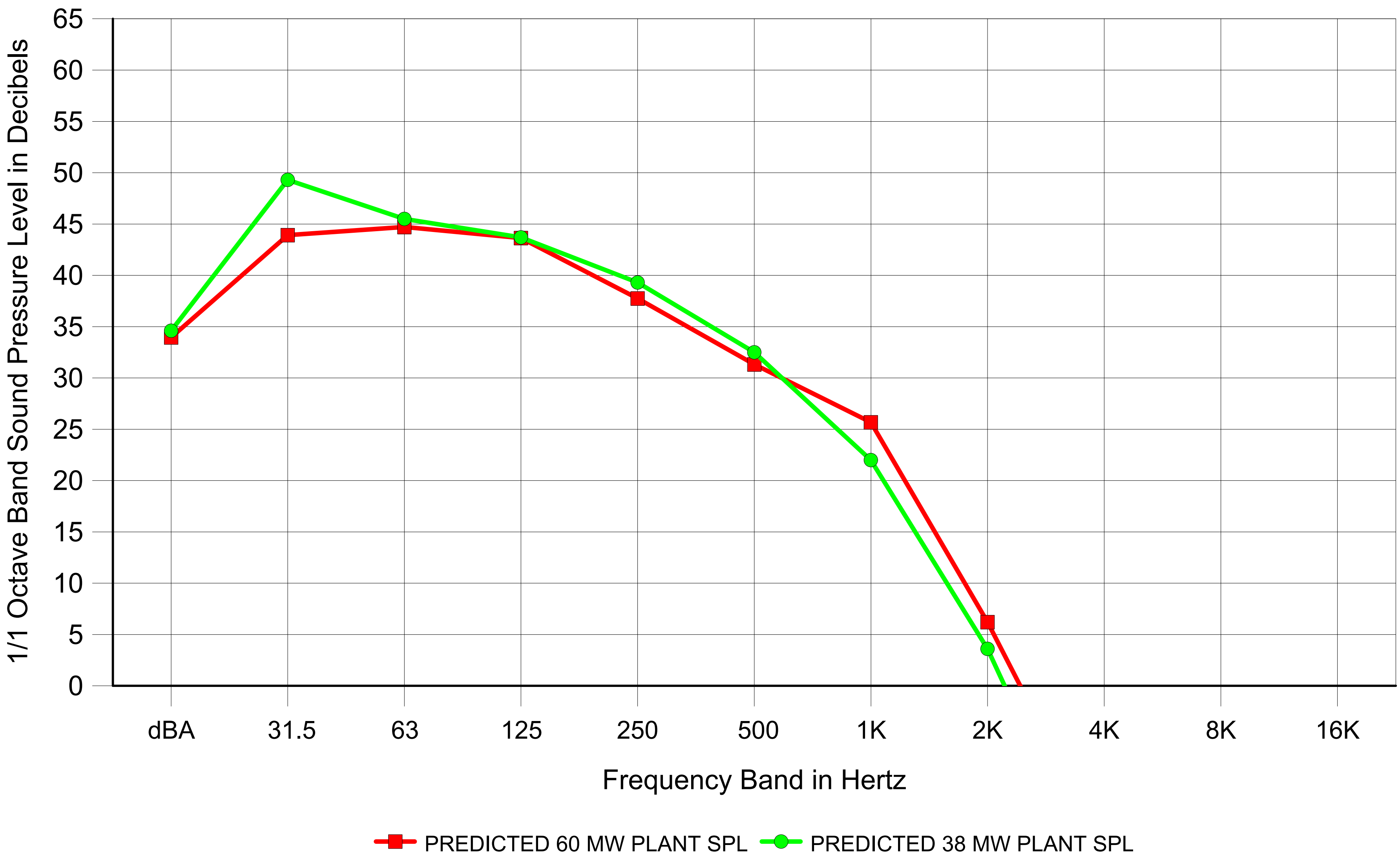


FIGURE 12. PREDICTED A-WEIGHT AND OCTAVE BAND PLANT NOISE LEVELS AT SITE 10A



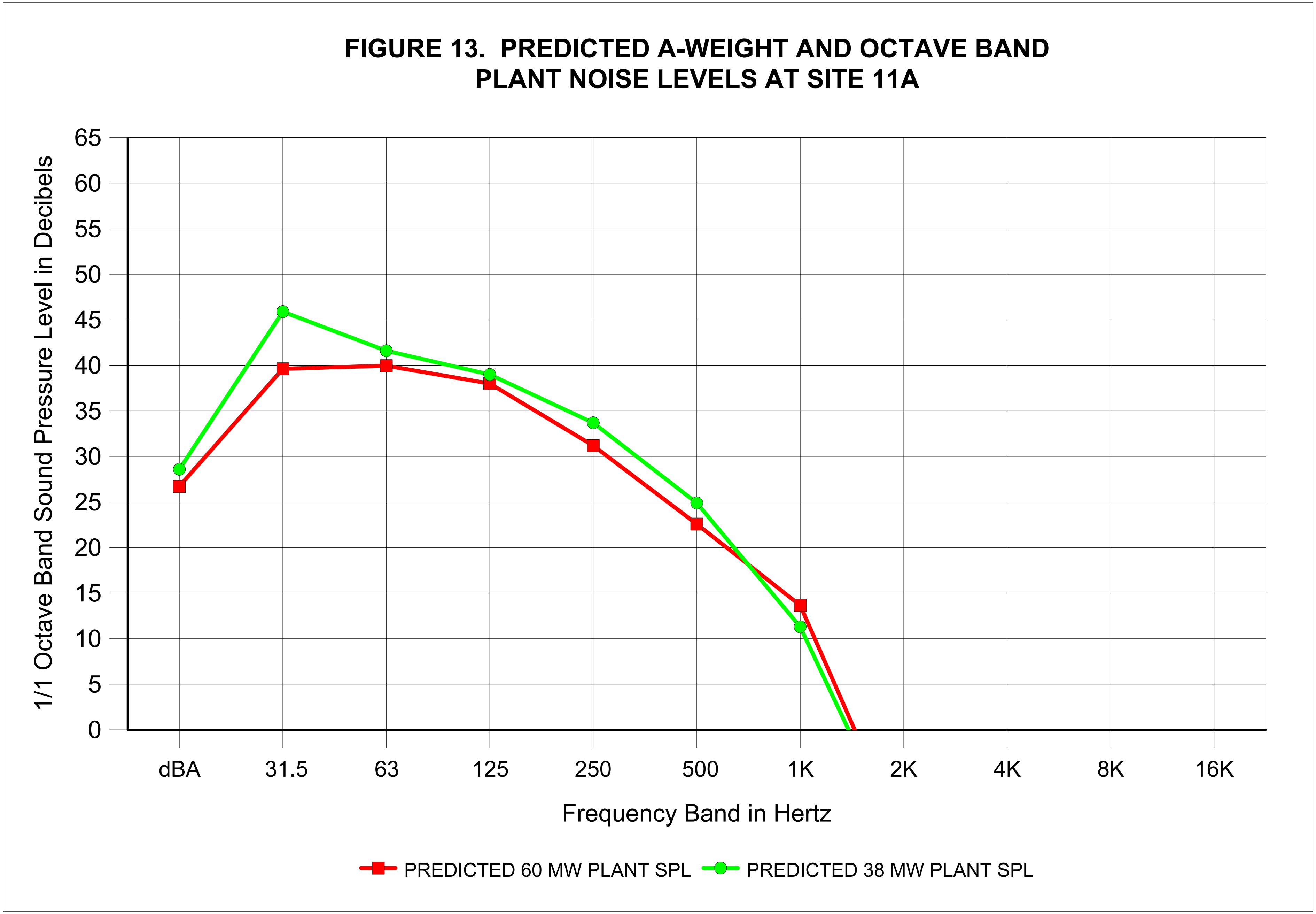


FIGURE 13. PREDICTED A-WEIGHT AND OCTAVE BAND
PLANT NOISE LEVELS AT SITE 11A
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1/1 Octave Band Sound Pressure Level in Decibels
dBA
31.5
63
125
250
500
1K
2K
4K
8K
16K
Frequency Band in Hertz
PREDICTED 60 MW PLANT SPL
PREDICTED 38 MW PLANT SPL

FIGURE 14. PREDICTED A-WEIGHT AND OCTAVE BAND PLANT NOISE LEVELS AT SITE M

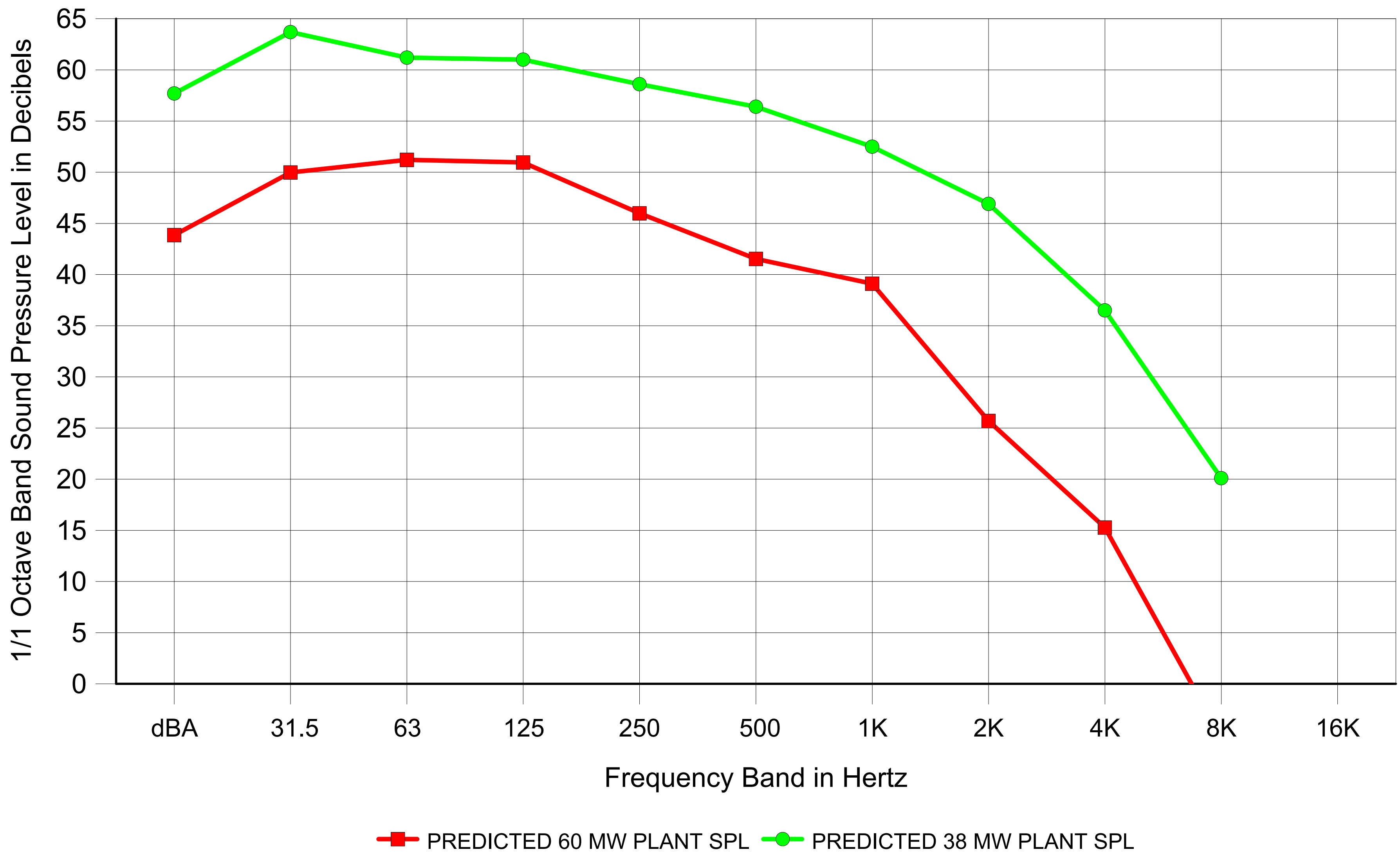


FIGURE 15. PREDICTED A-WEIGHT AND OCTAVE BAND PLANT NOISE LEVELS AT SITE N

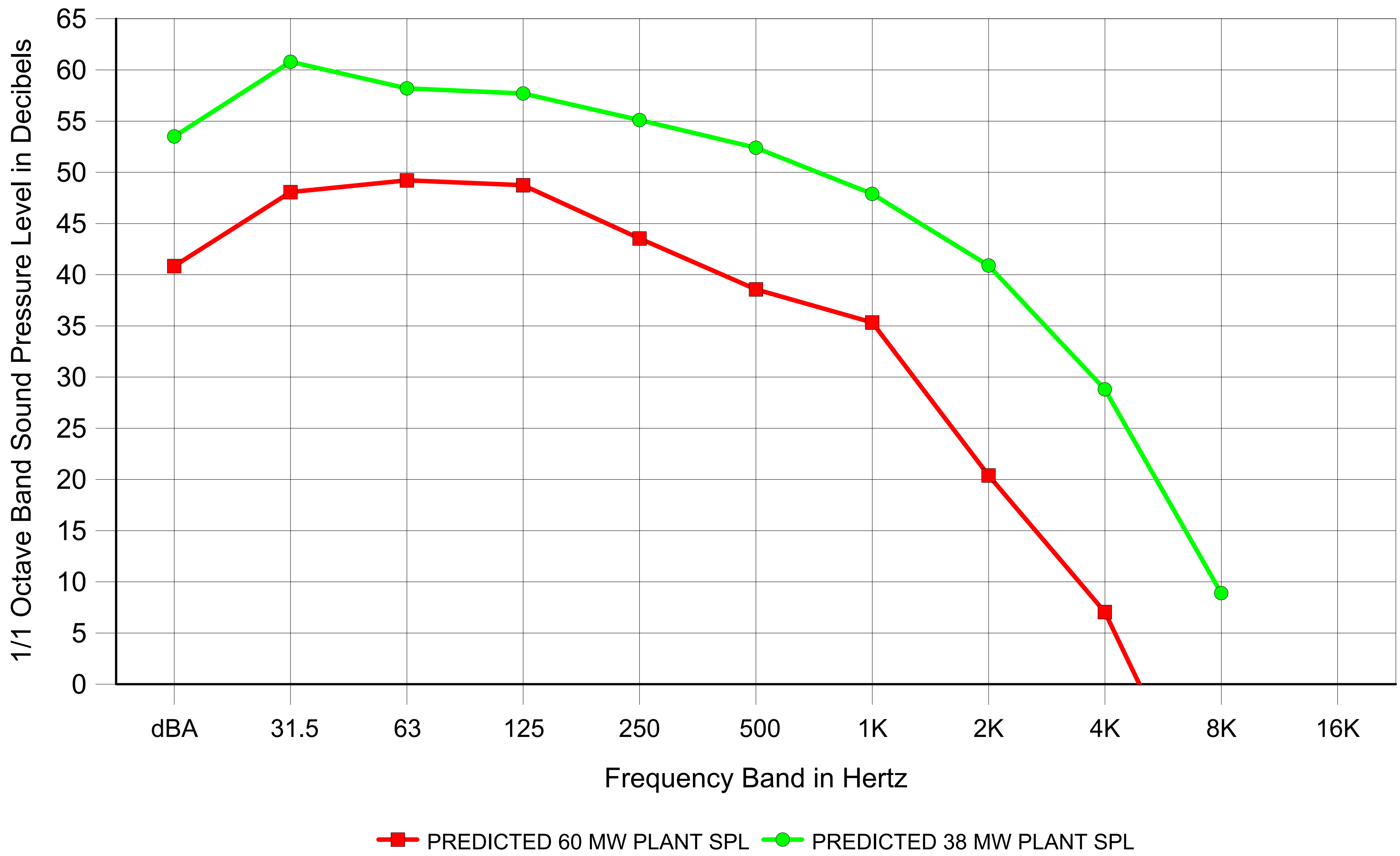


TABLE 1
RESIDUAL BACKGROUND NOISE MEASUREMENTS WITHOUT PLANT OPERATING
JUNE 7-8, 2019

RECEPTOR LOCATION	DAYTIME SPL (dBA)	UNPARSED / PARSED NIGHTTIME SPL (dBA)
Site 6	38.3 to 39.8	52.4 / 32.9
Site 4A	44.0 to 46.4	52.5 / 32.6
Site 10A	32.2 to 35.5	51.4 / 31.2
Site 11A	36.5 to 43.2	51.7 / 32.2
Site M	40.7 to 44.1	None
Site N	40.0 to 41.4	None
Site M1	41.5 to 44.9	43.3 / 33.0
PGV-A	52.8	None
PGV-B	None	None
PGV-C	None	None

Note:

1. Nighttime measurements were parsed of coqui frog contributions; i.e., coqui frog noise deleted from measured dBA values.

TABLE 2
MEASURED BACKGROUND NOISE LEVELS WITH 30 MW PLANT ON
W/O 8 MW PLANT

LOCATION 30 MW Puna Geothermal Plant
DATE: December 11, 2010

All Records are 15 minutes in duration.

Location	Start Time	Lmax	Leq	Lmin	L10	L90	Event Description
Site 1	02:28:48	66.9	50.0	47.7	51.7	48.2	Coqui Frogs; Plant Not Audible
Site 7	02:47:24	61.6	46.9	44.4	49.3	45.3	Single Coqui Frog; Plant Audible
Site 2	03:07:27	68.8	48.2	41.4	52.5	41.3	Coqui Frogs
Site 3	03:36:49	58.3	40.3	36.6	42.8	37.2	Coqui Frogs; Plant Not Audible
Site 8	03:59:36	67.9	41.7	39.6	42.2	40.6	Few Coqui Frogs; Plant Not Audible
Site 4	04:25:12	51.9	39.9	38.4	40.9	39.0	Few Coqui Frogs; Plant Not Audible
Site 9	04:43:03	62.5	41.5	36.7	43.8	37.8	Coqui Frogs; Plant Not Audible
Site 10	05:07:17	66.6	43.3	33.6	45.0	34.9	Coqui Frogs; Plant Not Audible
Site 11	05:35:49	63.6	45.1	39.1	49.6	40.3	Barking Dogs & Coqui Frogs
Site 5	05:58:24	76.2	50.2	43.6	48.5	44.5	Coqui Frogs & Cars; Plant Not Audible
Site 6	06:20:53	68.2	47.7	45.8	48.4	46.5	Barking Dogs, Birds, Insects
Site 12	06:48:20	68.4	49.6	44.7	51.9	46.8	Traffic Noise, Insects; Plant Audible
Site 2	12:28:36	70.0	49.0	40.0	50.1	42.6	Traffic Noise; Plant Audible
Site 1	13:02:39	92.2	66.8	36.8	51.3	38.8	Loud Rooster, Traffic Noise
Site 7	13:19:27	79.1	48.7	31.2	47.6	34.9	Barking Dogs; Not Audible.
Site 3	13:40:48	83.5	56.2	30.7	44.4	32.6	Traffic Noise
Site 8	13:58:48	56.7	35.6	30.8	37.7	32.2	Birds, Traffic Noise
Site 10	14:17:48	75.9	48.0	32.8	45.0	35.4	Birds, Traffic Noise
Site 4	14:35:06	73.5	48.1	33.6	46.0	35.8	Birds, Traffic Noise; Plant Audible
Site 9	14:51:42	59.7	41.1	34.4	44.0	36.7	Plant May Be Barely Audible
Site 11	15:09:52	68.3	46.1	34.8	48.9	34.9	Kids Talking; Birds, Barking Dogs
Site 5	15:28:44	78.8	55.3	33.6	46.8	37.1	Angry Resident; Birds, Barking Dogs
Site 6	15:42:40	67.6	42.5	33.2	44.3	36.4	Plant Not Audible

Notes:
a. Leq = Average A-Weighted Sound Level (in dBA)
b. Lmax = Maximum A-Weighted Sound Level (in dBA)
c. Lmin = Minimum A-Weighted Sound Level (in dBA)
d. L10 = A-Weighted Sound Level (in dBA) which was exceeded 10 percent of the time.
e. L90 = A-Weighted Sound Level (in dBA) which was exceeded 90 percent of the time.

TABLE 3
MEASURED BACKGROUND NOISE LEVELS WITH BOTH 30 MW AND 8 MW PLANTS ON

LOCATION 38 MW Puna Geothermal Plant
DATE: June 3-4, 2011

All Records are 15 minutes in duration.

Location	Start Time	Lmax	Leq	Lmin	L10	L90	Event Description
June 3, 2011:							
Site 1	11:57:26	79.7	59.1	41.8	61.5	44.7	Rooster; Tractor on Main Road
Site 7	12:14:19	75.1	47.6	39.3	49.7	44.2	Birds; Plant Not Audible; Talking
Site 2	12:31:50	68.4	49.7	43.6	51.7	46.2	Plant may be audible (low frequency)
Site 13	12:48:34	61.8	47.4	40.3	49.9	42.7	Plant may be audible (mid & high freq.)
Site 12	13:06:19	75.5	51.0	44.4	53.7	46.8	Plant audible (may be pumps)
Site 3	13:26:33	84.4	55.3	32.4	46.8	34.8	Few birds, very quiet, plant not audible
Site 8	13:44:17	75.6	46.5	32.7	40.9	35.2	Very quiet; low freq. may be audible
Site 10	14:03:17	58.8	40.0	32.4	42.9	35.4	Birds, plant not audible
Site 4	14:20:53	82.2	55.3	36.7	47.3	39.4	Low frequency audible at beginning
Site 9	14:37:35	75.7	49.6	33.8	45.8	35.4	Plant not audible.
Site 6	14:57:32	60.0	42.6	33.6	46.1	36.2	Birds, Plant (low freq.) may be audible
Site 11	15:15:34	79.9	52.0	33.3	50.8	35.3	Dog Bark, Plant not audible
Site 5	15:34:36	74.2	49.3	42.4	48.4	44.7	Birds, Plant not audible
June 4, 2011:							
Site 1	06:22:31	67.5	53.0	49.5	54.6	50.8	Plant audible (mid and high freq.)
Site 7	06:39:17	70.9	57.8	55.8	58.4	57.2	Dog barking, Birds, and Insects
Site 2	06:58:04	77.5	56.4	50.1	59.5	52.4	Plant clearly audible (mid and low freq.)
Site 13	07:15:42	67.9	47.1	43.1	49.5	44.6	New plant weakly audible
Site 12	07:34:29	67.2	51.8	45.8	54.4	47.0	
Site 3	07:57:46	77.5	55.0	39.3	54.4	41.6	Possible plant noise (mid freq)
Site 8	08:17:02	62.1	42.9	38.2	45.3	40.1	Plant may be audible
Site 9	08:36:55	71.3	49.5	37.5	50.3	39.8	Birds, Plant may be audible (low freq.)
Site 4	08:57:13	78.9	52.7	42.0	48.6	44.5	Plant not audible
Site 10	09:25:08	69.3	43.9	32.5	43.5	35.6	Birds, Insects, Plant not audible
Site 6	09:46:52	73.1	44.3	38.3	46.6	40.3	Plant not audible

Notes:
a. Leq = Average A-Weighted Sound Level (in dBA)
b. Lmax = Maximum A-Weighted Sound Level (in dBA)
c. Lmin = Minimum A-Weighted Sound Level (in dBA)
d. L10 = A-Weighted Sound Level (in dBA) which was exceeded 10 percent of the time.
e. L90 = A-Weighted Sound Level (in dBA) which was exceeded 90 percent of the time.

TABLE 4

THIRD OCTAVE BAND SOUND POWER LEVELS FOR EACH 15.3 MW MODULE'S NOISE SOURCES

SOUND POWER LEVELS RE 10 MINUS 12 WATTS:

		************************ Octave Band Frequency (Hz) ************************									Elevation
Point Noise Source	A-WHT	31.5	63	125	250	500	1000	2000	4000	8000	(feet)
2-FAN LEFT (2FLa)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN LEFT (2FLb)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN LEFT (2FLc)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN LEFT (2FLd)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
4-FAN LEFT1 (4FL1a)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT1 (4FL1b)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT1 (4FL1c)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT1 (4FL1d)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT2 (4FL2a)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT2 (4FL2b)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT2 (4FL2c)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN LEFT2 (4FL2d)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
2-FAN CENTER (2FCa)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN CENTER (2FCb)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN CENTER (2FCc)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN CENTER (2FCd)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
4-FAN RIGHT1 (4FR1a)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT1 (4FR1b)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT1 (4FR1c)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT1 (4FR1d)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT2 (4FR2a)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT2 (4FR2b)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT2 (4FR2c)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
4-FAN RIGHT2 (4FR2d)	99.7	102.7	104.7	104.7	100.7	97.7	94.7	86.7	82.7	78.7	665.8
2-FAN RIGHT (2FRa)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN RIGHT (2FRb)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN RIGHT (2FRc)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
2-FAN RIGHT (2FRd)	96.7	99.7	101.7	101.7	97.7	94.7	91.7	83.7	79.7	75.7	665.8
FEEDWATER PUMP1 (FWP1a)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP1 (FWP1b)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP1 (FWP1c)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP1 (FWP1d)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP2 (FWP2a)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP2 (FWP2b)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP2 (FWP2c)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP2 (FWP2d)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP3 (FWP3a)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP3 (FWP3b)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP3 (FWP3c)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP3 (FWP3d)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP4 (FWP4a)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP4 (FWP4b)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP4 (FWP4c)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
FEEDWATER PUMP4 (FWP4d)	83.5	82.5	81.2	79.8	81.2	80.7	78.8	75.0	73.1	68.1	646.1
15 MW TURBINE GENERATOR (TGa)	112.2	106.1	107.3	109.6	105.7	104.8	108.2	102.2	105.9	100.3	639.6
15 MW TURBINE GENERATOR (TGb)	112.2	106.1	107.3	109.6	105.7	104.8	108.2	102.2	105.9	100.3	639.6
15 MW TURBINE GENERATOR (TGc)	112.2	106.1	107.3	109.6	105.7	104.8	108.2	102.2	105.9	100.3	639.6
15 MW TURBINE GENERATOR (TGd)	112.2	106.1	107.3	109.6	105.7	104.8	108.2	102.2	105.9	100.3	639.6

TABLE 5
SUMMARY OF PREDICTED HISTORICAL AND FUTURE COMMUNITY NOISE LEVELS

LOCATION	EXISTING 30 MW PREDICTED SPL (dBA)	EXISTING 8 MW PREDICTED SPL (dBA)	EXISTING 38 MW PREDICTED SPL (dBA)	FUTURE 60 MW PREDICTED SPL (dBA)	PREDICTED CHANGE SPL (dBA)
Site 1	51.4	45.8	52.5	43.7	-8.8
Site 2	50.7	46.7	52.2	46.0	-6.2
Site 3	35.1	27.3	35.8	33.1	-2.7
Site 4	38.4	29.5	38.9	39.3	0.4
Site 5	27.5	19.1	28.1	26.4	-1.7
Site 6	32.2	22.9	32.7	31.7	-1.0
Site 7	46.6	36.2	47.0	36.9	-10.1
Site 8	38.2	33.1	39.4	40.2	0.8
Site 9	37.5	29.1	38.1	37.6	-0.5
Site 10	33.4	25.2	34.0	32.6	-1.4
Site 11	31.1	22.2	31.6	30.5	-1.1
Site 12	51.8	46.6	52.9	57.2	4.3
Site 13	50.5	46.7	52.0	49.3	-2.7
Site 4A	34.7	25.5	35.2	34.8	-0.4
Site 10A	34.1	25.1	34.6	34.0	-0.6
Site 11A	28.0	19.8	28.6	26.7	-1.9
Site M	57.6	41.7	57.7	43.9	-13.8
Site N	53.4	38.9	53.6	40.8	-12.8
Site M1	55.9	39.8	56.0	43.8	-12.2
PGV-A	57.5	42.6	57.6	43.4	-14.2
PGV-B	50.2	37.2	50.4	49.1	-1.3
PGV-C	38.1	32.7	39.2	44.6	5.4

Note:

1. All predicted plant sound levels are for unobstructed line-of-sight condition and without excess attenuation from terrain features.

TABLE 6
PREDICTED PLANT NOISE REDUCTIONS FROM SOUND WALL FOR PHASE 1 AND PHASE 2 REPOWER PLANT CONFIGURATIONS

Receptor Location	Wall Top Elevation (ft)	Wall Height (Above Gnd.)	PH1 dBA Reduction	PH2 dBA Reduction
Site 6	643	10	1	1
Site 6	653	20	2	2
Site 6	663	30	2	2
Site 6	668	35	4	4
Site 6	669	36	7	7
Site 6	673	40	7	7
Site 6	678	45	8	8
Site 6	683	50	9	10
Site 4A	643	10	2	2
Site 4A	653	20	2	2
Site 4A	663	30	2	2
Site 4A	668	35	7	7
Site 4A	669	36	7	7
Site 4A	673	40	8	8
Site 4A	678	45	9	9
Site 4A	683	50	10	11

APPENDIX G

BIOLOGICAL RESOURCES SURVEY

Biological Survey
PGV 9-acre Additional Work Area
TMK (3) 1-4-001:002 (por.), Island of Hawai‘i

By Ron Terry, Ph.D.
Geometrician Associates, LLC
November 2022

Introduction

This biological survey concerns a proposed expansion of the work area at the Puna Geothermal Ventures (PGV) site in the ahupua‘a of Kapoho, south of County Highway 132 in the Puna District of Hawai‘i. As shown in Figure 1, the work area involves a roughly 9-acre kipuka, which is a vegetated area surrounded by a more recent lava flow. This kipuka resulted when a forested ridge of spatter cones created as part of the 1955 lava flow of Kīlauea Volcano was surrounded by Kīlauea's massive 2018 lava flow. The kipuka will be partially disturbed by activities related to geothermal energy production at the PGV plant. The full area of interest is depicted in Figure 1 and is referred to throughout this document as the "property."

The objectives of the botanical component of this survey were to 1) describe the vegetation; 2) list all species encountered; and 3) identify the locations of any rare, threatened or endangered plant species, if found. The area was surveyed by Ron Terry, Ph.D., and Jonathan Price, Ph.D., on November 10, 2022. Plant species were identified in the field and, as necessary, collected and/or photographed and keyed out in the laboratory.

The work also involved a limited survey of birds and introduced mammals, reptiles, or amphibians observed during the botanical survey. Also considered in this report is the general value of the habitat for native birds and the Hawaiian hoary bat. Not included in the survey were invertebrates.

Regional Vegetation Types and Influences

The property is located at elevations between about 620 and 660 feet above sea level, in what would be considered the windward lowlands of Hawai‘i Island. Rainfall in the area is high, exceeding 120 inches per year (Giambelluca et al 2013). No streams, lakes or ponds were observed or are known to be present.

The site is located directly on the East Rift Zone (ERZ) of Kilauea, a radial fracture zone that extends from the summit to the base of the volcano. The surface here is rifting or splitting apart and its many cracks allow magma to make its way frequently to the surface. The vegetation of the ERZ is intimately related to the ever-shifting geology. With eruptions occurring almost continually at various points up and down the ERZ and spreading 1 to 20 miles north or south of this axis, most new lava surfaces only attain an age of a few hundred to a thousand years before once again being covered with lava. The vegetation of the ERZ is an intricate mosaic of old, new and medium-aged surfaces. It varies from bare lava, to sparse forest covered with pale lichens and small ‘ōhi‘a trees (*Metrosideros polymorpha*), to tall, diverse forests of trees, ferns, vines and herbs. In younger lava flows below 800 feet in elevation, the natural vegetation is Lowland Wet ‘Ohi‘a/Uluhe Fern Forest (Gagne and Cuddihy 1990). In wet forests on Puna lava flows younger than 100 years, ‘ōhi‘a trees are abundant but generally small (15-40 feet high; 2-10 inches in diameter at breast height) and sparsely to moderately distributed among patches of native uluhe (*Dicranopteris linearis*) fern. A variety of ferns (e.g., ama‘u [*Sadleria cyatheoides*]) and fern allies and sedges such ‘uki (*Machaerina mariscoides subsp. meyenii*) may also be fairly abundant. In general, very few native understory plants are present, but eventually certain species proliferate, including lama (*Diospyros sandwicensis*), kopiko (*Psychotria hawaiiensis*), kolea (*Myrsine lessertiana*), maile (*Alyxia oliviformis*), ‘ie‘ie (*Freycinetia arborea*) and hapu’u (*Cibotium menziesii* and *C. chamissoi*). Under natural conditions, younger-aged lava flows provide nurseries for more uncommon plants that establish in small numbers but eventually may become prominent elements. Endangered plants are usually not present in lowland Puna, but several individuals of an endangered subshrub, ha‘iwale (*Cyrtandra nanawaleensis*) have been found in a variety of locations. Several studies have revealed somewhat confusing associations between substrate age and species diversity that are well summarized in Dupuis (2012). Her research at five lowland forest reserves on and east of the Lower ERZ indicated that forests between 200 and 750 years in age were the primary sites for both high diversity forests and rare plants. Many of these lava flows are dominated by ‘a‘a, the clinkery form of lava.

The alteration of natural vegetation directly through agriculture, settlement and timber harvest, as well as indirectly through introduction of non-native animals, plants and pests, dramatically alters natural patterns (Cuddihy and Stone 1990). Even when evidence of direct human disturbance is not obvious, wildfire and cattle grazing have decreased native plant diversity and increased the prevalence of weed species in Puna’s younger substrates. GIS maps of Hawai‘i Island created by overlaying the geographic ranges of plant species reveal that the upper elevation parts of the ERZ are largely native-dominated, and the Lower ERZ where the property is located is mostly non-native dominated (Price et al 2007). Major invasive plants here include the extremely rapid-growing albizia tree (*Falcataria moluccana*), strawberry guava (*Psidium cattleianum*), broomsedge (*Andropogon virginicus*), Asian melastome (*Melastoma* spp.) and a host of other plants in the melastome family.

Vegetation History on the Property

The property’s two low, joined spatter cones created in the 1955 eruption slowly sprouted vegetation. Aerial imagery from 1955 by the U.S. Department of Agriculture (http://magis.manoa.hawaii.edu/remotesensing/GeoserverFiles/ShpFiles/Hawaii/064/jpegs/6254) shows a light-colored surface devoid of sizeable trees but likely containing lichens and seedlings. By the time of a U.S. Geological Survey photo in 1975 (http://magis.manoa.hawaii.edu/remotesensing/GeoserverFiles/ShpFiles/Hawaii/007/jpegs/484), forest had developed over the central portion of what is now the kipuka, although the rim and interior of the cones’ craters were still somewhat barren. Low resolution 1985 satellite imagery from Google Earth © shows little detail but an overall greenish hue, indicating that the entire kipuka was vegetated. By 2007, imagery shows the southwestern half was covered with a thick layer of albizia, while the northeastern half was much sparser and appeared to be at least partially composed of ʻōhiʻa. Google Earth © imagery from 2016, after Tropical Storm Iselle had ravaged much of Lower Puna's tree cover in 2014, reveals many downed trees on the southwestern side. By 2017 these had largely grown back, and albizia was encroaching well into the northeastern half, including the entire northern fringe. In May 2019 (the date of the imagery in Figure 1) – nine months after the 2018 lava flow had ceased – the margins of the kipuka consisted of burned and downed trees. The partial defoliation of unburned trees damaged by volcanic gases, which affected albizia more than ʻōhiʻa, is still visible in that image. Today, although the skeletons of burnt trees still surround and penetrate the kipuka, the vegetation appears green and vigorous. Due to the geologically recent substrate (1955 and 2018), no true soil is present, but the crumbly spatter cone surface and the abundant leaf litter has created a moist covering of decomposing organic material over mineral-rich decomposing rock that supports prolific vegetation.

Results: Vegetation and Flora

The basic vegetation pattern of albizia forest with a shrinking remnant of ʻōhiʻa cover that developed from about 1980 onwards is still present. Fire, heat and gases from the eruption killed or damaged ʻōhiʻa and especially albizia, but the latter is vigorously recovering and is the dominant species, while the former is only slowly rebounding (Figure 2a). ʻŌhiʻa is only dominant on the upper rims of the cinder cones (Figure 2b). A layer of understory trees is present, especially on the lava flow margins, consisting of Asian melastome, gunpowder tree (*Trema orientalis*), and lesser numbers of various other trees including cecropia (*Cecropia obtusifolia*) and strawberry guava (Figure 2c). Just a few amaʻu and hapuʻu tree ferns have survived (Figure 2d). The dominant species on the forest floor almost everywhere is non-native sword fern (*Nephrolepis multiflora*) (Figure 2e), but the native fern uluhe covers the bottom of the crater (Figure 2f). Other prominent species at the lowest layer are include broomsedge, Napier grass (*Cenchrus purpureus*), bamboo orchid (*Arundina bambusifolia*), maunaloa (*Canavalia cathartica)* and pilau maile (*Paederia foetida*), all non-native.

All plant species found on the property during the survey are listed in Table 1. Of the 48 species detected, four were indigenous (native to the Hawaiian Islands and elsewhere) and three were endemic (found only in the Hawaiian Islands). No plants introduced by Polynesians were observed. All native plants seen on the property are very common throughout the Hawaiian Islands, and no rare or unusual plant species were present. It should be noted that we were not able to identify certain plants because the example plants were sterile, juvenile and/or in poor condition. It is highly unlikely that any of these unidentified plants would be a rare species.

Threatened and Endangered Plant Species and Critical Habitat

No threatened or endangered plant species as listed by the U.S. Fish and Wildlife Service (2022) appear to be present on the property. No uniquely valuable plant habitat is present. The property is not suitable habitat for the endangered subshrub, haʻiwale (*Cyrtandra nanawaleensis*), which generally requires more intact ʻōhiʻa forest with a native understory. No federally designated or proposed critical habitat is present on or within ten miles of the property (https://ecos.fws.gov/ecp/report/table/critical-habitat.html accessed November 2022).

Botanical Impacts and Recommended Mitigation Measures

The low elevation, lack of diversity and heavy presence of invasives indicate very limited value in terms of conserving native vegetation or threatened or endangered plant species. The extreme disturbance and dominance by invasives on most of the property deprive this area of native plant conservation value. As such, no significant adverse botanical impacts are expected as a result of future industrial use and expansion of PGV operations.

An issue for construction in properties with ‘ōhi‘a trees has recently surfaced. Two species of fungus called *Ceratocystis lukuohia and C. huliohia* produce a disease that is relatively new to science – Rapid ‘Ōhi‘a Death (ROD) (Hawai‘i DLNR 2017). This disease has killed hundreds of thousands of ‘ōhi‘a trees across more than 34,000 acres of the Big Island. It was first discovered in Lower Puna. The property contains numerous ‘ōhi‘a trees. Projects that harm or relocate ‘ōhi‘a trees can spread the disease, and certain mitigation measures are recommended, although it is important to recognize that treatment protocols are evolving. The following mitigation protocol is proposed, but PGV is advised to consult with the Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife to confirm current optimum protocol:

- Prior to any forest clearing in any areas with ‘ōhi‘a, any isolated ‘ōhi‘a trees on the clearing boundary should be identified. Any such trees that are not planned for removal on the edges should be protected from disturbance entirely or cut and chipped or buried to ensure that they do not present a ready target for ROD infection that could spread to other trees;
- Treat any unavoidable scars on ‘ōhi‘a trees that result from clearing to prevent infestation of the fungus; and
- Stack all removed ‘ōhi‘a trees and dispose of by burying or chipping; do not remove from project site. Decontaminate boots and work tools before and after working in an area with ‘ōhi‘a trees.

Fauna

We observed only two bird species during the botanical survey, which took place between 9 AM and noon: northern cardinal (*Cardinalis cardinalis*) and warbling white-eye (*Zosterops japonicus*). Longer observations on many days in different seasons and times of the day would undoubtedly reveal additional bird species, nearly all of them likely to be non-native. Based on longer surveys in similar habitats in Puna (Geometrician 2016, 2021), the typical birds likely to be found are shown in Table 2.

The only native bird almost certain to be occasionally present is the Hawaiian hawk (*Buteo solitarius*). This raptor was formerly listed as endangered by the federal government and remains listed by the State of Hawai‘i. It occurs throughout the island of Hawai‘i from sea level to 8,500 feet in elevation. Hawks are frequently observed in a variety of habitats in the Puna District and all forested areas of Hawai‘i Island. They generally prefer ‘ōhi‘a forest habitat but are known from both native and non-native forests and even range into farmland and towns to forage. Hawks nest in tall trees within their large territories from early March through the end of September. Most nesting occurs in native ʻōhiʻa trees but non-natives including eucalyptus, ironwood, mango, coconut palm and macadamia, may also be used. The forest on the property lacks tall, mature ʻōhiʻa or any other trees that would make highly suitable nests. Although noise from nearby drilling, heavy equipment and other industrial activity at the PGV site likely discourages nesting, there is a small but not non-existent chance that hawks could nest on or near the property, especially in the tall trees in the center. If nests were present on the property, any grading, tree removal or other construction activities might disturb nesting.

As with all of the island of Hawaiʻi, several threatened or endangered seabirds may overfly, roost, nest, or utilize resources in the Pahoa area, including the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the endangered band-rumped storm petrel (*Oceanodroma castro*), and the threatened Newell's shearwater (*Puffinus auricularis newelli*). Although they may fly over various locations in Puna on their way to and from mountain nesting areas and the open ocean, very little suitable nesting habitat for any of these seabird species is present in the lowland areas of the ERZ. Research at larger, isolated volcanic cones at slightly higher elevations has indicated habitat potential at some of them (Reynolds and Ritchotte 1997). It is unlikely that any habitat is present at the property. The primary cause of mortality for these seabirds in Hawaiʻi is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is another significant cause. 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 manmade structures and, if not killed outright, become easy targets of predatory mammals.

The threatened Hawaiian goose or nēnē (*Branta sandwicensis*) has become very common on many Hawaiian islands and can be found at elevations ranging from sea level to sub-alpine areas above 7,000 feet. Historically, flocks moved between high-elevation feeding habitats and lowland nesting areas. Nēnē nests consist of a shallow scrape lined with plant material and down. Breeding pairs usually return to the previous year's nest site, typically in dense vegetation. Nēnē have an extended breeding season, and nesting may occur in all months except May, June, and July, meaning that even if nēnē were present they would not be nesting. Nēnē can be are abundant in shoreline areas of Puna where large ponds exist. The dense albizia forest, lack of water bodies, and absence of short grass make the property unsuitable habitat for nēnē foraging or nesting. We did not detect any nēnē on the property and would not expect to.

It is highly likely that endangered Hawaiian hoary bats (*Lasiurus cinereus semotus*), the only native Hawaiian land mammal, utilize the margins of property for feeding and may even utilize the interior for roosting. They have been found throughout the island of Hawaiʻi. Bats may forage for flying insects on the property on a seasonal basis and may also roost in trees and large shrubs.

Determination of bat populations or usage patterns requires sophisticated, long term studies. Bats are often visible while they are feeding on flying insects near dusk and dawn at various locations around the island of Hawaiʻi. Their presence can also be verified by ultrasound detectors or radar. If a bat is detected during a night's study, this merely indicates that they were present in the area. Conversely, a failure to detect bats does not indicate an absence of bats, which may have been gone for only a night, a week, or a season, or may have been present but undetected. No bats were observed in our surveys, which took place in full daylight and did not use any detection equipment. For the purposes of this assessment, it is assumed that Hawaiian hoary bats are present at least some of the time, as they have been frequently seen and detected by ultrasound and radar in young ʻōhiʻa forests as well as non-native forests, particularly on the edges of clearing. Hawaiian hoary bats are vulnerable to disturbance during the summer pupping season and require special mitigation measures.

No feral mammals were detected but it is possibly that pigs (*Sus scrofa*), small Indian mongooses (*Herpestes a. auropunctatus*), mice (*Mus* spp.), rats (*Rattus* spp.), cats (*Felis catus*) and dogs (*Canis f. familiaris*) could occasionally be present.
There are no native terrestrial reptiles or amphibians in Hawaiʻi. We did not observe any, but various species of skink (Family: Scincidae), geckoes (Family: Gekkonidae) and anoles (Genus: Anolis) could possibly be present. The highly invasive coqui frog (*Eleutherodactylus coqui*) is also known from the general area. None of these alien mammals, reptiles or amphibians have conservation value and all are deleterious to native flora and fauna.

The scope of work for the survey did not include invertebrates, but in general, rare, threatened or endangered invertebrates on the Island of Hawaiʻi tend to be associated with either high-elevation, diverse rainforests (e.g., various *Drosophila*); coastal dry shrubland (e.g., various *Hylaeus*); the summit of Mauna Kea (*Nysius wekiuicola*); extremely dry, disturbed ʻaʻa flows (*Manduca blackburnii*); or aquatic settings (various *Megalagrion*). Neither intensely invaded albizia forests nor young lowland ʻōhiʻa forests are likely settings for any threatened or endangered invertebrates. It is unlikely that any rare, threatened or endangered invertebrates would be expected from this property.

Impacts and Mitigation Measures for Fauna

We offer the following recommendations in order to avoid impacts to endangered but widespread native birds and the Hawaiian hoary bat:

- To minimize impacts to the endangered Hawaiian hoary bat, we recommend that trees taller than 15 feet not be removed or trimmed during the bat birthing and pup rearing season (June 1 through September 15).
- To minimize impacts to Hawaiian hawks, we recommend avoiding earthmoving within 100 meters of tall trees or tree cutting during the hawk breeding season (March 1 through September 30). If this time period cannot be avoided, arrange for a hawk nest search to be conducted by a qualified biologist. If hawk nests are present in or near the project site, all land clearing activity should cease until the expiration of the breeding season.
- Outdoor lighting may attract endangered seabirds, which may become disoriented by the lighting, resulting in birds being downed. Although it is recognized that the site is industrial and night operations must occur, the adverse effects of lighting should be minimized to the extent feasible. To avoid potential seabird downing through interaction with outdoor lighting, we recommend using no unshielded

equipment lighting after dark between the months of April and October. All permanent lighting should be kept to minimum necessary levels, with shielded lights so as to lower the ambient glare, in conformance with the Hawaiʻi County Outdoor Lighting Ordinance (Hawaiʻi County Code Chapter 9, Article 14). Furthermore, where possible, exterior lighting should consist of blue-deficient lighting such as filtered LED lights or amber LED lights, with a Correlated Color Temperature (CCT) of 2700 Kelvin. This will not only reduce the risk that threatened or endangered seabirds may be attracted to and then disoriented by lighting, but will also assist in protecting dark skies.

- Although not expected on the site, if nēnē nests or resting individuals are discovered during site preparation or work, the State of Hawaiʻi DLNR should be contacted to determine measures to avoid harm to this endangered bird.

A final biological concern related to the disposal of graded material is the spread of invasive species. In this case, there may be some concern for little fire ants, which are rampant in Lower Puna (although we did not detect any on the property). If offsite movement of excavated rock or vegetation is involved, we recommend that PGV consult with the Hawaiʻi Division of Forestry and Wildlife and the Big Island Invasive Species Council in order to solicit comment and potential additional measures that could reasonably be adopted.

Report Limitations

No biological survey of a large area can claim to have detected every species present. Some plant species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. Thick brush can obscure even large, healthy specimens. Birds utilize different patches of habitat during different times of the day and seasons, and only long-term study can determine the exact species composition. The findings of this survey must therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

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Figure 1. Property Map

Figure 2. Property Vegetation Photos

2a. Dominant tree albizia ▲

▼ 2b. ‘Ōhi‘a on upper rim of spatter cone

Figure 2. Property Vegetation Photos

2c. Understory non-native trees on kipuka edge ▲ ▼ 2d. One of a few ama‘u tree ferns

Figure 2. Property Vegetation Photos

2e. Sword fern ground cover ▲ ▼ 2f. Native uluhe fern in spatter cone crater

Table 1. Plant Species Observed on Property

Scientific Name	Family	Common Name	Life Form	Status*
Adiantum hispidulum	Pteridaceae	Rough Maidenhair	Fern	A
Ageratum conyzoides	Asteraceae	Ageratum	Herb	A
Andropogon virginicus	Poaceae	Broomsedge	Herb	A
Arundina bambusifolia	Orchidaceae	Bamboo Orchid	Herb	A
Begonia sp.	Begoniaceae	Begonia	Herb	A
Bidens pilosa	Asteraceae	Beggar's Tick	Herb	A
Buddleja asiatica	Buddlejaceae	Dog Tail	Shrub	A
Canavalia cathartica	Fabaceae	Maunaloa	Vine	A
Cecropia obtusifolia	Urticaceae	Cecropia	Tree	A
Cenchrus purpureus	Poaceae	Elephant Grass	Herb	A
Chamaecrista nictitans	Fabaceae	Partridge Pea	Herb	A
Christella parasitica	Thelypteridaceae	Christella	Fern	A
Cibotium glaucum	Dicksoniaceae	Hapu'u Pulu	Fern	E
Clidemia hirta	Melastomataceae	Clidemia	Herb	A
Clusia rosea	Clusiaceae	Autograph Tree	Tree	A
Conyza bonariensis	Asteraceae	Conyza	Herb	A
Crotalaria pallida	Fabaceae	Smooth Rattlepod	Herb	A
Crotalaria trichotoma	Fabaceae	Curara Pea	Herb	A
Cyperus polystachyos	Cyperaceae	Pycreus Sedge	Herb	I
Desmodium incanum	Fabaceae	Spanish Clover	Herb	A
Desmodium tortuosum	Fabaceae	Florida Beggarweed	Herb	A
Dicranopteris linearis	Gleicheniaceae	Uluhe	Fern	I
Digitaria sp.	Poaceae	Crabgrass	Herb	A
Emilia sonchifolia	Asteraceae	Flora's Paintbrush	Herb	A
Euphorbia hirta	Euphorbiaceae	Garden Spurge	Herb	A
Euphorbia hypericifolia	Euphorbiaceae	Graceful Spurge	Herb	A
Euphorbia hyssopifolia	Euphorbiaceae	Spurge	Herb	A
Falcataria moluccana	Fabaceae	Albizia	Tree	A
Heterocentron subtriplinervium	Melastomataceae	Pearlflower	Shrub	A
Hyptis pectinata	Lamiaceae	Hyptis	Herb	A
Machaerina mariscoides subsp. meyenii	Cyperaceae	'Uki	Herb	I
Megathyrsus maximus	Poaceae	Guinea Grass	Herb	A
Melastoma candidum	Melastomataceae	Asian Melastome	Shrub	A
Melinus minutiflora	Poaceae	Molasses Grass	Herb	A
Melochia umbellata	Sterculiaceae	Melochia	Tree	A
Metrosideros polymorpha	Myrtaceae	'Ōhi'a	Tree	E
Miconia calvescens	Melastomataceae	Miconia	Tree	A
Mimosa pudica	Fabaceae	Sleeping Grass	Herb	A
Nephrolepis multiflora	Nephrolepidaceae	Sword Fern	Fern	A
Paederia foetida	Rubiaceae	Maile Pilau	Vine	A
Phymatosorus grossus	Polypodiaceae	Maile Scented Fern	Fern	A
Pityrogramma calomelanos	Pteridaceae	Silver Fern	Fern	A
Pluchea symphytifolia	Asteraceae	Pluchea	Shrub	A
Polygala paniculata	Polygalaceae	Milkwort	Herb	A
Psidium cattleianum	Myrtaceae	Strawberry Guava	Tree	A
Sadleria cyatheoides	Blechnaceae	Ama'u Fern	Fern	E
Schizachyrium condensatum	Poaceae	Beardgrass	Herb	A

Sida rhombifolia	Malvaceae	Broomweed	Herb	A
Spathoglottis plicata	Orchidaceae	Philippine Ground Orchid	Herb	A
Spermococe assurgens	Rubiaceae	Spermacoce	Herb	A
Sphenomeris chinensis	Lindseaceae	Pala‘a	Fern	I
Tibouchina herbacea	Melastomataceae	Cane Tibouchina	Herb	A
Trema orientalis	Ulmaceae	Trema	Tree	A

Table 2. Typical Bird Species Expected to at Least Occasionally Use Property

Scientific name	Common name	Status
Acridotheres tristis	Common Myna	Alien Resident
Buteo solitarius	Hawaiian Hawk	Native Resident
Cardinalis cardinalis	Northern Cardinal	Alien Resident
Carpodacus mexicanus	House Finch	Alien Resident
Crithagra mozambica	Yellow-fronted Canary	Alien Resident
Gallus gallus domesticus	Chicken	Alien Resident
Geopelia striata	Zebra Dove	Alien Resident
Leiothrix lutea	Red-billed Leiothrix	Alien Resident
Leucodioptron canorum	Melodious Laughing-thrush	Alien Resident
Streptopelia chinensis	Spotted Dove	Alien Resident
Zosterops japonicus	Warbling White-eye	Alien Resident

List based on long-term observations of similar habitat in Puna (Geometrician 2016, 2021)

APPENDIX H

ARCHAEOLOGICAL FIELD INSPECTION

SCS 2839 AFI-1

ARCHAEOLOGICAL FIELD INSPECTION AND LITERARATURE REVIEW REPORT FOR THE PUNA GEOTHERMAL REPOWER PROJECT IN KAPOHO AHUPUA‘A, PUNA DISTRICT, HAWAI‘I ISLAND, HAWAI‘I [TMK: (3) 1-4-001: 001, 002, AND 019]

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INTRODUCTION

Scientific Consultant Services, Inc. (SCS) conducted an archaeological field inspection (AFI) of a 9.0-acre portion of the Puna Geothermal Venture (PGV) property [TMK: (3) 1-4-001:002 (por.) located in Kapoho Ahupuaʻa, Puna District, Island of Hawaiʻi, Hawaiʻi (Figure 1 through Figure 3). The existing PGV facilities, including roads and lots, cover approximately 4.6 acres (primarily within Parcel 002 and 019) of the of the overall 811.649-acre property (see Figure 3). The remaining 807.049 acres are undeveloped open land. Roughly 590 acres (73%) of the property ground surface is covered by portions of the 1955 and 2018 lava flows (Figure 4). The property address is 14-3860 Pāhoa-Kapoho Road [Parcel 019] and 14-3864 Pāhoa Kapoho Road [Parcel 002]. Parcel 001 is not assigned a street address. The project area is located approximately 4.15kilometers (km) east-southeast of Pāhoa town. The property is privately owned by Kapoho Land Development Co., Ltd (KLDC) and s leased by PGV.

PGV, a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant on the project area property and proposes to replace the current 12 operating power-generating units with new more efficient power-generating units and replace and install new piping (Puna Geothermal Repower Project, hereafter PGV project) (Figure 5). The proposed Project would be constructed within the current PGV facility site fence line, would include grading of 13.0 acres of the 2018 and 1955 lava flows, and would increase power production from 38 to 46 megawatts (MW) in Phase 1 and further increase production to 60 MW in Phase 2.

The AFI was conducted on a 9.0-acre portion of previously unsurveyed PGV property as supporting documentation for an Environmental Impact Study (EIS) for the proposed Puna Geothermal Repower project. The project area is dominated by two 1955 spatter cones and is surrounded to the north, south, and west by the 2018 lava flow. The east side of the project area is bounded by an existing dirt road. The study was conducted under subcontract to Stantec Consulting Services, Inc. Stantec is preparing the EIS for the proposed project.

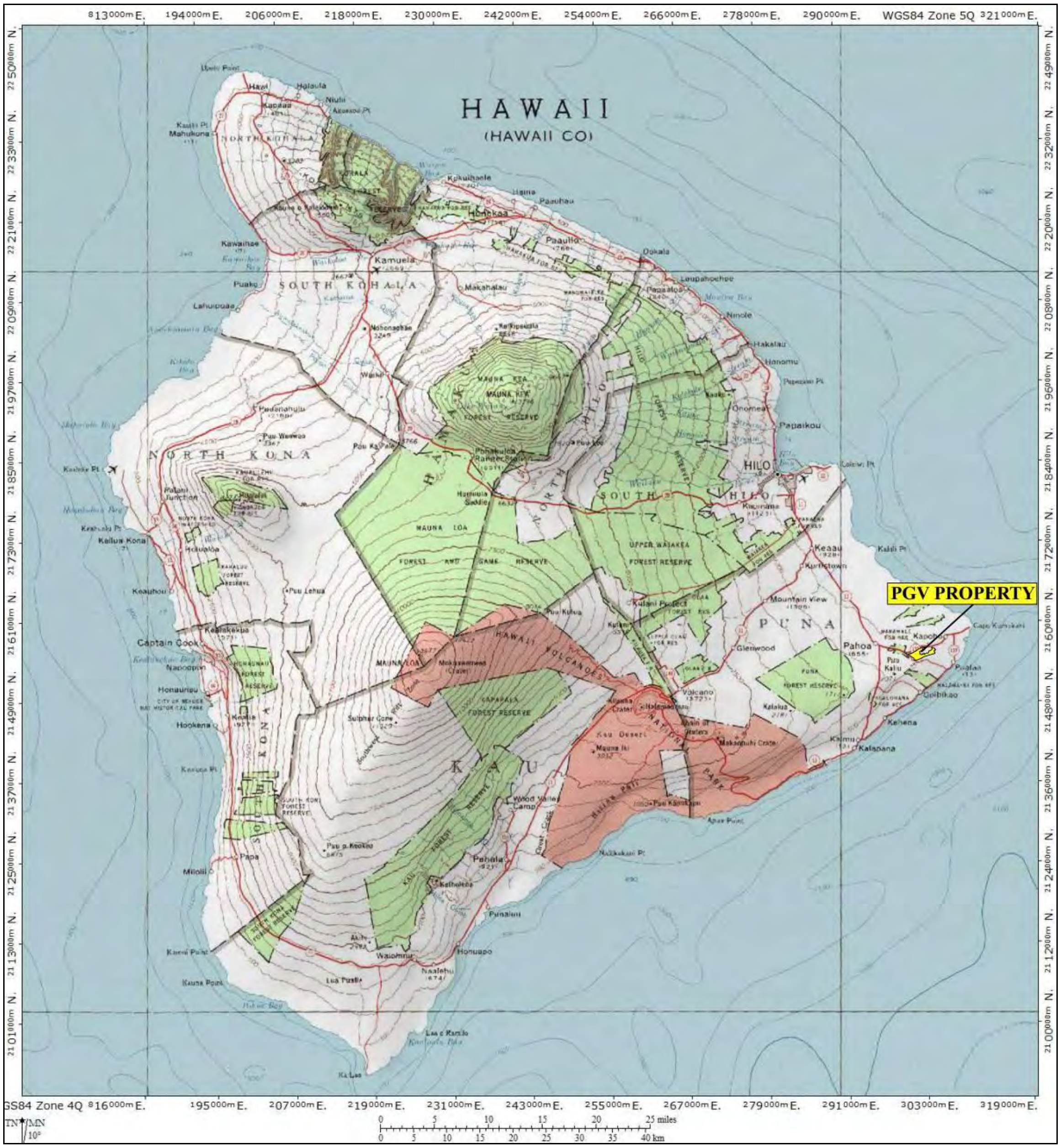

Figure 1: 5,500 K-Series Map of Hawai'i Showing Location of Project Area (National Geographic Topo!, 2003. Data Sources: National Geographic Society, USGS).

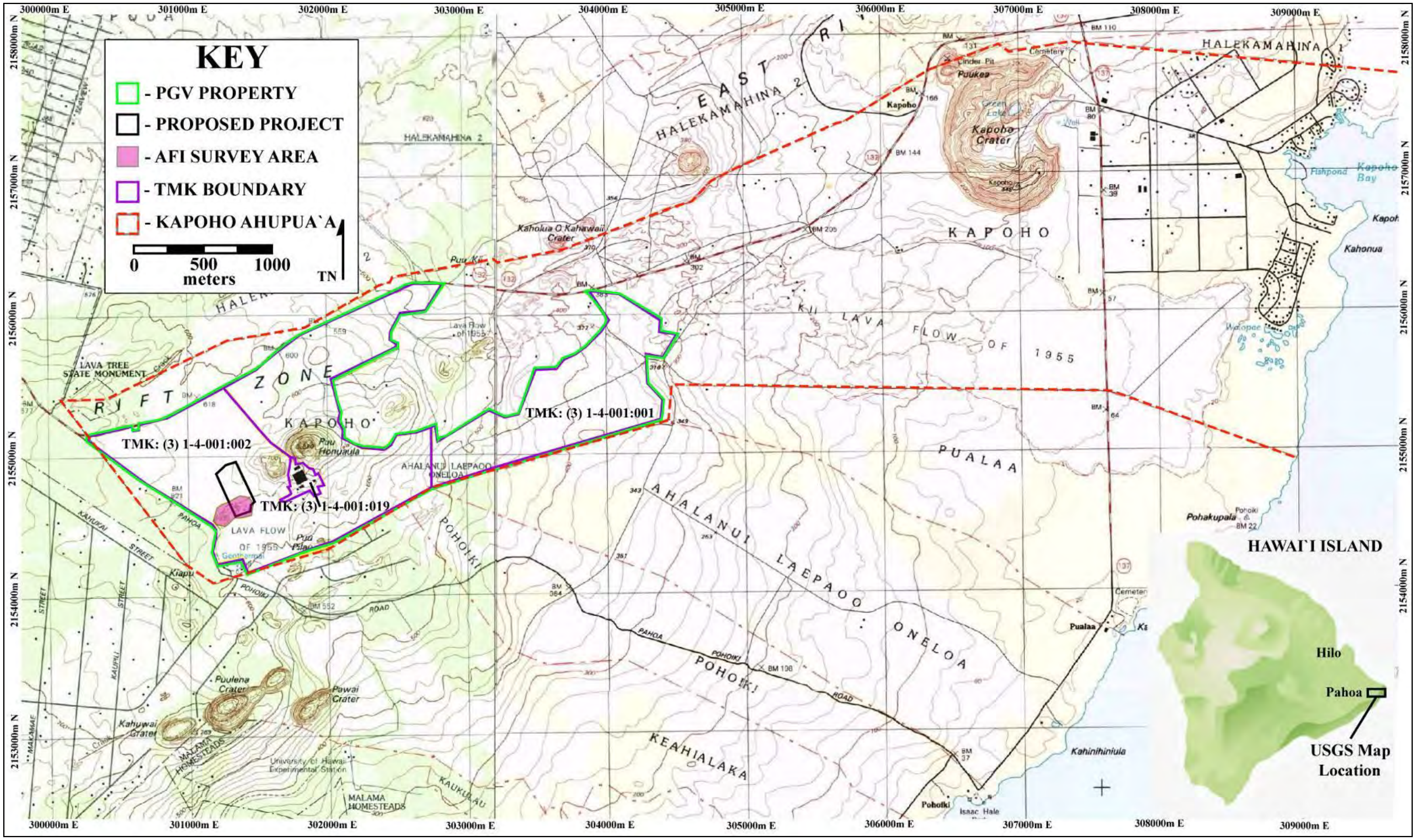

Figure 2: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai‘i Planning Department, 2022).

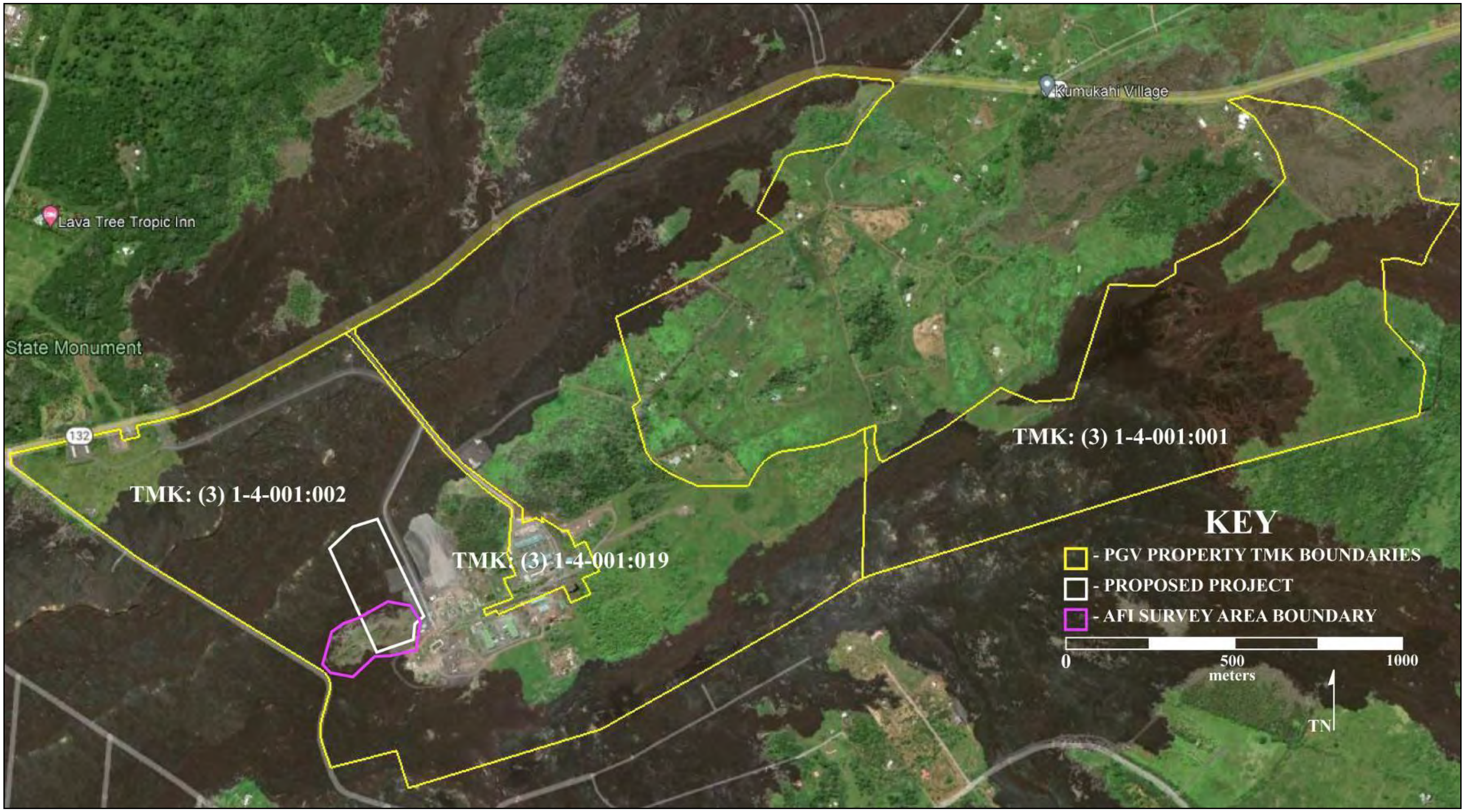

Figure 3: Aerial Photograph Showing Project Area, Kapoho, HI, Zone 5 North, 302466 m E, 2155320 m N. (Google Earth, 2021 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

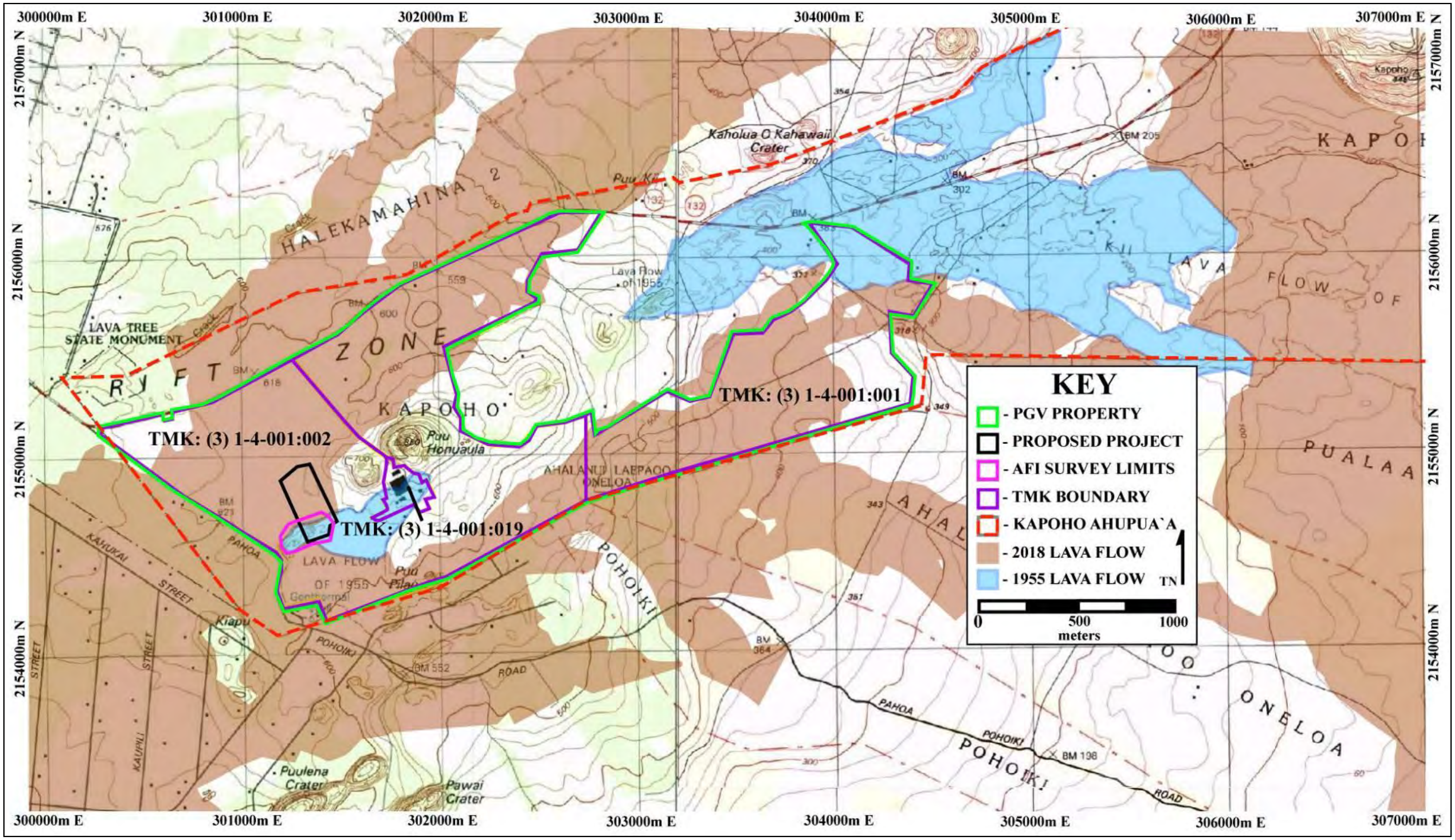

Figure 4: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Area and Modern Lava Flows (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: USGS, National Geographic and County of Hawai'i Planning Department, 2022).

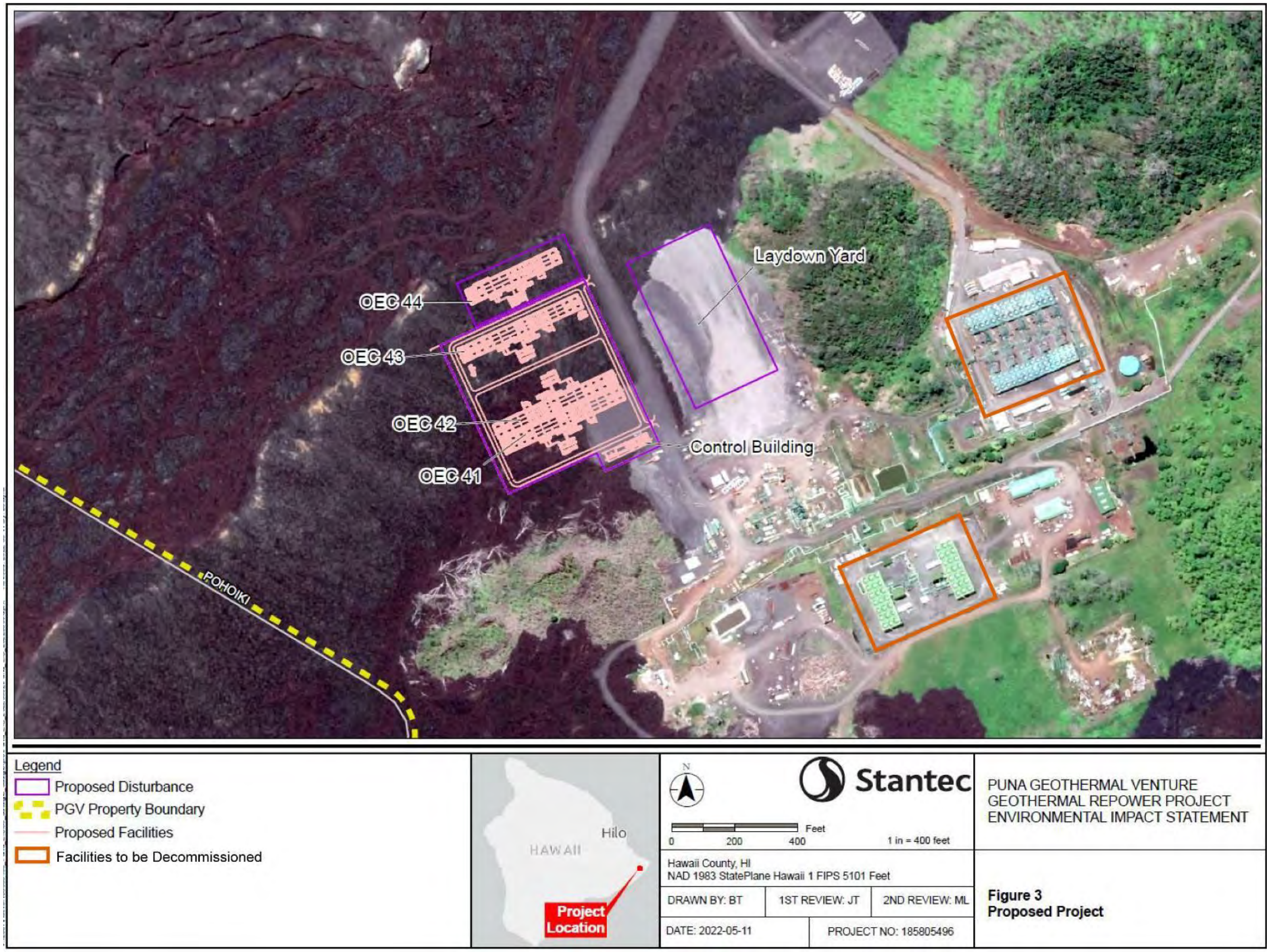

Figure 5: Aerial Photograph Showing Existing Facilities and Proposed Project Work (Adapted from Stantec 2022).

METHODOLOGY

Prior to fieldwork, archival research was conducted using both published and unpublished ethnographic, historical and previous archaeological studies within Puna District and Kapoho Ahupuaʻa. A search of geological maps, aerial photographs, historical maps, historical and ethnographic documents, land-use records, and previous archaeological reports was conducted at the University of Hawaiʻi – Hilo Moʻokini Library, Ulu Kau, County of Hawaiʻi Planning Department and the State Historic Preservation Division (SHPD) Hilo library. These included legendary accounts of native Hawaiian and early foreign writers; early historical journals and narratives; historic maps and land records such as Land Commission Awards, Royal Patent Grants, and Boundary Commission records; historic accounts, and previous archaeological project reports.

A 100% pedestrian survey of the entire project area was conducted on October 7, 2022 by SCS Senior Archaeologists Glenn Escott, M.A and Suzan Escott, B.A. A series of northeast-southwest transects, spaced 1.0 to 2.0 meters apart was walked across the project area. Vegetation was not too thick and ground visibility was good. Glenn Escott was the principal investigator and project director for the study.

ENVIRONMENTAL SETTING

The project area is situated on level to moderately sloping land at 300.0 to 650.0 feet (91.0-198.0 m) above mean sea level (amsl) (see Figure 4). There project area is along a portion of the Lower East Rift Zone which is visible as a series of spatter cones and cinder cones situated southwest to northeast across Kapoho Ahupuaʻa (see Figure 4). The project area substrate is two spatter cones from the 1955 Kīlauea lava flows surrounded to the north, south and west by the 2018 Kīlauea lava flow.

There are scattered small *ʻōhiʻa lehua* (*Metrosideros polymorpha*) trees grasses, shrubs and albizia (*Falcataria moluccana*) trees growing within the project area. Rainfall in the project area is between 120 and 160 inches per year (Giambelluca et al. 2013). There are no gulches or major gulches or drainages within the project area.

HISTORICAL AND CULTURAL CONTEXTS

Many archaeologists believe that Hawaiʻi Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; Mulrooney et al. 2011; Rieth et al. 2011; Wilmhurst et al. 2011a and 2011b). An article published in the Journal of Archaeological Science reviewing radiocarbon dates recovered at archaeological sites on the Island of Hawaiʻi suggests that, by relying on only carbon samples from short-lived plant remains, the most reliable dates point to initial Polynesian colonization of Hawaiʻi Island occurring between A.D. 1220 and 1261 (Rieth et al. 2011:2747).

The recent studies that included Hawaiʻi Island short-lived radiocarbon dating samples assess those recovered exclusively from sites in North Kohala, South Kohala and Hāmākua (Rieth et al. 2011) or from South Point (Ka Lae) in Kaʻū (Dye 1992; Kirch 2011). Many of the former region sites are rock shelters and the latter are sand dune sites. Sixteen radiocarbon samples from North Kohala, South Kohala and Hāmākua returned conventional radiocarbon ages from 400 to 781 years before present (Rieth et al. 2011:2745). The early date is consistent with ranges of A.D. 1040-1090 and A.D. 1120-1280 from Ka Lae in South Point, Kaʻū discussed by Kirch (2011:20). All of the samples were recovered from sites in arid environments that have not been disturbed by modern development or human activity. There are no radiocarbon dating samples from Hilo or Puna where there has been a lot of development associated disturbance and where environmental conditions for radiocarbon sample preservation is less favorable.

Historians and ethnographers have long believed that Hilo was one of the first settlements on the Island of Hawaiʻi (Handy and Handy 1972:12; Maly 1996:1). The rich marine resources of Hilo Bay and the gently sloping forests of Mauna Loa and Mauna Kea provided abundant resources. Fresh water was available from the Wailoa and Wailuku rivers and smaller streams such as Waiākea, Waiolama, Pukihae, and ʻAlenaio (Maly 1996:1). While there are no streams in Puna, there is enough rainfall so that it sometimes seeps from the ground surface at the coast and collects in small pools.

The project area is located in Kapoho Ahupuaʻa, Puna District, roughly 28.0 kilometers southeast of Hilo. Puna District is located on the eastern tip of Hawaiʻi Island and extends from the ocean to the eastern edge of Kīlauea-iki Crater (Halemaʻumaʻu) at 4,000 ft amsl and Kūlani cone at 5,518 ft amsl (Figure 6). The division of Hawaii Island into six *moku-o-loko* (districts) and smaller *ahupuaʻa* was formalized during in the early sixteenth century under the rule of ʻUmi-a-Līloa (Maly 1999:11). The divisions are part of a sociopolitical agricultural land management system that likely inculcated earlier natural environmental factors, agricultural zones, family relationships, and traditional Hawaiian cultural values.

Puna is translated as well-spring (Matsuoka et al. 1996:33). There were 57 *ahupuaʻa* recorded within the *moku-o-loko* of Puna during the eighteenth century, though the boundaries of some were not mapped. From north to south, the *ahupaʻa* are ʻŌlaʻa, Keaʻau, Waikahekahenui, Waikahekahe, Waikahekaheiki, Makuʻu, Pōpōkī, Hālo, Keonepokoiki, Keonepokonui, Waiakahiula (*mauka*), Waiakahiula (*makai*), Kaʻohe (*mauka*), Kaʻohe (*makai*), Honolulu, Nānāwale, Waʻawaʻa, Kahuwai, Halepuaʻa, Kanekiki, Puua, Kula, Kapoho, Pūʻālaʻa, Ahalanui, Laepaoʻo, Pohoiki, Keahialaka, Kaukalau, Ki, Malama, Kauaea, Iliʻililoa, Opihikao, Kaueleau, Kukuihala, Kamāʻili, Keauohana, Kahena, Kīkala 1, Kīkala 2, Kēōkea, Kaimū, Kalapana, Kupahua, Hulunanai, Kahaualeʻa, Poupou 1, Poupou 2, Pūlama, Kamoamoa, Laeapuki, Pānaui-iki, Pānauinui, Kealakomo, Kahue, and ʻĀpua.

Kapoho Ahupuaʻa is located from the ocean just below Cape Kumukahi at the eastern tip of Hawaii Island to 680 ft amsl. Kapoho is translated literally as "the depression" (Pukui et al. 1974:89), a reference to the large Kapoho Crater 2.0 km west of the coastline. The crater is the remains of a cone formed between 400 and 700 years ago. Puʻu Honuaʻula, second large cone formed between 200 and 400 years ago, is located within the project area. Puʻuhonuaʻula is translated literally as "red place of refuge" (Pukui et al. 1974:197).

Many of the traditional *moʻolelo* (legendary accounts) passed down orally refer to the specific *moku-o-loko*, *ahupuaʻa*, *puʻu* (cones), and other natural geological features where the stories take place.

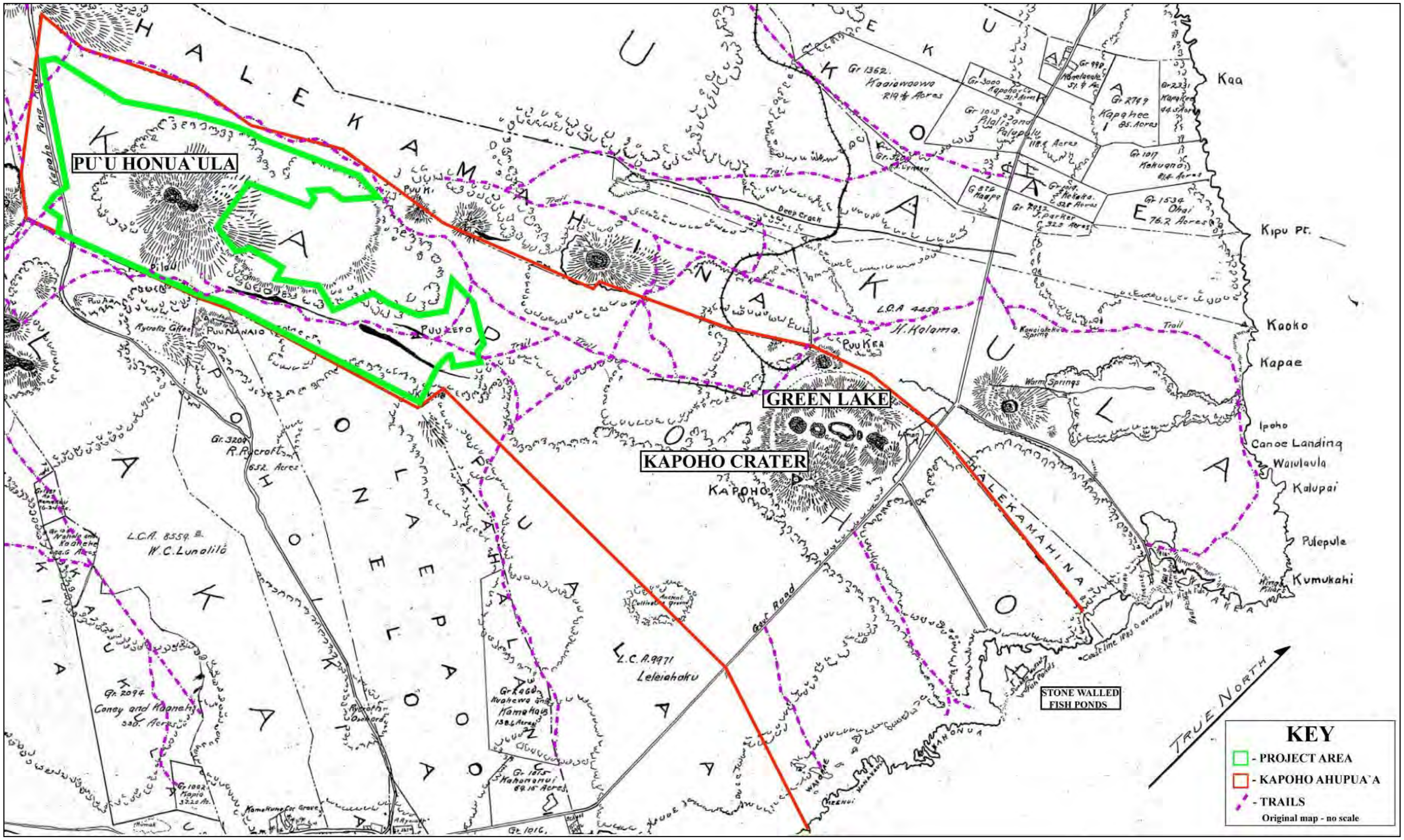

Figure 6: Portion of Puna District Map Showing Kapoho Ahupuaʻa Trails and PGV Property Boundaires (Baldwin 1902).

TRADITIONAL ACCOUNTS (*MOʻOLELO*) OF PUNA AND KAPOHO

There are numerous *moʻolelo* and *ʻōlelo noʻeau* (proverbs and sayings) that tell of Puna's natural beauty, its gods (*akua* and *aumakua*) and places, and its inhabitant's practices. A detailed list and descriptions of *akua* and *aumakua* associated with Puna can be found ion Uyeoka et al. (2014). An in-depth ethnographic study for the Hawaii Geothermal Project documenting traditional accounts and beliefs can be found in Matsuoka et al. (1996).

Puna is closely associated with Kāne, god of the verdant forests of Puna and the Hawaiian god of sun light, also known as Kāne-i-ka-nohi-o-ka-l (Kāne-in-the-eyeball-of the sun) (Maly 1999:9). Kāne is foremost among the great gods and is associated with procreation, regeneration, the dawn, sunlight, lightning, refreshing spring water, irrigated agriculture, and fishponds (Uyeoka et al. 2014:65-66). Kāne and Lono were the deities most commonly addressed by those who offered prayers for the restoration of any one to health" (Uyeoka et al. 2014:72). Westervelt recounts that

> When Hawaiians, who had been ill, recovered, they frequently vowed to make a "journey of health." This meant that they came to the place now known as Hilo Bay. There they bathed by the beautiful little Coconut Island, fished up by the demi-god Maui. There they swam around a stone known as Moku-ola (The-island-of-life). Then they walked along the seashore day after day until they were below the volcano of Kilauea. They went up to the pit of Pele, offered sacrifices, and then followed an overland path back to Hilo. It was an ill omen if for any reason they went back by the same path. They must make the "journey of health" with the face forward. Hopoe (The dancing stone), Kapoho (The green lake), and Kumu-kahi were among the places which must be visited. {Westyervelt 1916:27]

One *ʻōlelo noʻeau* says "*Puna, ka ʻāina i ka haupo o Kāne* – the land [held] in the bosom of Kāne (Maly 1999:9). Another says of Puna "*Ke one lauʻena a Kāne* – the rich, fertile land of Kāne (Uyeoka et al. 2014:173). Puna is known through traditional oral accounts and proverbs for its groves of *pū hala* (pandanus trees) with their fragrant clusters of *hua hala* (pandanus fruit born on the female trees) and the *hīnano* (blossoms of the male pandanus) (Maly 1999:9).

The traditional oral accounts of early Puna recognize the presence of a volcanic god of fire, called ʻAi-lāʻau (the devourer of forests) that live within Kīlauea, before the arrival of Pele to the island (Westervelt 1916:1). While ʻAi-lāʻau lived within Kīlauea, he also inhabited the East Rift Zone craters for a time, before returning to his main residence within Kīlauea. It was there he resided when Pele first arrived.

Pele first landed on the island along the shore of Puna and proceeded inland to meet ʻAi-lāʻau and to find a new home with him. ʻAi-lāʻau, seeing Pele coming, was filled with fear, ran away, became utterly lost, and vanished (Westervelt 1916:1). Pele made her new home within Kīlauea.

Ke One Lauʻena A Kāne, The Great Sands of Kāne

Traditional *moʻolelo* describe early Kaʻū and Puna as beautiful lands without lava beds (Uyeoka et al. 2014:86). It was said that there was only earthen soil from one end to the other. The *moʻolelo* tell of the existence of a very long sandy stretch called Keonelauenaakāne (ʻKāne's great sand stretch') in the district of Puna that was covered by lava and that transformed Puna into a land of lava rock (McGregor 2007:147).

> The *moʻo*, Wakakeakaikawai and Punaʻaikoaʻe were destroyed by Pelehonuamea of the eternal fires. According to this legend, the fight between these *moʻo* and Pelehonuamea began in Punaluʻu in Kaʻū, continued in Puna, and ended in Waiākea in Hilo. Through the course of the battle, a long stretch of sand extending from Waiākea, Hilo, to Pānau in Puna, called Keonelauenaakāne, was covered with lava. Because Waka ran through Puna, with Pelehonuamea in pursuit, most of the land in Puna became covered with rough and smooth lava and remains so to this day. The famous stretch of sand disappeared. Only traces of it can be seen in small pockets, scattered here and there from Waiākea to Puna (McGregor 2007:147-148).

Pelehonuamea and Keliʻikuku

In the nineteenth century, Frenchman Jules Remy recorded a story told to him by an *aliʻi* of Kona called Kanuha. According to the story (Westervelt 1993:33-34), an *aliʻi* from Puna named Keliʻikuku was boasting of Puna to a prophet of Pele from Kauai named Kane-a-ka-lau. Keliʻikuku boasted of Puna's charms, abundance, and rich sandy plains where everything grows luxuriantly. Pele, hearing Keliʻikuku's boasting, covered the fertile plains and forests of Puna with burning lava. Kanuha believed the story might have taken place during the seventeenth century (McGregor 2007:149).

Pele was known to become impatient with the misdeeds of others and would often

> [S]end a flood of lava in her anger and burn everything up. Earthquakes came when Pele stamped the floor of the fire-pit in anger. Flames thrusting themselves through cracks in a breaking lava crust were the fire-spears of Pele's household of au-makuas or ghost-gods. Pele's voice was explosive when angry. Therefore it was called "pu." [Westervelt 1916:14]

There are numerous traditional accounts of Pele punishing arrogant and impudent chiefs, including chief Kahawali (Matsuoka et al. 1996:39-40), chief Kumu-kahi (Westervelt 1916:27), chief Papalauahi (Westervelt 1916:28), Kapapala (Westervelt 1916:30), and Kealohalani (Uyeoka et al. 2014:90). Pele punished them by sending out rivers of lava that often chased the offenders to the sea where they or their families and lands were covered and destroyed. Pele would also reward those who treated her with generosity and proper respect (Uyeoka et al. 2014:90). According to Westervelt, offerings made to appease Pele include fruits, flowers, lei, pigs, chickens, fish, and men (Westervelt 1916:14).

Pōhaku-o-Hanalei and Pōhaku-o-Lēkia

Pōhaku-o-Hanalei and Pōhaku-o-Lēkia are *pōhaku* (stones) that reside within the *ahupuaʻa* of Kapoho in Puna. These *pōhaku* are situated on either side of the lake called Wai a Pele, also known as Green Lake today (Pukui; Elbert; Moʻokini 1974:221) (Uyeoka et al. 2014:81). When Pele and her immediate family came from Tahiti, certain rock *kupua* accompanied her to the islands of Hawaiʻi, namely…Pōhakuolēkia lived in Kapoho, Puna (Uyeoka et al. 2014:81)

HISTORIC ACCOUNTS OF PRE-CONTACT ERA PUNA

Historical accounts pertaining to lands of the project area region are scarce but provide some information on traditional residence patterns, land-use, and subsistence.

Situated along the windward coast of Hawaiʻi Island, Puna is a verdant and abundant district with good rainfall and rich soils. However, it is also subject to volcanic eruptions and has been covered by new lava in many places over the last 1,000 years (Cordy 2000:17, and 22). Much of the district's coastal areas have thin soils, and there are no good deep water harbors. The ocean along the Puna coast is often rough and wind-blown.

As a result of these two factors, settlement patterns in Puna tend to be dispersed and without major population centers in contrast to North and South Kona, North and South Kona, and Hilo and Hāmākua (Figure7). Villages in Puna tend to be spread out over larger areas and often are inland, sometimes away from the coast, where the soil is better for agriculture (Cordy 2000: 45). At this time, a strict social hierarchy and a system of *kapu* (taboo) regulating hierarchical social interactions did not exist.

The lack of population centers had an effect on the development of a hierarchy of district rulers. Puna was often not strongly tied together by a tight web of allegiances between *aliʻi* and *konohiki*. As a result, Puna was often conquered and ruled by stronger district leaders in Hilo or Kaʻū (Kamakau 1992:17 and 77; Matsuoka et al. 1996:41).

The earliest written historical accounts of Puna include the arrival of Pāʻao, a priest, prophet, chief and navigator from Tahiti or Samoa. Pāʻao landed in Puna sometime o the 11th cnetury and built his first *heiau* in Pulama Ahupuaʻa, dedicated to ʻAhaʻula, called Wahaʻula (Thrum 1908:38; Kamakau 1991:100). Wahaʻula was a walled *luakini heiau* approximately 132 ft by 72 ft with walls that were between eight and ten feet in height. The structure was oriented along the cardinal points of the compass.

The earliest account of Hilo appears in ʻUmi-a-Līloa's (1600–1620) conquest of the Island of Hawaiʻi, which establishes Hilo as a royal center by the sixteenth century. In the account, ʻUmi-a-Līloa began his conquest of the Island of Hawaiʻi by defeating chief Kulukuluʻā, who lived in Waiākea, the other chiefs of Hilo, ʻImaikalani, chief of Kaʻū, and Huaʻā, the chief of Puna (Kamakau 1992:16–19). ʻUmi-a-Līloa's second son, Keawe-nui-a-ʻUmi, ruled Hāmākua, Hilo, and Puna from his residence at Hilo (Kamakau 1992: 34). It was from Hilo that he waged war on the Kona chiefs and unified the island. Keawe-nui-a-ʻUmi's descendants single handedly continued rule for many generations from Hilo though Puna at times rebelled and was controlled by Puna and Kaʻū chiefs (Kamakau 1992:106; Matsuoka et al. 1996:42-43).

After the death of Keawe-nui-a-ʻUmi the kingdom was divided into three parts and was established under warring chiefs; Hilo was ruled by Kumalae-nui-puʻawa-lau and his son Makua *(*Kamakau 1992: 45). It was during the period of time and the following period of Kalaniʻōpuʻu's rule that Puna continued to be ruled the rebellious chief Imakakoloa. It was during this time also that Kamehameha I was born.

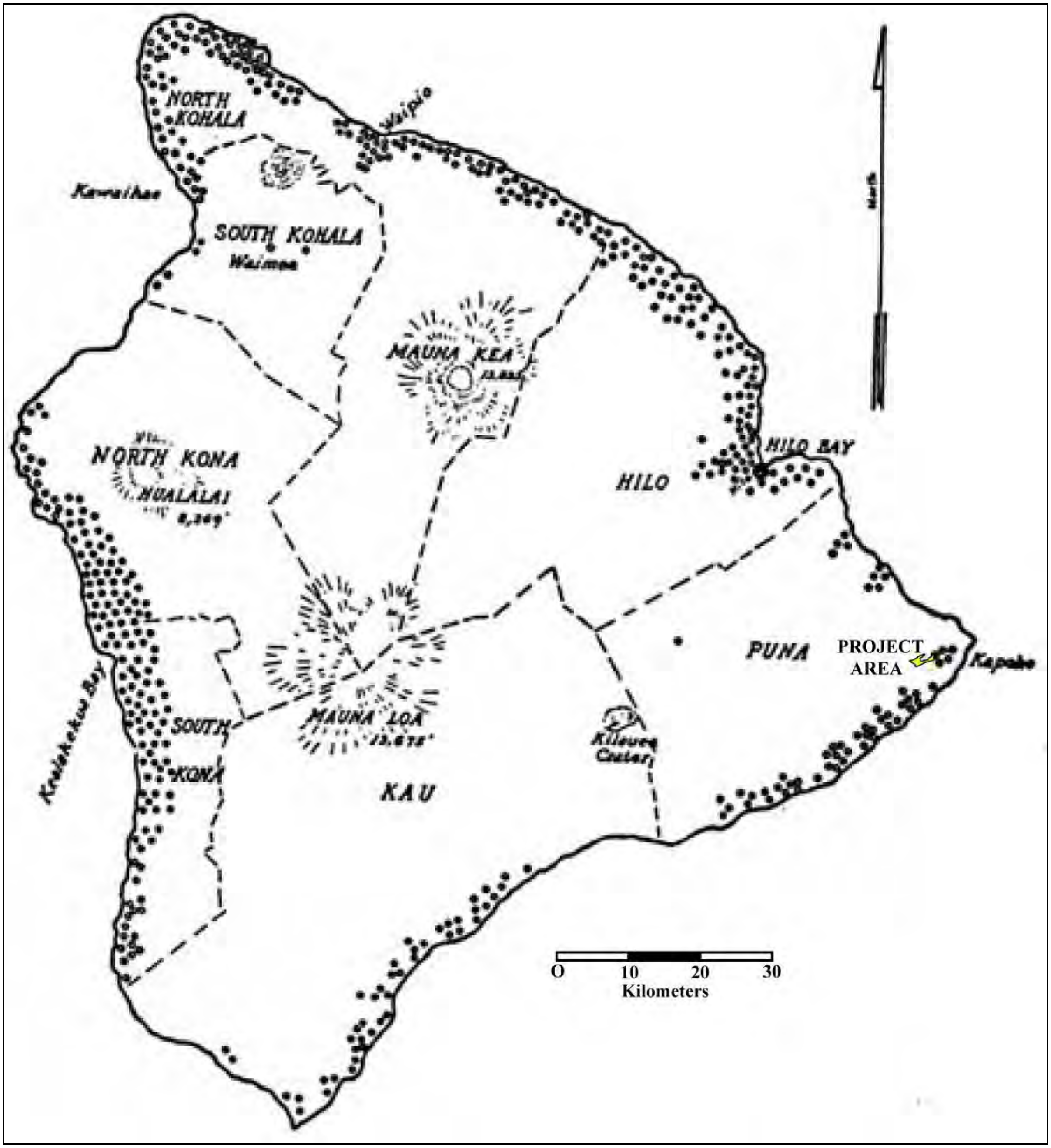

Figure 7: Map of Hawaii Island Population Concentrations by District (Coulter 1853).

Kalaniʻōpuʻu and his warriors travelled to Puna and defeated Imakakaloa (Kamakau 1992:108-109). Kalaniʻōpuʻu's grandson, Keoua Kuahuʻula and nephew Kamehameha I vied for control over the six chiefdoms constituting the island kingdom and Keoua conquered Hilo chief Keawe-mau-hili and harvested the benefits for a short time only to be vanquished by Kamehameha I late in 1791.

Puna District was famous for its valuable products, including "hogs, gray *kapa* cloth (*ʻeleuli*), tapas made of *māmaki* bark, fine mats made of young pandanus blossoms (ʻ*ahuhinalo*), mats made of young pandanus leaves (*ʻahuao*), and feathers of the *ʻōʻō* and *mamo* birds" Kamakau 1992:106). Puna was also famous for its abundant *ulu* (breadfruit).

HISTORIC ACCOUNTS OF CONTACT ERA PUNA

William Ellis passed through Puna in 1823 while travelling along the coastal trail from Kīlauea to Waiākea Ahupuaʻa in Hilo (Figure 8). Ellis' journey took him along the coast near past Kapoho Crater and Green Lake. His journal includes descriptions of the villages and landscape he passed through, descriptions of gardens and the availability and quality of drinking water, population estimates, and *moʻolelo* are the most detailed and complete from the Contact Era accounts of Puna. It should be noted that Ellis' own western religious and cultural values sometimes distort his representations of traditional Hawaiian cultural values and beliefs he encountered. Ellis' description of Kapoho Crater follows below.

> A cluster, apparently of hills three or four miles round, and as many hundred feet high, with deep indented sides, overhung with trees, and clothed with herbage, standing in the midst of the barren plain of lava, attracted our attention.
>
> We walked through the gardens that encircled its base, till we reached the S. E. side, where it was much lower than on the northern parts. Here we ascended what appeared to us to be one of the hills, and, on reaching the summit, were agreeably surprised to behold a charming valley opening before us. It was circular, and open towards the sea.
>
> The outer boundary of this natural amphitheatre was formed by an uneven ridge of rocks, covered with soil and vegetation. Within these there was a smaller circle of hills, equally verdant, and ornamented with trees. The sides of the valley, which gradually sloped from the foot of the hills, were almost entirely laid out in plantations, and enlivened by the cottages of their proprietors.
>
> In the centre was an oval hollow, about half a mile cross, and probably two hundred feet deep, at the bottom of which was a beautiful lake of brackish water, whose margin was in a high state of cultivation, planted with taro, bananas, and sugar-cane.

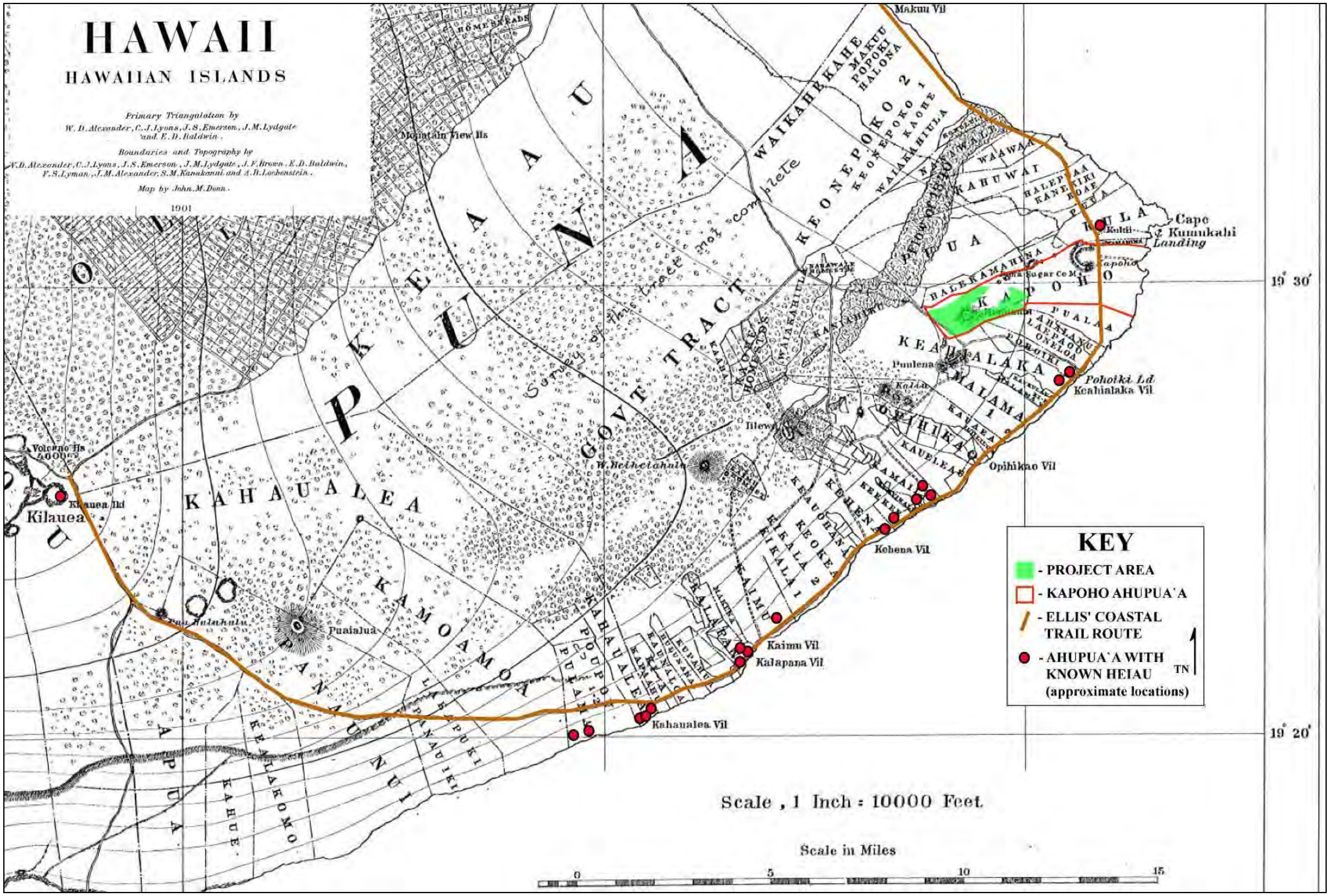

Figure 8: Portion of Hawai‘i Island Map Showing Ellis’ Route Along the Puna Coastal Trail, Ahupua‘a with Known *Heiau*, and the Project Area (Donn 1901).

The steep perpendicular rocks, forming the sides of the hollow, were adorned with tufts of grass, or blooming pendulous plants, while, along the narrow and verdant border of the lake at the bottom, the bread-fruit, the kukui, and the ohia trees, appeared, with now and then a lowly native hut standing beneath their shade.

We walked to the upper edge of the rocks that form the side of the hollow, where we viewed with pleasure this singularly beautiful scene.

The placid surface of the lake, disturbed only by the boys and girls diving and sporting in its waters, the serpentine walks among the luxuriant gardens along its margin, the tranquil occupations of the inhabitants, some weaving mats, others walking cheerfully up and down the winding path among the steep rocks, the sound of the cloth-beating mallet from several directions, and the smiling gaiety of the whole, contrasted strongly with the panorama we had recently beheld at Kirauea. Yet we felt persuaded, that this now cheerful spot had once presented a similar spectacle, less extended, but equally grand and appalling.

The traditions of the people informed us, that the valley itself was originally a crater, the indented rocks along the outer ridge forming its rim, and the opening towards the sea its mouth. But had tradition been silent, the volcanic nature of the rocks, which were basaltic, or of compact lava in some parts and cellular in others, the structure of the large basin in which we were standing, and the deep hollow in the centre which we were viewing, would have carried conviction to the mind of every beholder, that it had once been the seat of volcanic fires.

We asked several natives of the place, if they had any account of the king in whose reign it had burned; or if they knew any songs or traditions, in which it was stated how many kings had reigned in Hawaii, or how many chiefs had governed Puna, either since it first broke out, or since it became extinct; but they could give us no information on these subjects.

They told us the name of the place was Kapoho (the sunken in,) and of the lake, Ka wai a Pele (the water of Pele).

The saltiness of the water in this extinguished volcano proves the connection of the lake with the sea, from which it is about a mile distant; but we could not learn that it was at all affected by the rising or falling of the tides.

TESTIMONY BEFORE THE COMMISSION TO QUIET LAND TITLES

Article IV of the Board of Commissioners to Quiet Land Titles was passed in December 1845 and began the legal process of private land ownership. The Māhele (1848-1850) established a board of five commissioners to oversee land claims and to issue patents and leases for valid claims. Many scholars believe that Kauikeaouli (Kamehameha III) established laws intended to protect Hawaiian sovereignty and crown lands from foreigners who had already begun claiming ownership of land they were granted permission to use for homes and business interests (Daws 1968:111; Kame‘eleihiwa 1992: 169-70, 176; Kelly 1983: 45; Kuykendall 1938(1): 145 footnote 47, 152, 165-6, 170). Among other things, the foreigners were demanding private ownership of land to secure their island investments, particularly agricultural and ranching ventures (Kuykendall 1938(1): 138, 145, 178, 184, 202, 206, 271; Kame‘eleihiwa 1992: 178).

As legal statutes defining the Māhele continued to be enacted from 1845 to 1850, the lands of the kingdom of Hawai‘i were divided among the king (crown lands), the *ali‘i* and *konohiki*, and the government. Once lands were thus divided and private ownership was instituted, the *maka`āinana* (commoners), if they had been made aware of the procedures, were able to claim the plots on which they had been cultivating and living as stipulated in the *Kuleana* Act (1850). These claims, however, could not include any previously cultivated or presently fallow land, ‘*okipu‘u* (forest clearing created to allow sunlight to reach the forest floor), stream fisheries, or many other resources traditionally necessary for survival (Kame‘eleihiwa 1992:295; Kelly 1983:45-76; Kirch and Sahlins 1992 vol.1:3, 135-137, and vol. 2:2).

The right of claimants to land was based on the written testimony of at least two witnesses who could corroborate the claimant’s long-standing occupation and use of the lot(s) in question. The claimant was then awarded a patent for the property, subsequently called Land Commission Awards (LCAs) (Chinen 1961:16).

The *ahupua‘a* of Kapoho was awarded to Charles Kanaina as part of Land Commission award (LCA) 8559-B. Charles Kanaina was the father of William Charles Lunalilo (King Kamehameha III), a grandnephew of King Kamehameha I. There were no Land Commission awards made in Kapoho Ahupua‘a.

CHANGING RESIDENTIAL AND LAND-USE PATTERNS (1845-1865)

Between 1845 and 1900, traditional land-use and residential patterns changed drastically. In particular, the regular use of Hilo Bay by foreign vessels, including whaling merchant and inter-island vessel, the growth of tourism, the establishment of missions in the Hilo area, the legalization of private land ownership, the introduction of cattle ranching, the introduction of sugar cane cultivation, and the construction of Government Roads and railroad lines all brought about changes in settlement patterns and long-established land-use patterns (Kelly *et al*. 1981:111-112). Much of the change in residential location and the growth of towns in Puna District were driven by the availability of arable land suited to commercial crops and the location of newly constructed roads.

The modern history of land-use in Kapoho Ahupuaʻa is tied to the development of commercial agriculture and the construction of transportation routes. The potential to use Kapoho's rich arable land for commercial prospects was recognized in the late 1800s and early 1900s when it was purchased for commercial sugarcane and coffee growing, as well as for cattle pasture. In 1881, large tracts of land in north and south Puna were purchased at auction by Samuel Damon, William H. Shipman, and E. Elderts from trustees of the deceased William C. Lunalilo Estate. Shipman bought out the two partners within three years of purchasing the land.

William H. Shipman operated a cattle ranch in Kapoho Ahupuaʻa and was the owner of the Waiākea Stock Ranch. Shipman was also co-owner of the Shipman Meat Market, later the Hilo Meat Company. He also established the ʻŌlaʻa Sugar Company in Puna District in 1899 and leased large portions of his land in Puna to the newly formed company.

SUGARCANE, RAILROADS AND COMMERCE

The ʻŌlaʻa Sugar Company, established in 1899, became the largest sugarcane plantation and milling operation in Puna District. By the 1950s the ʻŌlaʻa Sugar Company was in debt and sugar production and sales were stagnant. The company stockholders changed the company name to the Puna Sugar Company, Ltd. and sold off land to invest in new equipment and upgrade their facilities. By 1966, the company was debt free and making a good profit. American Factors (AMFAC) bought out the minority shareholders in 1969 and Puna Sugar Company became a subsidiary of AMFAC.

AMFAC expanded sugarcane processing in the 1970s through new extraction facilities upgrades at the mill in Keaʻau (ʻŌlaʻa Mill) and by building a 15KW bagasse and trash burning power plant next to the mill. Hilo Electric Light Company (HECO) agreed to purchase 12.5KW of power for their customers.

Puna Sugar Company, like many other sugar companies, struggled in the late 1970s and early 1980s due to changes in the sugar market that made sugar production less profitable. By the start of 1982, AMFAC had decided to close Puna Sugar Company. The work of selling off assets and preparing severance packages took three full years. The sugar mill was sold to Fiji Sugar Corporation in 1988 and the power plant operation taken over HECO.

The Hilo Railroad Company

One of the largest concerns for early sugar plantations was the task of hauling processed raw sugar and molasses from the mill to the coast at Waiākea (Reed's Landing and Reed's Bay area), and later to the Hilo Railroad terminal next to the Wailoa River, and finally to Hilo Port (Kūhiō Bay), for shipment (Kelly et al. 1981: 93, 110, 144). In 1879 and 1880, Waiākea Plantation laid the first two miles of track in Hilo (*ibid*. 93). Ten years later, eight miles of Hilo Railroad Company track were constructed from Waiākea to the ʻŌlaʻa Sugar Company Mill. The rail line was constructed under an 1899 charter held by Dillingham and was completed in 1900 with assistance from the ʻŌlaʻa Sugar Company Mill (*ibid*. 110, 119, 142, 143, 297-307). Railroad track was next laid from the ʻŌlaʻa Sugar Company Mill to Kapoho and Pāhoa (completed 1902) to service sugar plantations and the Pāhoa Lumber Mill established in 1909 (*ibid*. 114, 146-149, 162).

The Hilo Railroad Company also transported passengers, both locals and tourists. The company built a spur line up to Glenwood to carry tourists heading up to see the volcano, as well as to service the small farmers that lived in the ʻŌlaʻa Lots subdivision. The company issued an increasingly number of bonds over the years to fund their construction (Kelly et al. 1981: 163). By fiscal year 1914-1915 the company was obligated to pay $269,700.00 annual interest on bonds (*ibid*. 165). As the company was failing to meet its annual bond interest obligations, in 1915, the bondholders forced the foreclosure of the company (*ibid*. 165).

The Hilo Railroad Company holdings were reconsolidated into the Hawai‘i Consolidated Railway, Ltd in 1916. The new board of directors consisted of prominent sugar plantation owners (Kelly et al. 1981: 165). Additional rail lines were constructed past Kapoho to ‘Opihikao. The railroad was just south of the current project area (Figure 10). The 1924 USGS Kalapana Quadrangle map shows sugarcane railroad spur extending just south of Pu‘u Honua‘ula (Figure 11). Hawai‘i Consolidated Railway continued to operate for thirty years, despite the increasing use of automobiles, and a small number of droughts, blights and tsunamis (*ibid*. 166-175). The 1946 tsunami that damaged Hilo Town, also destroyed much of the railroad infrastructure in coastal Hilo, so much so that, despite record earnings, the company decided to liquidated its assets rather than pay the cost to repair (*ibid*. 175). The railroad tracks and ties were removed sometime after 1946.

MODERN LAND USE

During the modern era, lands surrounding the project were used primarily for private residences and small privately owned farms.

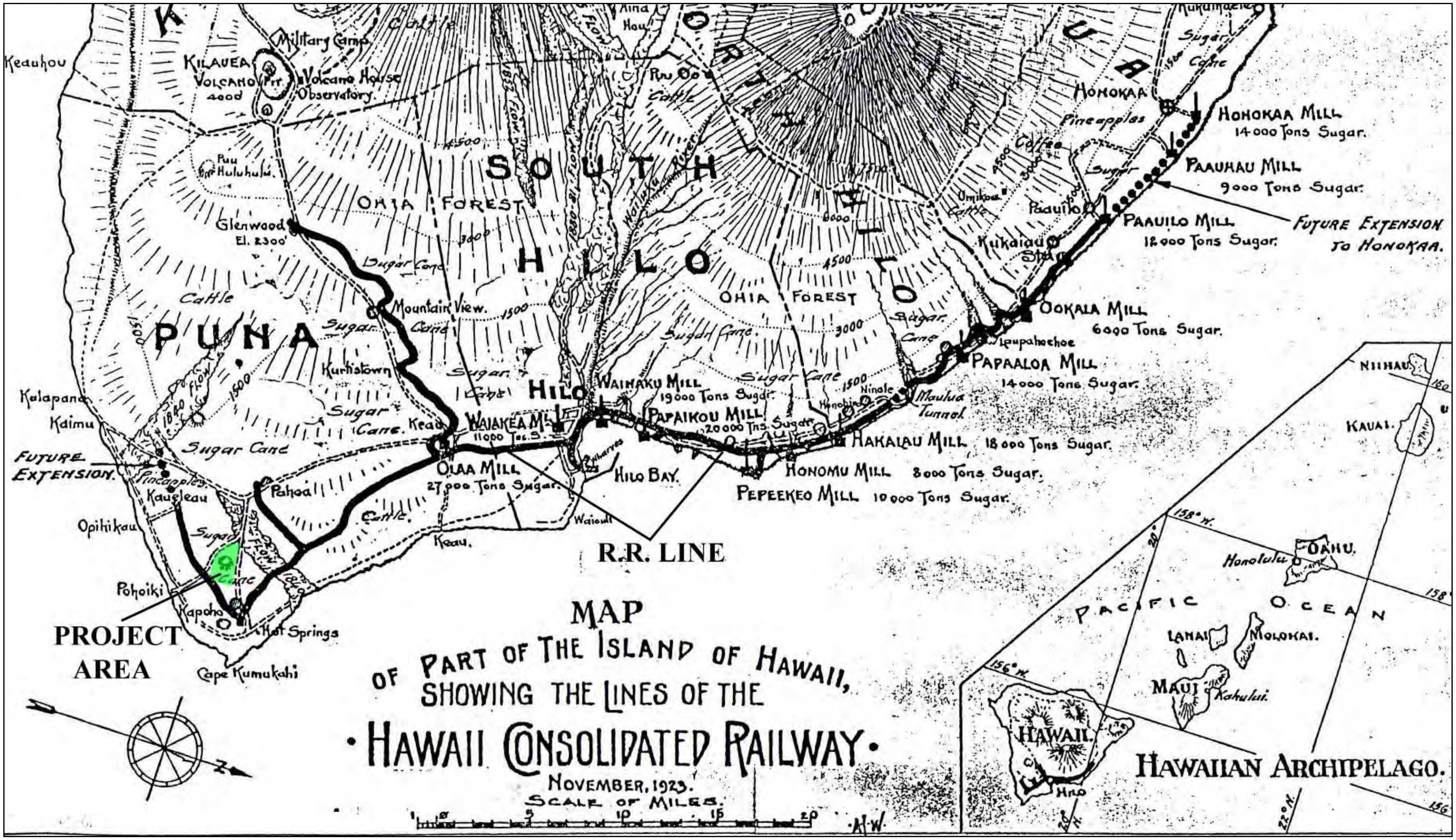

Figure 9: Map Showing Locations of Hawaiian Consolidated Railway Main Railroad Lines in Bold Black Line and Project Area Shaded Green (H.C.R. Annual Report November 1923; adapted from Kelly et al. 1983: 164).

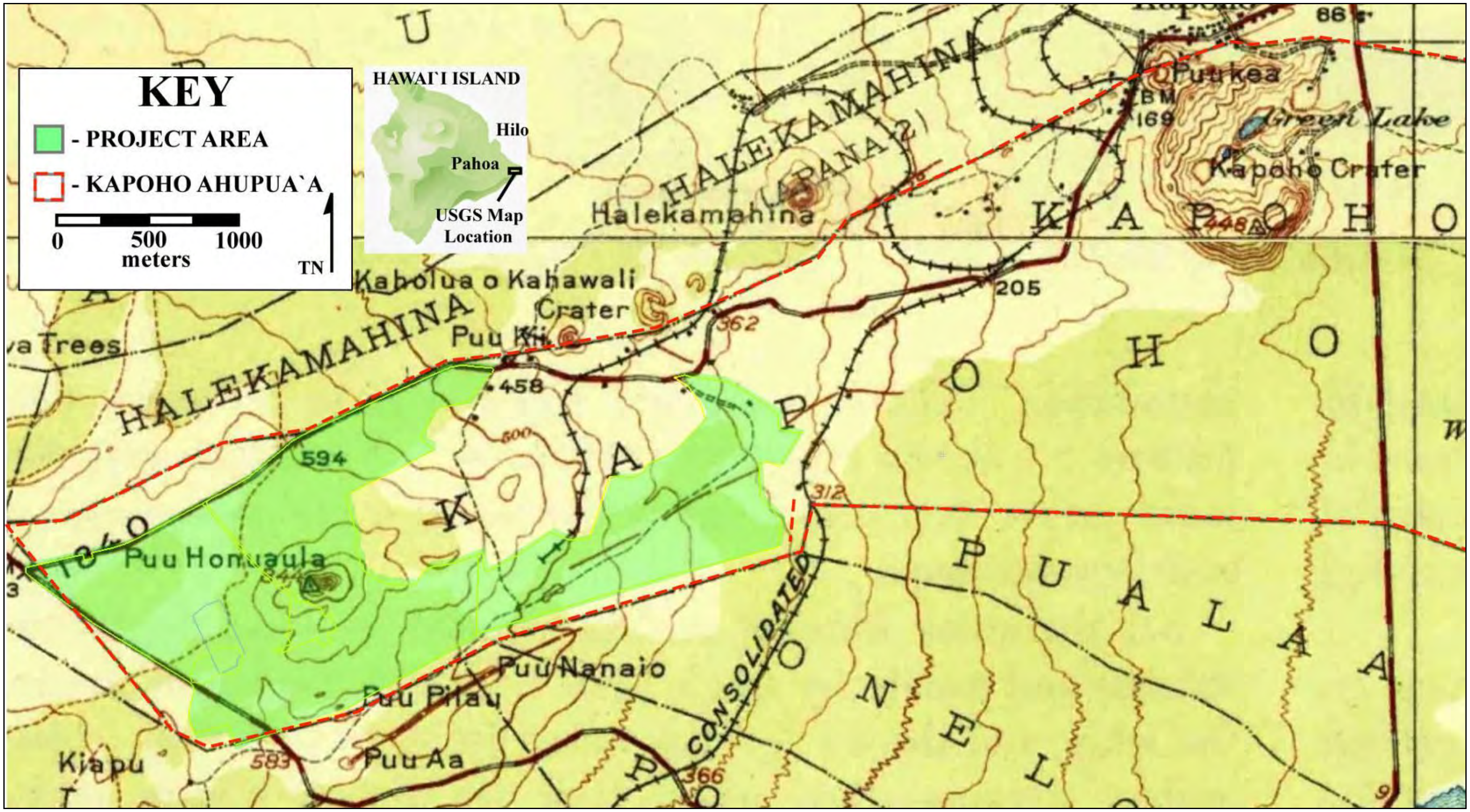

Figure 10: 15-Minute Series USGS 1924 Topographic Map Showing the PGV Property and Railroad Tracks (ESRI, 2013. Sources: USGS. Kalapana Quadrangle).

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

There are very few previous archaeological studies within Kapoho Ahupuaʻa. Thrum (1908) published a list and descriptions of *heiau* identified in Puna (Table 1 and Figure 12). Many of the *heiau* were abandoned and in disrepair at the time they were recorded. There were no *heiau* identified in Kapoho Ahupuaʻa.

Table 1: Heiau Recorded by Thrum (1908) in Puna District.

DISTRICT OF PUNA.

Names.	Location and Remarks.
Wahaula	Pulama.—The first constructed temple of Paao, built, according to tradition, in the 11th century; rebuilt by Imaikalani, and later by Kalaniopuu who dedicated it to Kukailimoku. A walled structure of luakini class, 132x72 ft. in size; stands practically N. E. and S. W.; its walls still 8 to 10 ft. high. The last of the temples to give up its heathen worship upon the overthrow of idolatry in 1819. It is still one of the best conditioned heiaus in all the islands. See "Tales from the Temples" and plan.
Makaiwa	Pulama.—A small heiau, paved, of ipu olono class; its walls now fallen.
Waiaka	Kahaualea.—A small heiau 85 ft. long by 44 ft. wide on its upper end and 36 ft. on the lower end; near the cave of Luamakini, whose makai entrance is said to be in the adjacent pond of Waikupanaha. Class uncertain.
Makaoiki	Kahaualea.—A medium sized heiau now all destroyed; its stones taken for graves, of which a number adjoins its site on the east side.
Punaluu	Near spring of same name, in Kahaualea. A medium sized heiau 119x37 ft. with walls 3 to 5 ft. thick, of heavy lava slabs. Its south end wall is 17 ft. thick, standing 3 ft. above main floor, well leveled off with shore pebbles. Badly shattered by earthquake. Parts of walls yet standing are 4 to 8 ft. high, according to slope of the land.

Niukukahi.............Kalapana.—One of the noted Puna heiaus, of which Kapihe was priest and Kuahailo its deity. Of pookanaka class. It is in a thick grove of coconut, breadfruit and other trees; its foundations and parts of walls still to be seen though in a jungle of undergrowth; said to be 150 ft. square.

Napalua...............Near Waiokolea, Kalapana, a walled heiau about 80x100 ft. in size, said to have been under Kapihe's jurisdiction. Its walls were thrown down by the earthquake of 1868.

Kikoa..................Kalapana, a small sized heiau of which little could be ascertained.

Kumakaula............Kaimu, a medium sized heiau of unknown class, a part of which only now remains. It was an ancient temple of the "truncated pyramidal" type, but destroyed in the fifties by one Kahuluhulu and his father, for their house site. In early years the tide came up to its base, and at its front was the noted place for akule. It is now one-eighth mile from the sea, the main road running by it, though this coast line for quite a distance subsided in 1868.

Mahinaakaka...........Keahialaka, near Pohoiki, a platform heiau 41x75 ft. built up six ft. high on sea side of the road, standing practically east and west. Its north wall shows double construction for about half its height nearly the whole length, and the eastern end rounded out some ten or more feet, not quite the height of the main structure, but whether a feature for its ceremonies, or a protection from the sea, could not be determined. Its walls and floor in a much disturbed condition.

Oolo..................Pohoiki, said to have been an important heiau; now entirely destroyed.

Kalepa................Or Kalelepa, near Kamaili, a heiau of the time of Keawemauhili, dedicated to Ku and Lono: of large size. Noted by Ellis as the probable Puna heiau where Cook's bones were deposited and worshipped. Almost wholly dedestroyed; its stones taken for roads.

Kue....................At Kehena. Nothing left to mark its site.

Aliipalala..............Kamaili, a small heiau of ipu olono class said to have had connection with Wahaula (listed below.) Entirely destroyed.

Wahaula..............Kamaili. A reported verv large heiau of ancient time; nothing now remains but a portion of its smooth pebbled floor. The Kamaili people claim that part of the well known heiau

	of same name, at Pulama, was built with stones from this temple, hence its name Wahaula.
Pulena................	Keekee. No particulars gathered; now in ruins in a tangle of bushes.
Kukii..................	On hill of same name, at Kapoho, 67x120 ft., built by Umi of lava blocks, or slabs, well fitted. Now in ruins; portions of walls only remaining. Some of its stones were brought down by Kalakaua, in 1879, which went into the foundation walls of the palace.
Oalalauo..............	Kilauea-iki: on summit of precipice; temple of Pele, Kamakaakeakua its priest. In ruins in 1825.

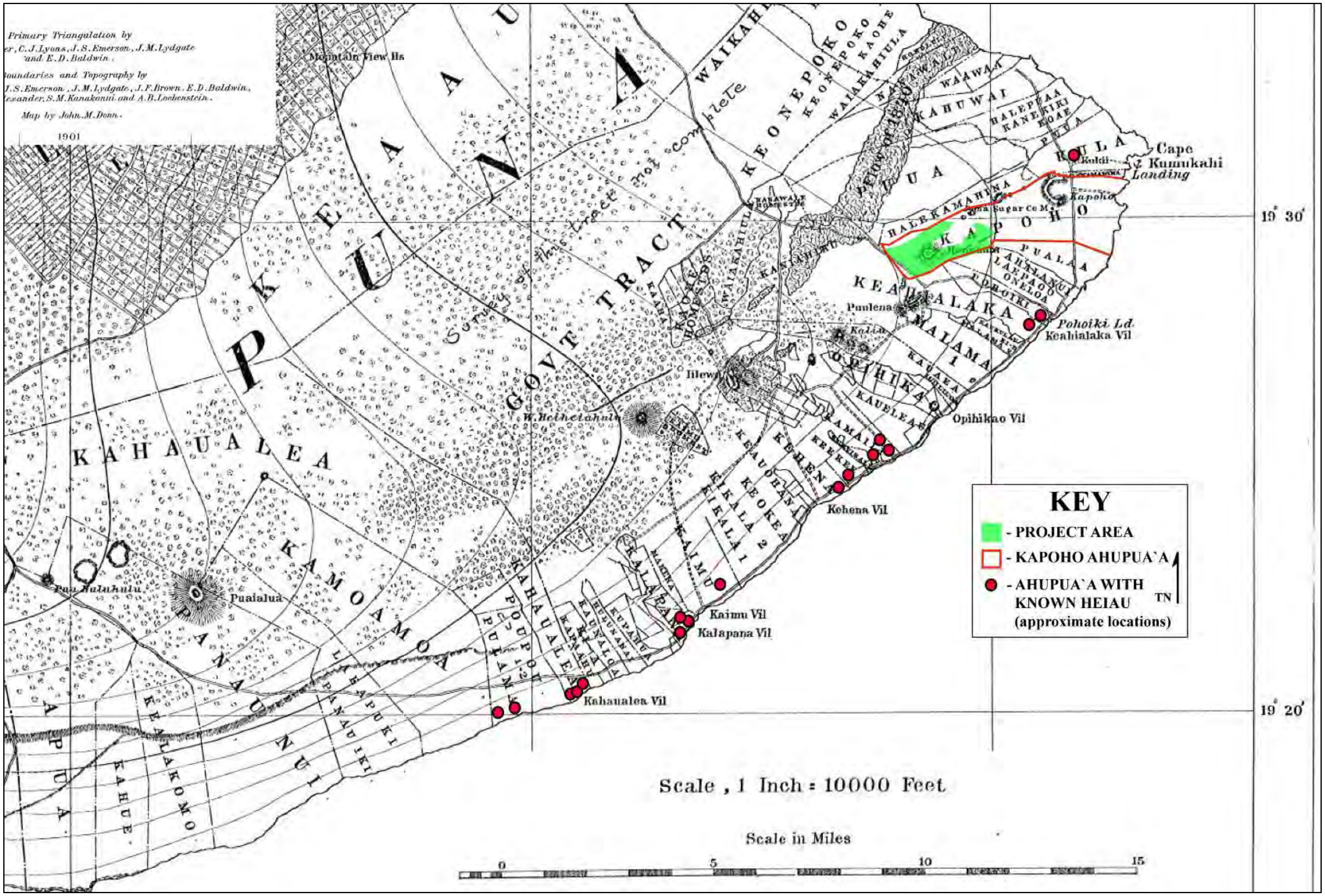

Figure 11: Portion of Hawai'i Island Map Showing *Heiau* Identified by Thrum (1908) in Puna District (Donn 1901).

Four archaeological studies were conducted within the current PGV property (Escott 2023; Kennedy 1990; Rechtman 2000; Rogers-Jourdane 1984; Rosendahl 1981). Paul H. Rosendahl, PhD, Inc. (PHRI) conducted an archaeological reconnaissance survey of Kapoho Well Site 1 and Kapoho Well Site 2 within the currently existing PGV facility (Rosendahl 1981). There were no archaeological remains identified within the project area.

Bishop Museum archaeologists conducted an archaeological reconnaissance survey of approximately 12.0 acres within the currently existing PGV facility (Rogers-Jourdane 1984). The survey included an intensive pedestrian survey of Area A, Area B and an Expansion Area and a less intensive pedestrian survey of the area within a one mile radius of the three intensively surveyed areas (Figure 12). Kapoho Well Site 1 in the Rosendahl (1981) study was the same as Area A in the Rogers-Jourdane (1984) study and Kapoho Well Site 2 was the same as Area B. There were no archaeological remains identified within the project area.

Archaeological Consultants of the Pacific conducted an archaeological reconnaissance survey of approximately 12.0 acres within the currently existing PGV facility (Kennedy 1990). The project area was similar to the Bishop Museum project area, though perhaps slightly larger (Figure 13). There were no archaeological remains identified within the project area.

Rechtman Consulting, LLC conducted an archaeological survey (Rechtman 2000) of a proposed cellular tower site 450 meters east of Puʻu Honuaʻula (Figure 14). The survey area is not within the current PGV project area. The survey report does state the size of the project area, though it appears to be less than half an acre. There were no archaeological remains identified within the project area.

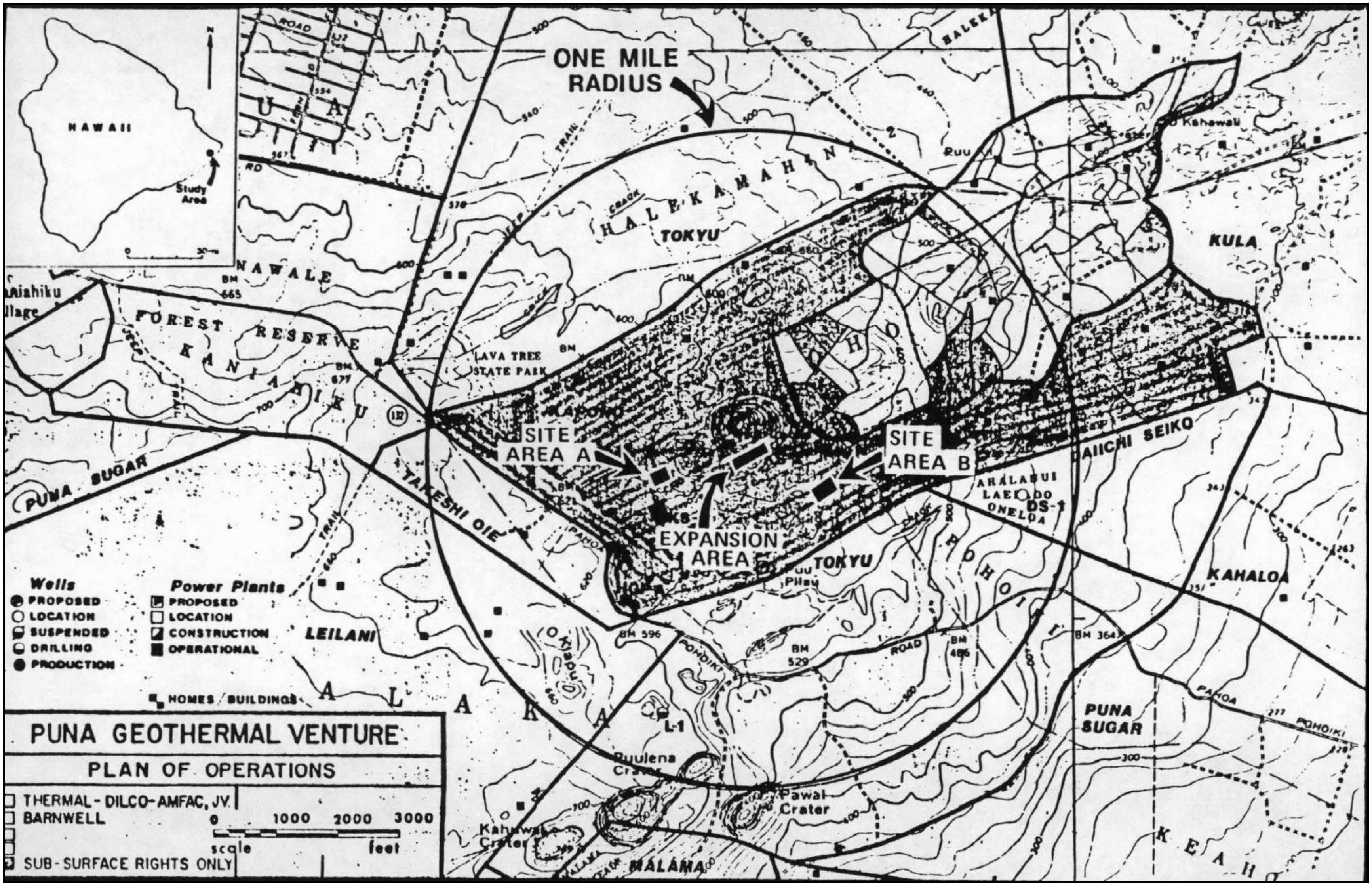

Figure 12: Bishop Museum Archaeological Reconnaissance Survey Project Area Map (Rogers-Jourdane 1984, Figure 1).

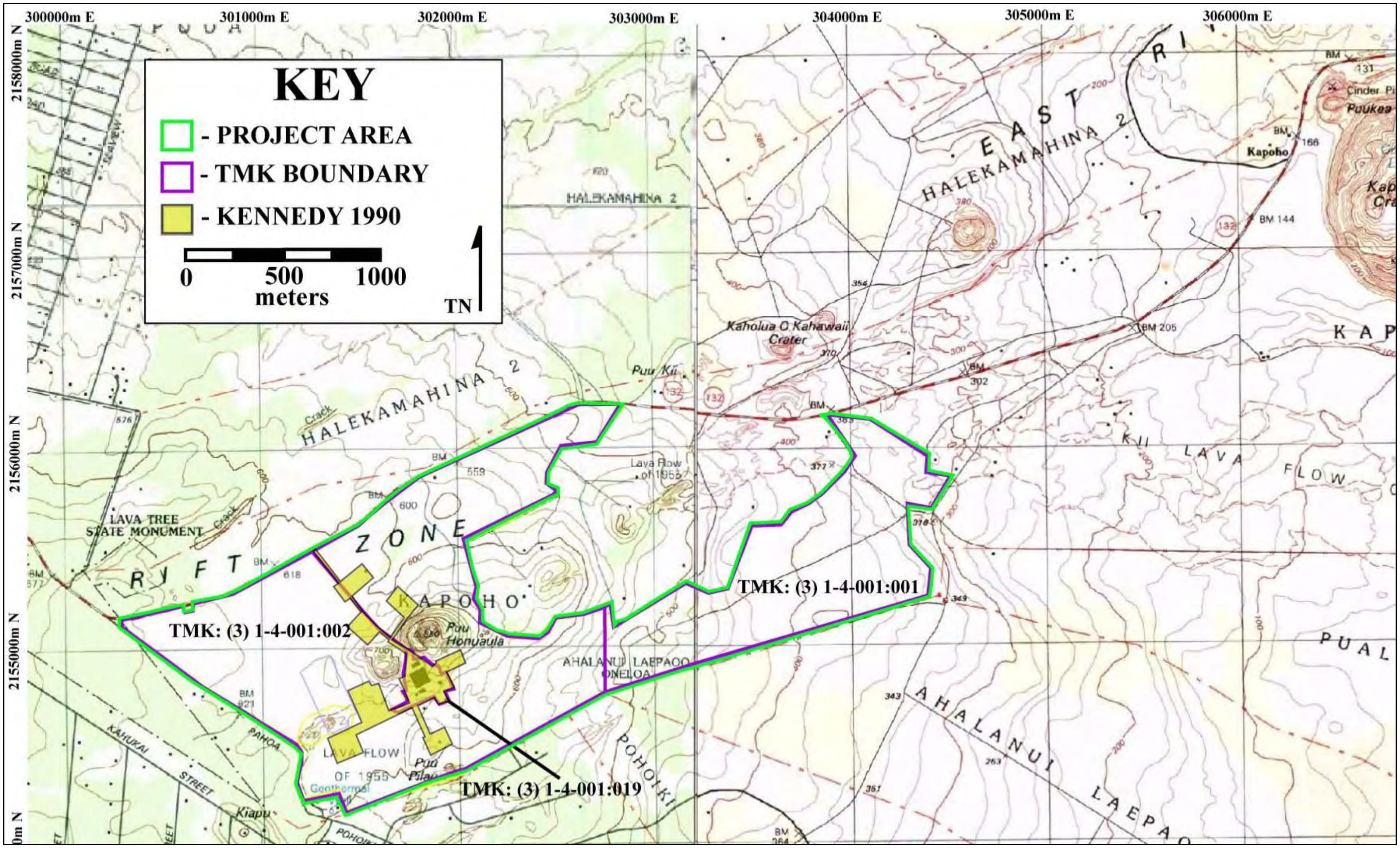

Figure 13: 7.5-Minute Series USGS Topographic Map Showing the Location of Kennedy (1990) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai'i Planning Department, 2022).

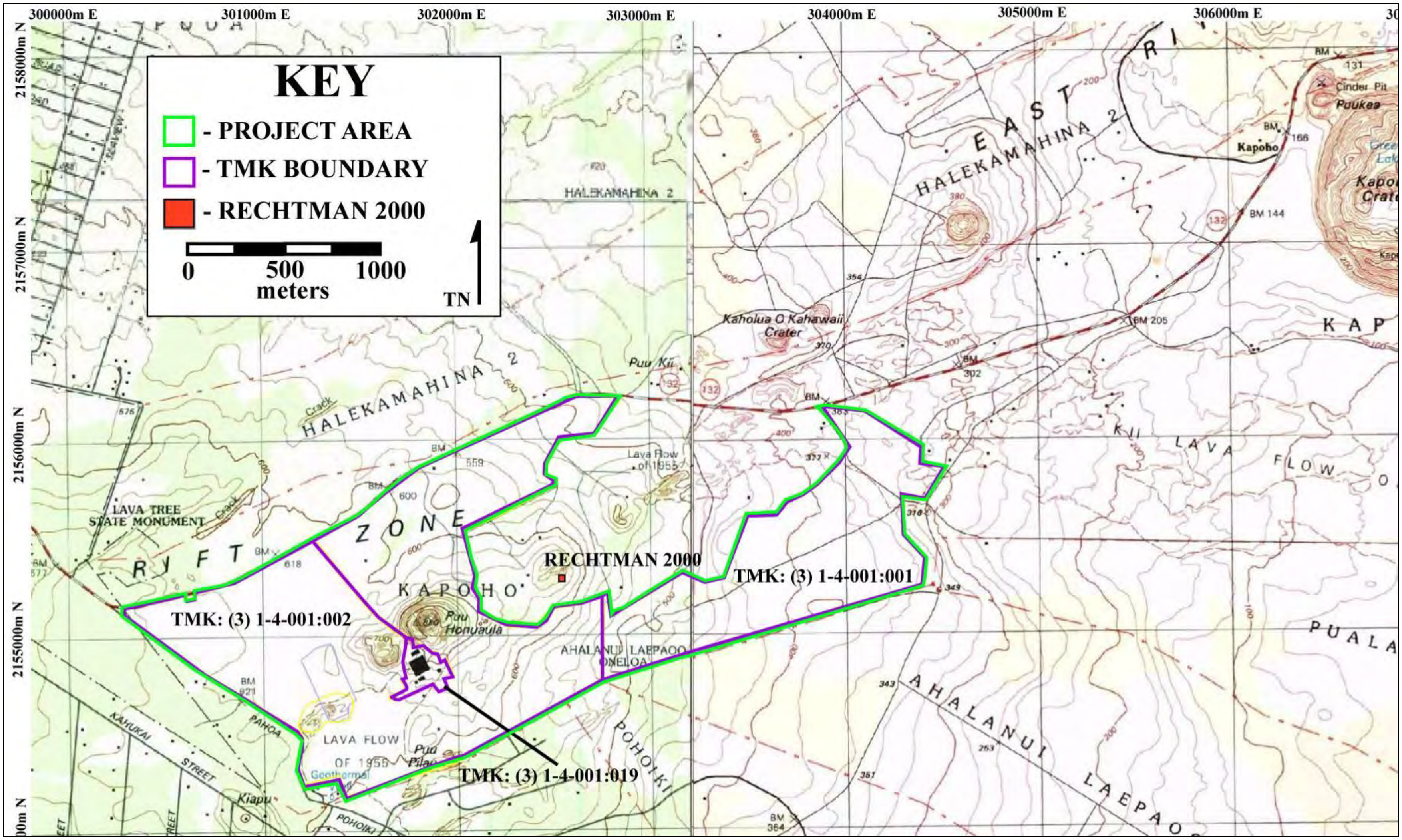

Figure 14: 7.5-Minute Series USGS Topographic Map Showing the Location of Rechtman (2000) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawaiʻi Planning Department, 2022).

RESULTS OF THE ARCHAEOLOGICAL FIELD INSPECTION SURVEY

Scientific Consultant Services, Inc. (SCS) conducted an archaeological field inspection (AFI) of approximately 9.0 acres of the TMK: (3) 1-4-001:002 within the PGV property (Figure 15). The project area is dominated by two 1955 spatter cones and is surrounded to the north, south, and west by the 2018 lava flow. The east side of the project area is bounded by an existing dirt road. Photographs of the project area are provided below (Figure 16 through Figure 19). There were no archaeological remains identified within the project area.

Project Determination

There were no archaeological features, feature remains, or artifacts identified within the pedestrian survey area, nor are there any on the 2018 lava flow. The field inspection pedestrian survey concluded that there are no archaeological sites or features within the project area and that there will be no effect to historic properties posed by the proposed PGV project.

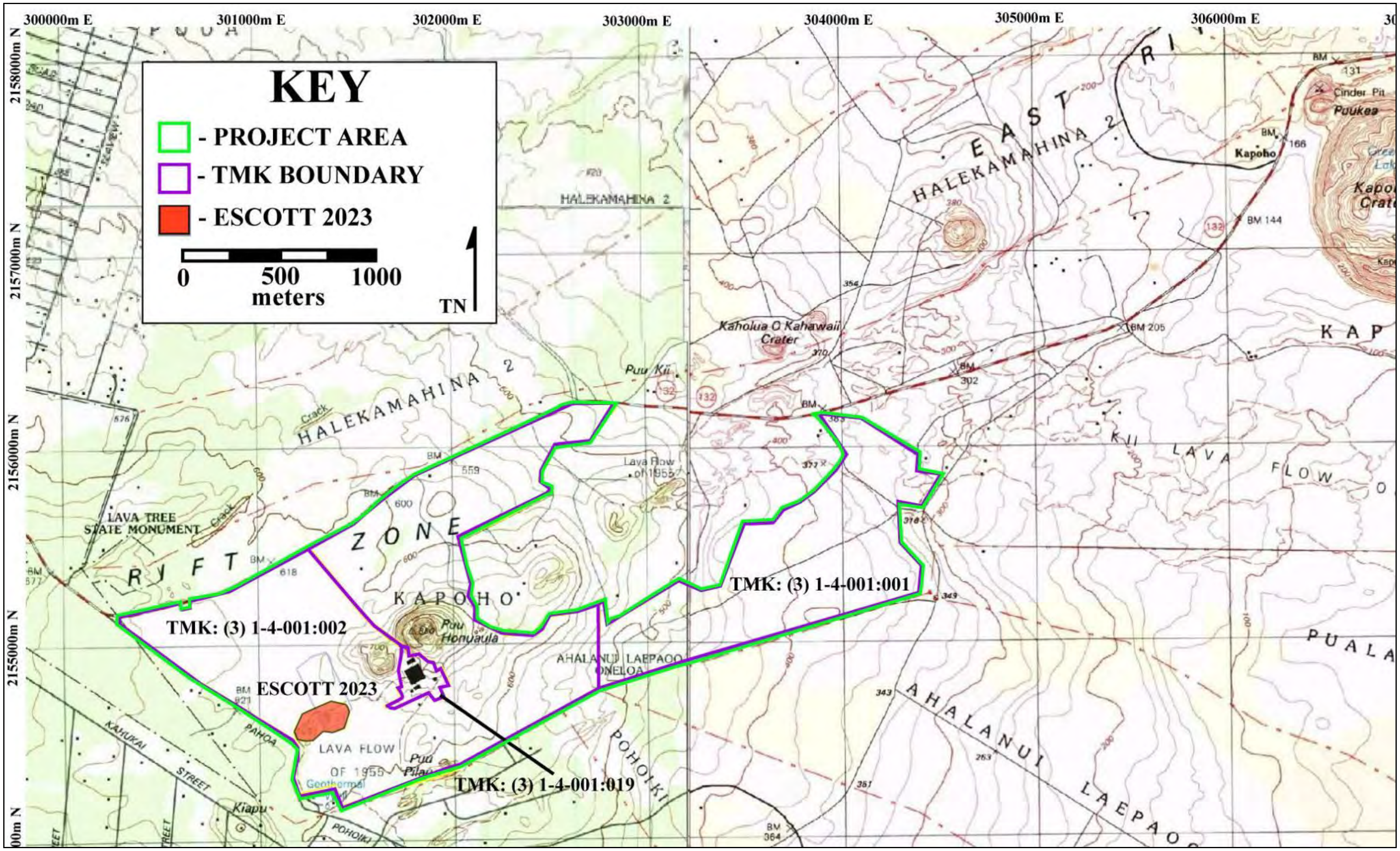

Figure 15: 7.5-Minute Series USGS Topographic Map Showing the Location of Escott (2023) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawaiʻi Planning Department, 2022).

Figure 16: Photograph of the East End of the AFI Survey Area Looking North.

Figure 17: Photograph of the East End of the AFI Survey Area Looking Northeast.

Figure 18: Photograph of the Eastern Spatter Cone Looking East.

Figure 19: Photograph of the Top of the Eastern Spatter Cone Looking North.

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APPENDIX I

CULTURAL IMPACT ASSESSMENT

SCS 2744 CIA-1

A CULTURAL IMPACT ASSESSMENT AND KA PAʻAKAI O KA ʻAINA ANALYSIS FOR THE PUNA GEOTHERMAL REPOWER PROJECT IN KAPOHO AHUPUAʻA, PUNA DISTRICT, HAWAIʻI ISLAND, HAWAIʻI [TMK: (3) 1-4-001: 001, 022, AND 019]

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JANUARY 2023
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INTRODUCTION

Scientific Consultant Services, Inc. (SCS) conducted a Cultural Impact Assessment (CIA) and *Ka Pa'akai O Ka 'Aina* Analysis (KPKA) for the Puna Geothermal Venture (PGV) property [TMK: (3) 1-4-001:001, 002, and 019] located in Kapoho Ahupua'a, Puna District, Island of Hawai'i, Hawai'i (Figure 1 through Figure 3). The existing PGV facilities, including roads and lots, cover approximately 4.6 acres (primarily within Parcel 002 and 019) of the of the 811.649-acre property (see Figure 3). The remaining 807.049 acres are undeveloped open land. Roughly 590 acres (73%) of the property ground surface is covered by portions of the 1955 and 2018 lava flows (Figure 4). The property address is 14-3860 Pāhoa-Kapoho Road [Parcel 019] and 14-3864 Pāhoa Kapoho Road [Parcel 002]. Parcel 001 is not assigned a street address. The project area is located approximately 4.15kilometers (km) east-southeast of Pāhoa town. The property is privately owned by Kapoho Land Development Co., Ltd (KLDC) and s leased by PGV.

PGV, a subsidiary of Ormat Technologies, Inc. (Ormat), is currently authorized for and operating a geothermal power plant on the project area property and proposes to replace the current 12 operating power-generating units with new more efficient power-generating units and replace and install new piping (Puna Geothermal Repower Project, hereafter PGV project) (Figure 5). The proposed Project would be constructed within the current PGV facility site fence line, would include grading of 13.0 acres of the 2018 and 1955 lava flows, and would increase power production from 38 to 46 megawatts (MW) in Phase 1 and further increase production to 60 MW in Phase 2.

The CIA and KPKA were conducted as supporting documentation for an Environmental Impact Study (EIS) for the proposed Puna Geothermal Repower project. The CIA and KPKA were conducted under subcontract to Stantec Consulting Services, Inc. Stantec is preparing the EIS for the proposed project.

Cultural Impact Assessment

Act 50, enacted by the Legislature of the State of Hawaii (2000) with House Bill 2895, relating to Environmental Impact Statements, proposes that:

> …there is a need to clarify that the preparation of environmental assessments or environmental impact statements should identify and address effects on Hawai'i's culture, and traditional and customary rights… [H.B. NO. 2895].

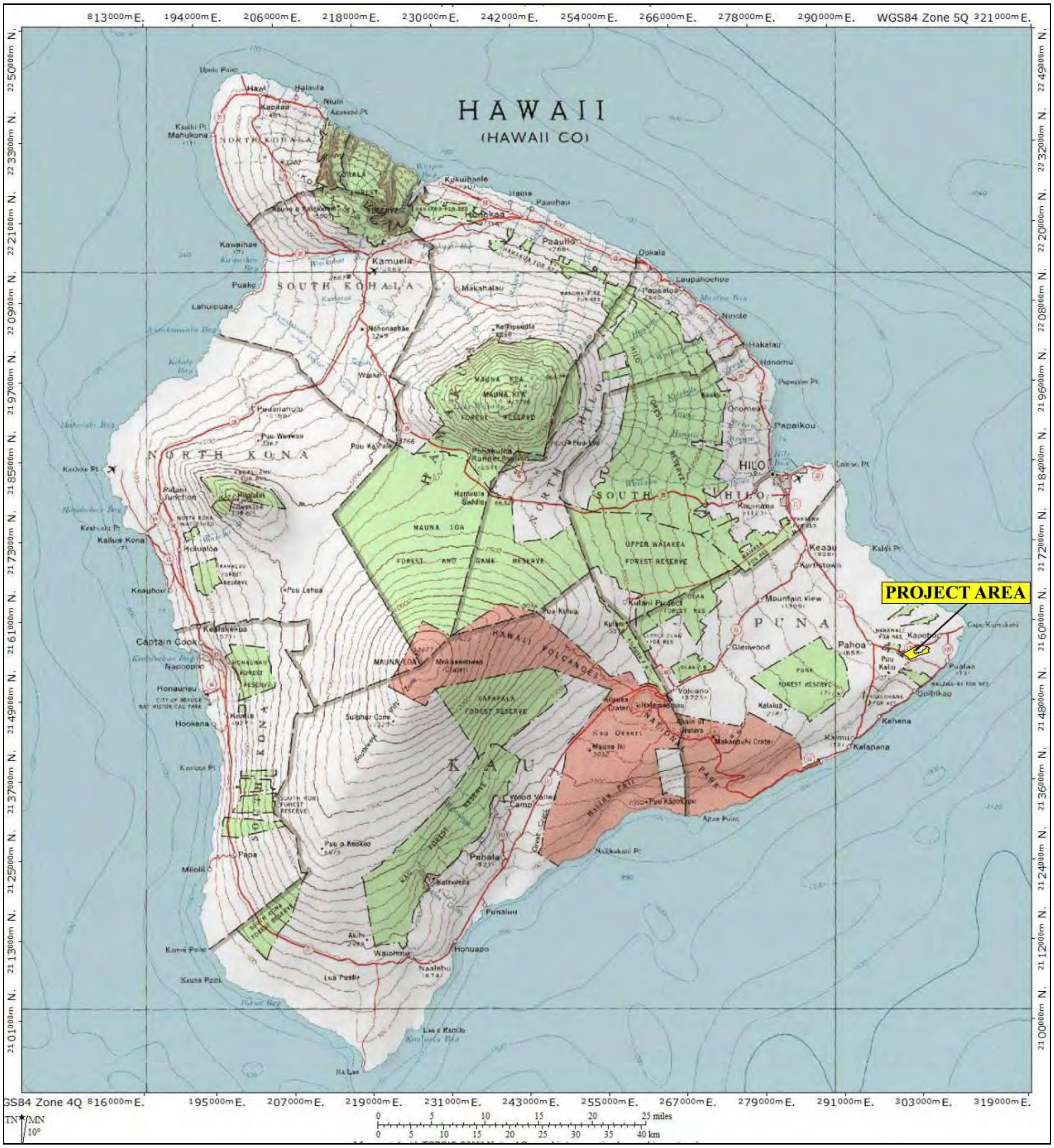

Figure 1: 5,500 K-Series Map of Hawaiʻi Showing Location of Project Area (National Geographic Topo!, 2003. Data Sources: National Geographic Society, USGS).

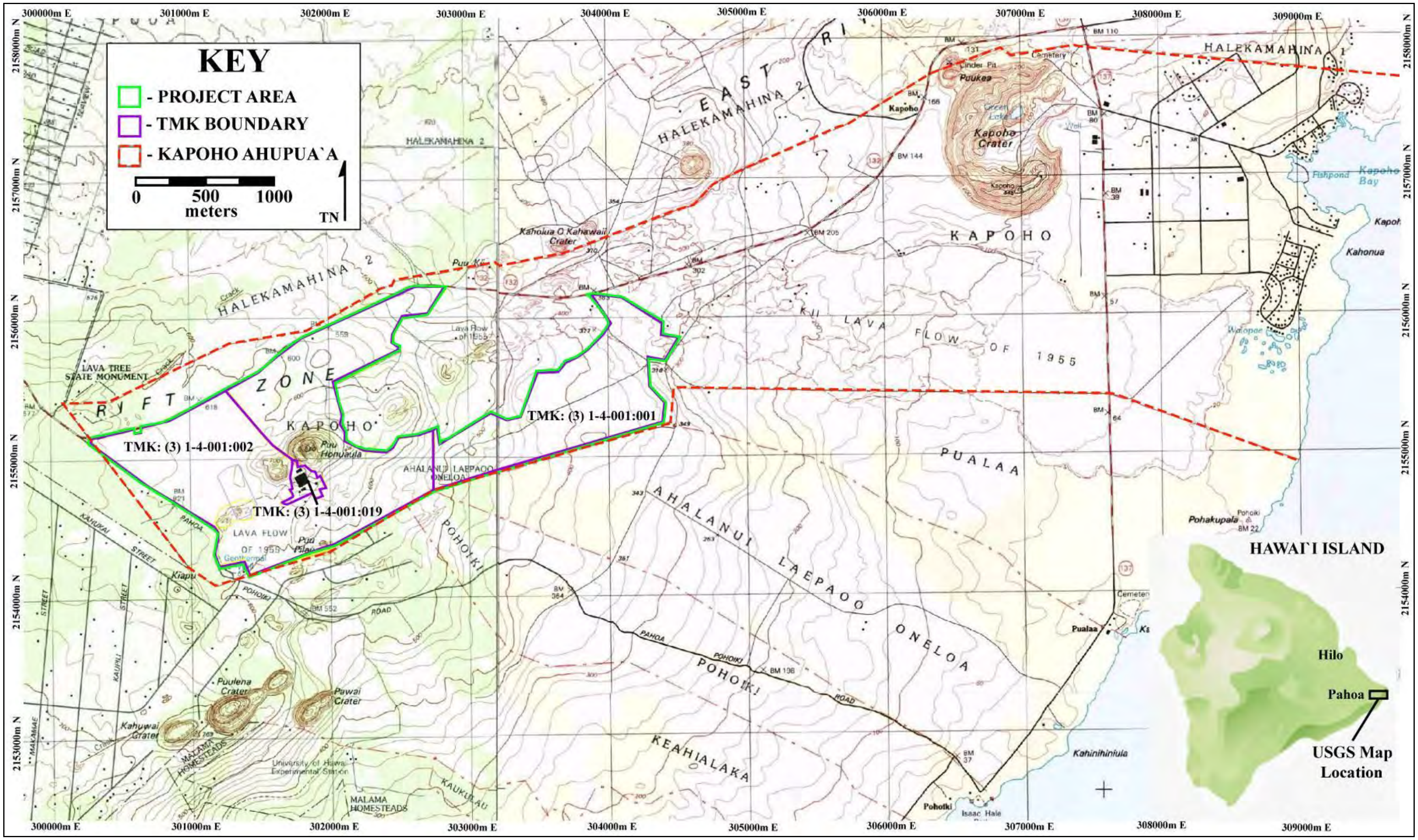

Figure 2: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Area TMK Parcels (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai'i Planning Department, 2022).

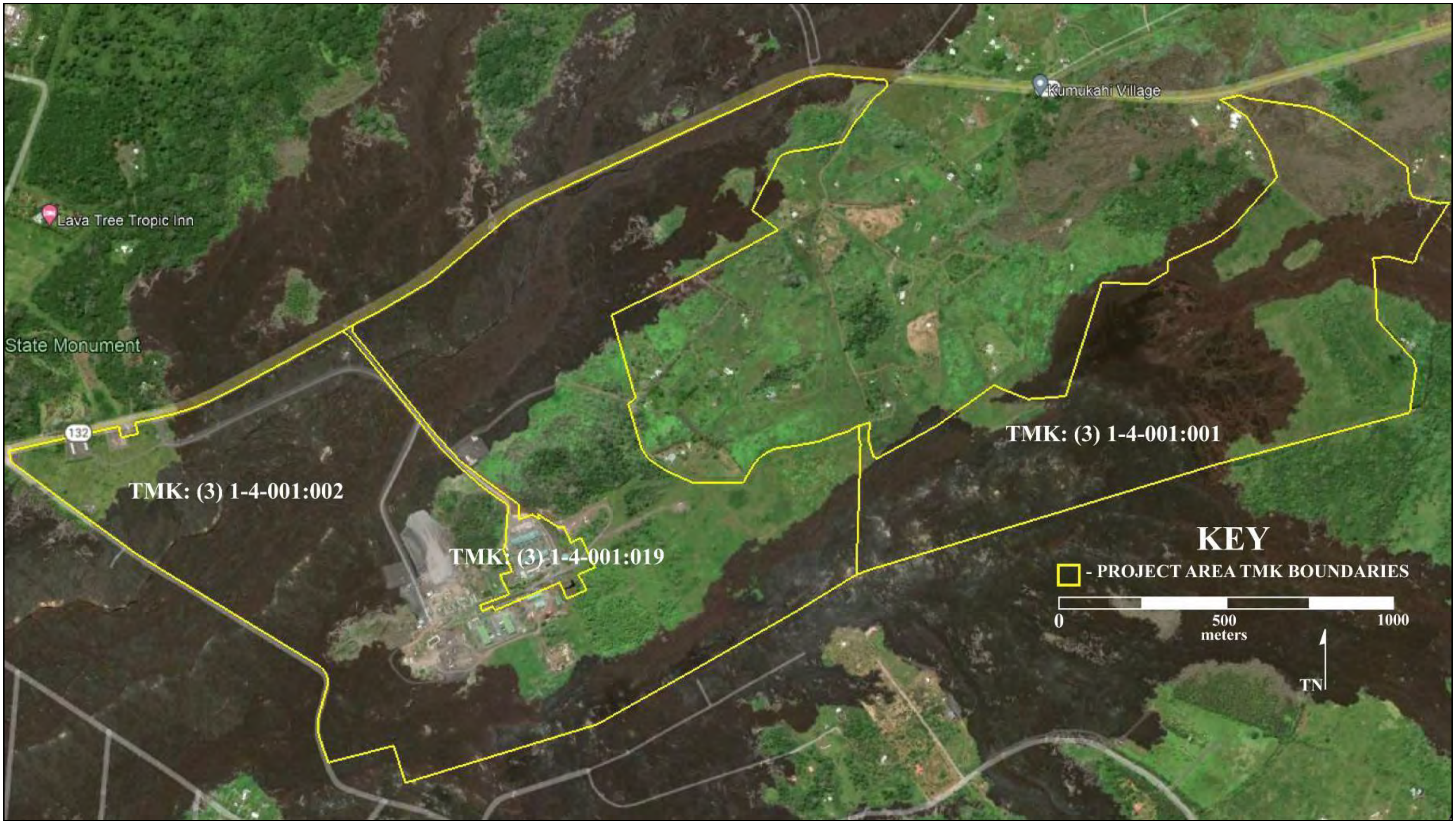

Figure 3: Aerial Photograph Showing Project Area Parcels, Kapoho, HI, Zone 5 North, 302466 m E, 2155320 m N. (Google Earth, 2021 Image. Data Sources: Digital Globe, GeoEye, Earthstar, USDA, and USGS).

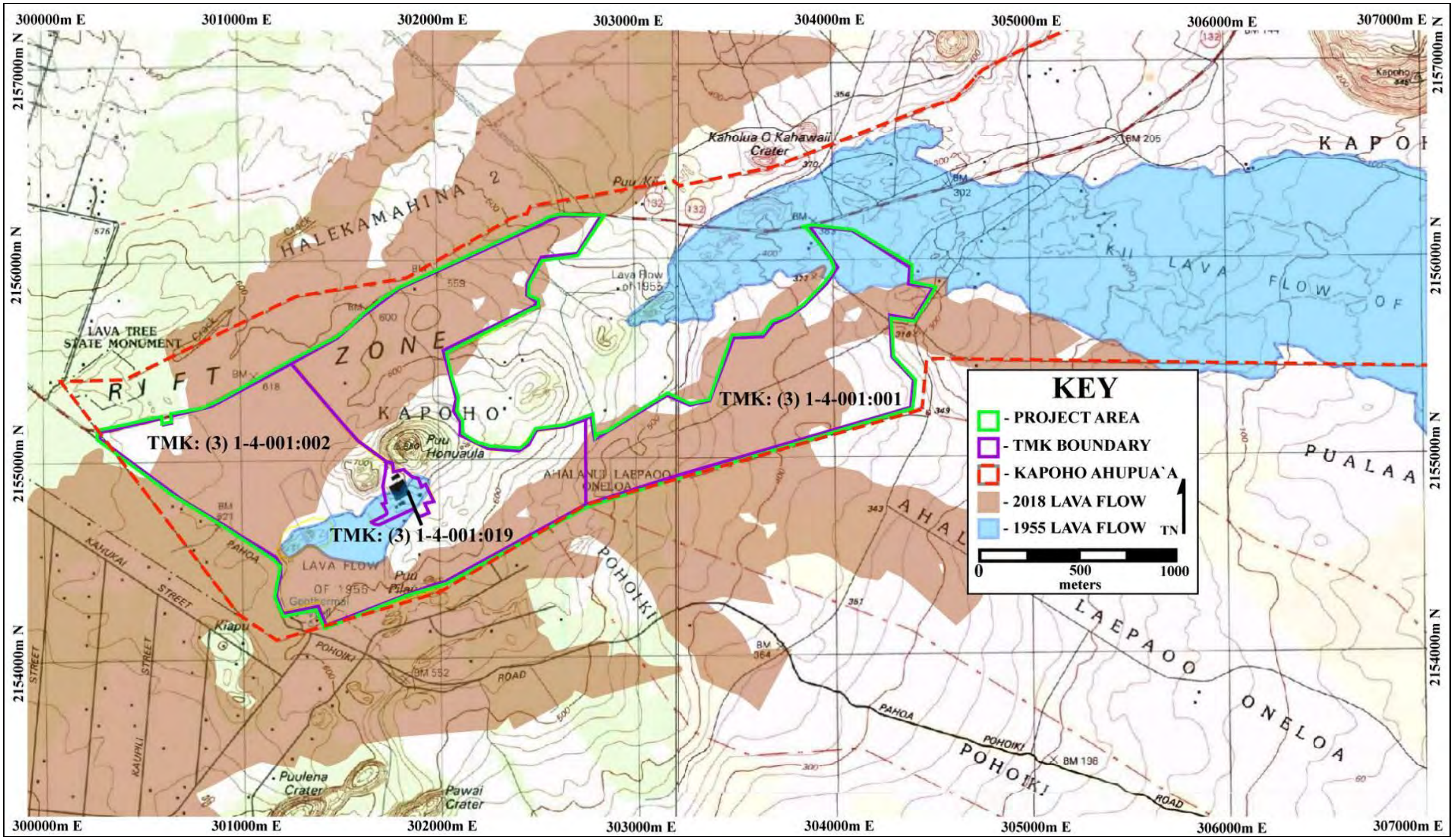

Figure 4: 7.5-Minute Series USGS Topographic Map Showing the Location of Project Area TMK Parcels and Modern Lava Flows (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: USGS, National Geographic and County of Hawai‘i Planning Department, 2022).

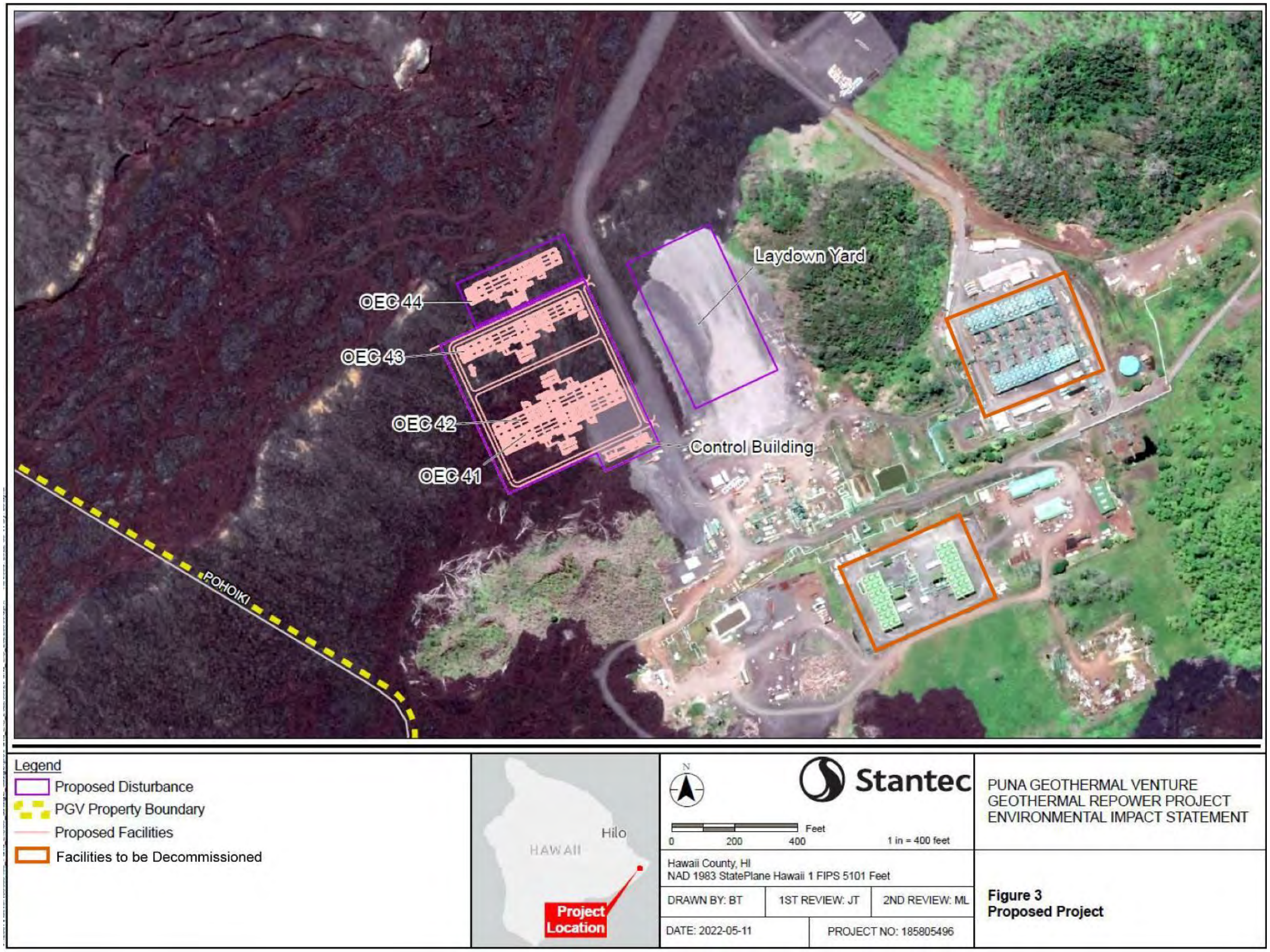

Figure 5: Aerial Photograph Showing Existing Facilities and Proposed Project Work (Adapted from Stantec 2022).

Act 50 requires state agencies and other developers to assess the effects of proposed land use or shoreline developments on the "cultural practices of the community and State" as part of the HRS Chapter 343 environmental review process (2001).

Its purpose has broadened, "to promote and protect cultural beliefs, practices and resources of native Hawaiians [and] other ethnic groups, and it also amends the definition of 'significant effect' to be re-defined as "the sum of effects on the quality of the environment including actions that are…contrary to the State's environmental policies…or adversely affect the economic welfare, social welfare, or cultural practices of the community and State" (H.B. 2895, Act 50, 2000).

Thus, Act 50 requires an assessment of cultural practices to be included in the Environmental Assessments and the Environmental Impact Statements, and to be taken into consideration during the planning process. The concept of geographical expansion is recognized by using, as an example, "the broad geographical area, e.g. district or *ahupua'a*" (OEQC 1997). It was decided that the process should identify 'anthropological' cultural practices, rather than 'social' cultural practices. For example, *limu* (edible seaweed) gathering would be considered an anthropological cultural practice, while a modern-day marathon would be considered a social cultural practice. According to the Guidelines for Assessing Cultural Impacts established by the Hawaii State Office of Environmental Quality Control:

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both manmade and natural, which support such cultural beliefs (OEQC 1997).

This Cultural Impact Assessment involves evaluating the probability of impacts on identified cultural resources, including values, rights, beliefs, objects, records, properties, and stories occurring within the project area and its vicinity (H.B. 2895, Act 50, 2000).

Ka Pa'akai O Ka 'Aina Analysis

The September 11, 2000 Hawai'i Supreme Court decision in *Ka Pa'akai O Ka 'Aina* v Land Use Commission ruled that State agencies are required to assess, preserve and protect traditional Hawaiian practices associated with lands over which State agencies have power of permit *Ka Pa'akai O Ka 'Aina* v Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 (2000). The Hawai'i Supreme Court ruled that,

> Article XII, Section 7 of the Hawai'i Constitution requires State agencies, such as the LUC, "to preserve and protect customary and traditional practices of native Hawaiians. Under Article XII, Section 7 of the Hawai'i Constitution. The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ahupua'a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights.
>
> This provision places an affirmative duty on the State and its agencies to preserve and protect traditional and customary native Hawaiian rights, and confers upon the State and its agencies "the power to protect these rights and to prevent any interference with the exercise of these rights." Stand. Comm. Rep. No. 57, in 1 Proceedings of the Constitutional Convention of 1978, at 639 (1980). *See also PASH,* 79 Hawai'i at 437, 903 P.2d at 1258; HRS §§ 1-1 FN24 and 7-1 FN25 (providing two additional sources from which gathering rights are derived). Article XII, section 7's mandate grew out of a desire to "preserve the small remaining vestiges of a quickly disappearing culture [by providing] a legal means by constitutional amendment to recognize and reaffirm native Hawaiian rights." Stand. Comm. Rep. No. 57, in 1 Proceedings of the Constitutional Convention of 1978, at 640. The Committee on Hawaiian Affairs, in adding what is now article XII, section 7, also recognized that "[s]ustenance, religious and cultural practices of native Hawaiians are an integral part of their culture, tradition and heritage, with such practices forming the basis of Hawaiian identity and value systems." Comm. Whole Rep. No. 12, in 1 Proceedings of the Constitutional Convention of 1978, at 1016. [*Ka Pa'akai O Ka 'Aina* v Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 (2000:23)].

The September 11, 2000 Hawai'i Supreme Court *Ka Pa'akai O Ka 'Aina* v Land Use Commission decision provides an analytical framework for addressing the preservation and protection of native Hawaiian customary and traditional practices. The framework includes determining:

> (1) the identity and scope of "valued cultural, historical, or natural resources" in the petition area, including the extent to which traditional and customary native Hawaiian rights are exercised in the petition area; (2) the extent to which those resources-including traditional and customary native Hawaiian rights-will be affected or impaired by the proposed action; and (3) the feasible action, if any, to be taken by the LUC [State agency] to reasonably protect native Hawaiian rights if they are found to exist. [*Ka Pa'akai O Ka 'Aina* v Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 (2000:10)].

This report includes a KPKA analysis to identify cultural, historic and natural resources, and traditional cultural practices associated with the project area lands. The report also identifies any potential impacts to those resources and practices posed by the proposed project. The report also addresses mitigation measures to protect native Hawaiian rights if they are found to exist.

METHODOLOGY

The CIA was prepared in accordance with the methodology and content protocol provided in the Guidelines for Assessing Cultural Impacts (OEQC 1997). In outlining the "Cultural Impact Assessment Methodology", the OEQC states: …information may be obtained through scoping, community meetings, ethnographic interviews and oral histories… (1997). The KPKA analysis prepared in accordance with the September 11, 2000 Hawai'i Supreme Court ruling and guidance.

The report contains archival and documentary research, as well as communication with organizations having knowledge of the project area, its cultural resources, and its practices and beliefs. This Cultural Impact Assessment was prepared in accordance with the methodology and content protocol provided in the Guidelines for Assessing Cultural Impacts (OEQC 1997). The assessment concerning cultural impacts should address, but not be limited to, the following matters:

(1) a discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints of limitations with might have affected the quality of the information obtained;

(2) a description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken;

(3) ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained;

(4) biographical information concerning the individuals and organizations consulted, their particular expertise, and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed, their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area;

(5) a discussion concerning historical and cultural source materials consulted, the institutions and repositories searched, and the level of effort undertaken, as well as the particular perspective of the authors, if appropriate, any opposing views, and any other relevant constraints, limitations or biases;

(6) a discussion concerning the cultural resources, practices and beliefs identified, and for the resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site;

(7) a discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area, affected directly or indirectly by the proposed project;

(8) an explanation of confidential information that has been withheld from public disclosure in the assessment;

(9) a discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs;

(10) an analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place, and;

(11) the inclusion of bibliography of references, and attached records of interviews, which were allowed to be disclosed.

Based on the inclusion of the above information, assessments of the potential effects on cultural resources in the project area and recommendations for mitigation of these effects can be proposed.

ARCHIVAL RESEARCH

Archival research focused on a historical documentary study involving both published and unpublished sources. A search of geological maps, aerial photographs, historical maps, historical and ethnographic documents, land-use records, and previous archaeological reports was conducted at the University of Hawai‘i – Hilo Mo‘okini Library, Ulu Kau, County of Hawaii Planning Department and the State Historic Preservation Division (SHPD) Hilo library. These included legendary accounts of native Hawaiian and early foreign writers; early historical journals and narratives; historic maps and land records such as Land Commission Awards, Royal Patent Grants, and Boundary Commission records; historic accounts, and previous archaeological project reports.

INTERVIEW METHODOLOGY

Interviews are conducted in accordance with applicable state laws and guidelines. Individuals and/or groups who have knowledge of traditional practices and beliefs associated with a project area or who know of historical properties within a project area are sought for consultation. Individuals who have particular knowledge of traditions passed down from preceding generations and a personal familiarity with the project area are invited to share their relevant information. Often people are recommended for their expertise, and indeed, organizations, such as Hawaiian Civic Clubs, the Island Branch of Office of Hawaiian Affairs, historical societies, Island Trail clubs, and Planning Commissions are depended upon for their recommendations of suitable informants. These groups are invited to contribute their input, and suggest further avenues of inquiry, as well as specific individuals to interview.

If knowledgeable individuals are identified, personal interviews are sometimes taped and then transcribed. These draft transcripts are returned to each of the participants for their review and comments. After corrections are made, each individual signs a release form, making the information available for this study. When telephone interviews occur, a summary of the information is often sent for correction and approval, or dictated by the informant and then incorporated into the document. Key topics discussed with the interviewees vary from project to project, but usually include: personal association to the *ahupua‘a*, land use in the project’s vicinity; knowledge of traditional trails, gathering areas, water sources, religious sites; place names and their meanings; stories that were handed down concerning special places or events in the vicinity of the project area; evidence of previous activities identified while in the project vicinity.

In this case, invitations to consult were sent to individuals and organizations whose jurisdiction includes knowledge of the area with an invitation for consultation. Consultation was sought from Shane Palacat-Nelsen, Office of Hawaiian Affairs (OHA); Jordan Kea Calpito, SHPD Burial Sites Specialist; and Desmond Haumea, Hawaiʻi Island Burial Council (HIBC) Puna Representative. Consultation was also conducted as a result of public notices. Public notices (Appendix A) were published in the Honolulu Star-Advertiser, the Hawaiʻi Tribune Herald, and the Office of Hawaiian Affairs (OHA) Ka Wai Ola.

If cultural resources are identified based on the information received from these organizations and/or additional informants, an assessment of the potential effects on the identified cultural resources in the project area and recommendations for mitigation of these effects can be proposed.

ENVIRONMENTAL SETTING

The project area is situated on level to moderately sloping land at 300.0 to 650.0 feet (91.0-198.0 m) above mean sea level (amsl) (see Figure 4). The project area substrate is Kīlauea lava flows. Most (73%) of the project area is covered by the 2018 and 1955 pāhoehoe lava flows, and 27% percent of project area is covered by flows dated to between 200 and 750 years ago (Wolfe and Morris 1996). There project area is along a portion of the Lower East Rift Zone which is visible as a series of spatter cones and cinder cones situated southwest to northeast across Kapoho Ahupuaʻa (see Figure 4 and Figure 6). The largest of these is Puʻu Honuaʻula (850 ft amsl) within Parcel 002, just north of the existing PVG main facilities.

The 2018 lava flow is devoid of soil and vegetation. There are scattered small *ʻōhiʻa lehua* (*Metrosideros polymorpha*) trees grasses, shrubs and albizia (*Falcataria moluccana*) trees growing on the 1955 lava flows. Rainfall in the project area is between 120 and 160 inches per year (Giambelluca et al. 2013). There are no gulches or major gulches or drainages within the project area.

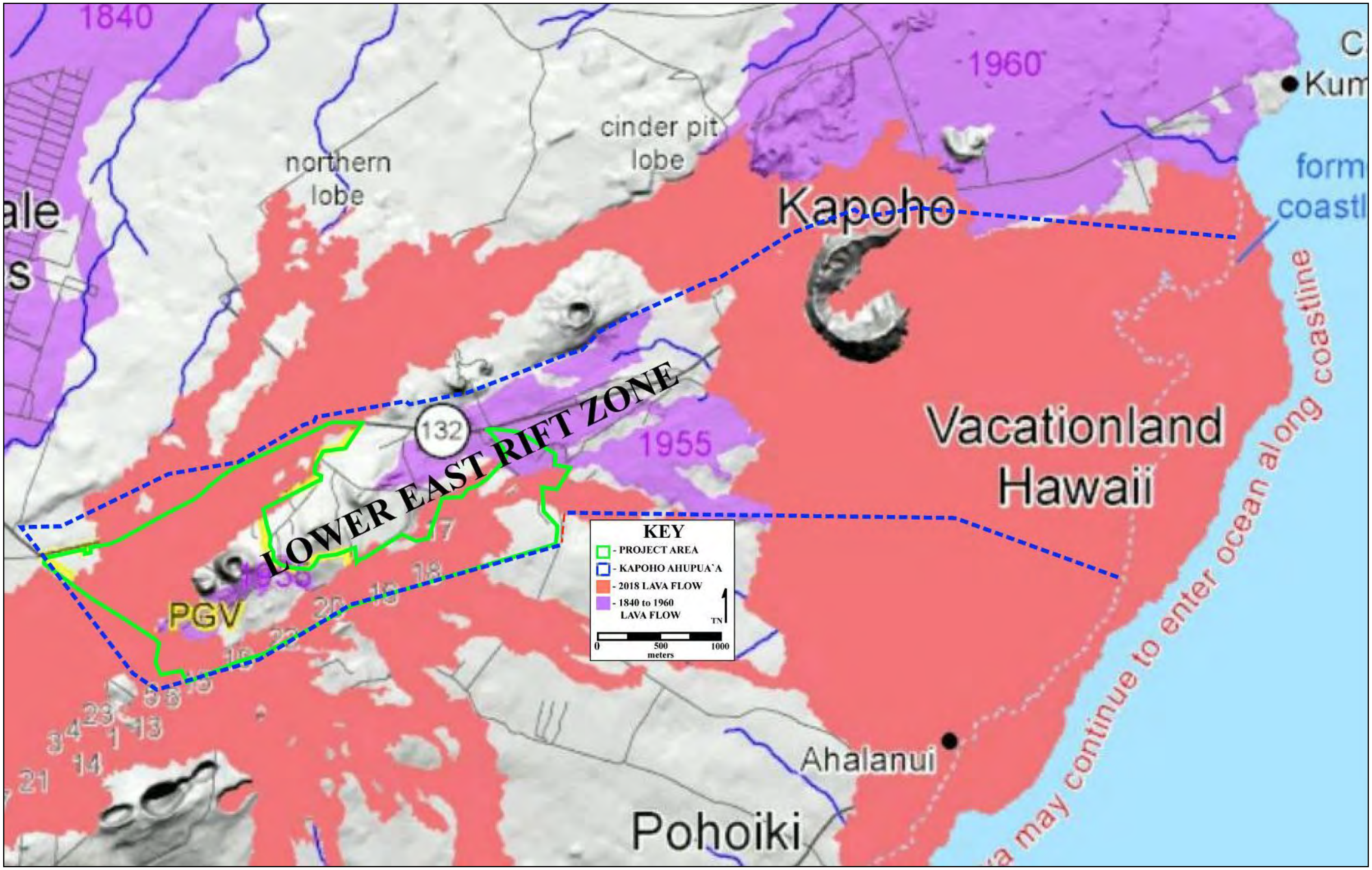

Figure 6: Map of Lower East Rift Zone Modern Lava Flows Showing Project Area (Adapted from USGS 2018 Data).

HISTORICAL AND CULTURAL CONTEXTS

Many archaeologists believe that Hawai'i Island was first settled around A.D. 1,000 by people sailing from the Marquesas (Athens et al. 2014; Dye 2011; Kahn et al. 2014; Kirch 2011; Kirch and McCoy 2007; Mulrooney et al. 2011; Rieth et al. 2011; Wilmhurst et al. 2011a and 2011b). An article published in the Journal of Archaeological Science reviewing radiocarbon dates recovered at archaeological sites on the Island of Hawai'i suggests that, by relying on only carbon samples from short-lived plant remains, the most reliable dates point to initial Polynesian colonization of Hawai'i Island occurring between A.D. 1220 and 1261 (Rieth et al. 2011:2747).

The recent studies that included Hawai'i Island short-lived radiocarbon dating samples assess those recovered exclusively from sites in North Kohala, South Kohala and Hāmākua (Rieth et al. 2011) or from South Point (Ka Lae) in Ka'ū (Dye 1992; Kirch 2011) (Figure 7). Many of the former region sites are rock shelters and the latter are sand dune sites. Sixteen radiocarbon samples from North Kohala, South Kohala and Hāmākua returned conventional radiocarbon ages from 400 to 781 years before present (Rieth et al. 2011:2745). The early date is consistent with ranges of A.D. 1040-1090 and A.D. 1120-1280 from Ka Lae in South Point, Ka'ū discussed by Kirch (2011:20). All of the samples were recovered from sites in arid environments that have not been disturbed by modern development or human activity. There are no radiocarbon dating samples from Hilo or Puna where there has been a lot of development associated disturbance and where environmental conditions for radiocarbon sample preservation is less favorable.

Historians and ethnographers have long believed that Hilo was one of the first settlements on the Island of Hawai'i (Handy and Handy 1972:12; Maly 1996:1). The rich marine resources of Hilo Bay and the gently sloping forests of Mauna Loa and Mauna Kea provided abundant resources. Fresh water was available from the Wailoa and Wailuku rivers and smaller streams such as Waiākea, Waiolama, Pukihae, and 'Alenaio (Maly 1996:1). While there are no streams in Puna, there is enough rainfall so that it sometimes seeps from the ground surface at the coast and collects in small pools.

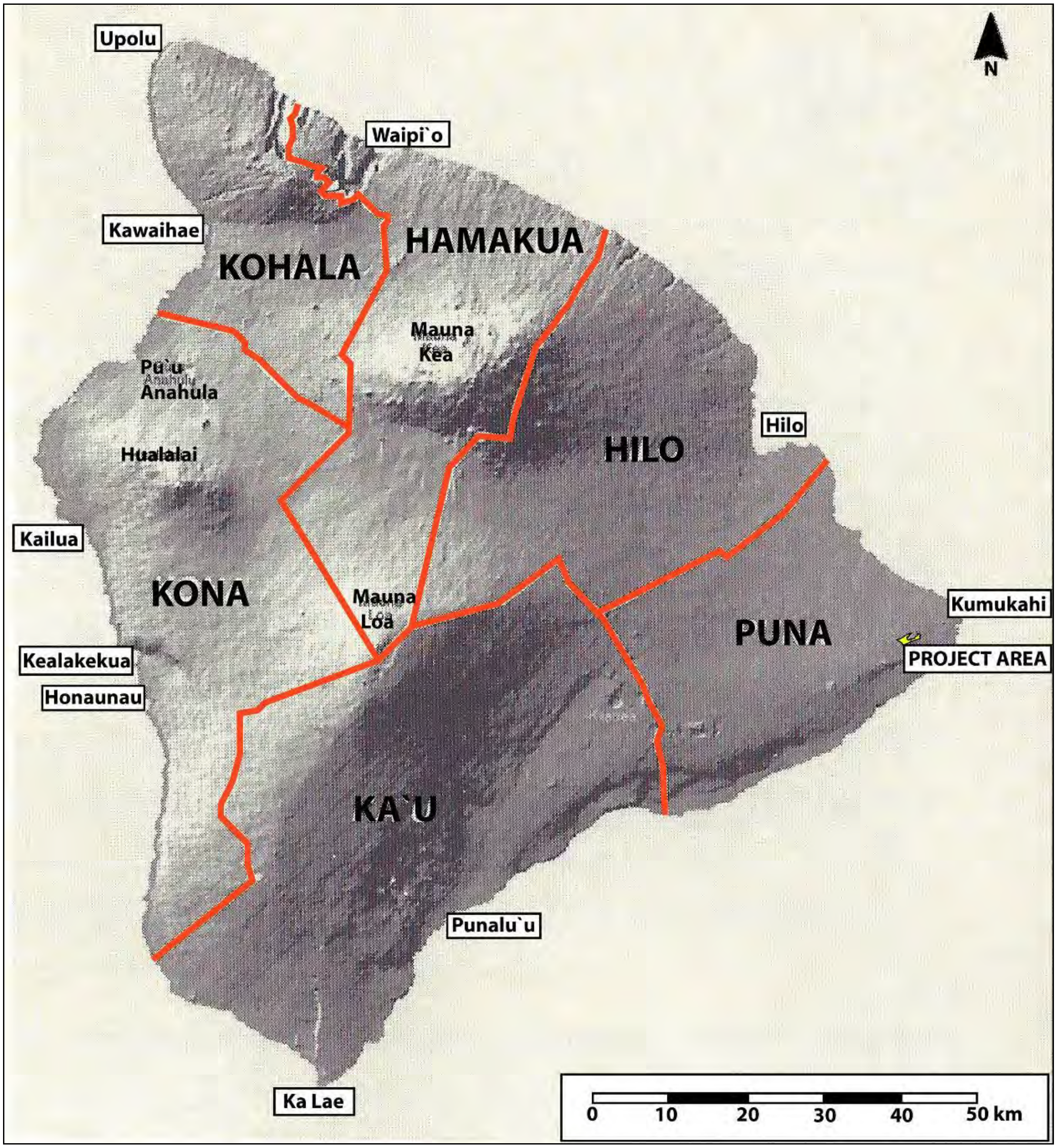

Figure 7: Map of Hawai‘i Island Showing the Six Traditional *Moku-O-Loko* (District-Size Land Divisions) and the Location of the Project Area (Adapted from Cordy 1985).

The project area is located in Kapoho Ahupuaʻa, Puna District, roughly 28.0 kilometers southeast of Hilo (see Figure 7 and Figure 8). Puna District is located on the eastern tip of Hawaiʻi Island and extends from the ocean to the eastern edge of Kīlauea-iki Crater (Halemaʻumaʻu) at 4,000 ft amsl and Kūlani cone at 5,518 ft amsl. The division of Hawaii Island into six *moku-o-loko* (districts) and smaller *ahupuaʻa* was formalized during in the early sixteenth century under the rule of ʻUmi-a-Līloa (Maly 1999:11). The divisions are part of a sociopolitical agricultural land management system that likely inculcated earlier natural environmental factors, agricultural zones, family relationships, and traditional Hawaiian cultural values.

Puna is translated as well-spring (Matsuoka et al. 1996:33). There were 57 *ahupuaʻa* recorded within the *moku-o-loko* of Puna during the eighteenth century, though the boundaries of some were not mapped (see Figure 8). From north to south, the *ahupaʻa* are ʻŌlaʻa, Keaʻau, Waikahekahenui, Waikahekahe, Waikahekaheiki, Makuʻu, Pōpōkī, Hālo, Keonepokoiki, Keonepokonui, Waiakahiula (*mauka*), Waiakahiula (*makai*), Kaʻohe (*mauka*), Kaʻohe (*makai*), Honolulu, Nānāwale, Waʻawaʻa, Kahuwai, Halepuaʻa, Kanekiki, Puua, Kula, Kapoho, Pūʻālaʻa, Ahalanui, Laepaoʻo, Pohoiki, Keahialaka, Kaukalau, Ki, Malama, Kauaea, Iliʻililoa, Opihikao, Kaueleau, Kukuihala, Kamāʻili, Keauohana, Kahena, Kīkala 1, Kīkala 2, Kēōkea, Kaimū, Kalapana, Kupahua, Hulunanai, Kahaualeʻa, Poupou 1, Poupou 2, Pūlama, Kamoamoa, Laeapuki, Pānaui-iki, Pānauinui, Kealakomo, Kahue, and ʻĀpua.

Kapoho Ahupuaʻa is located from the ocean just below Cape Kumukahi at the eastern tip of Hawaii Island to 680 ft amsl (Figure 9). Kapoho is translated literally as “the depression” (Pukui et al. 1974:89), a reference to the large Kapoho Crater 2.0 km west of the coastline (Figure 10). The crater is the remains of a cone formed between 400 and 700 years ago. Puʻu Honuaʻula, second large cone formed between 200 and 400 years ago, is located within the project area. Puʻuhonuaʻula is translated literally as “red place of refuge” (Pukui et al. 1974:197).

Many of the traditional *moʻolelo* (legendary accounts) passed down orally refer to the specific *moku-o-loko*, *ahupuaʻa*, *puʻu* (cones), and other natural geological features where the stories take place.

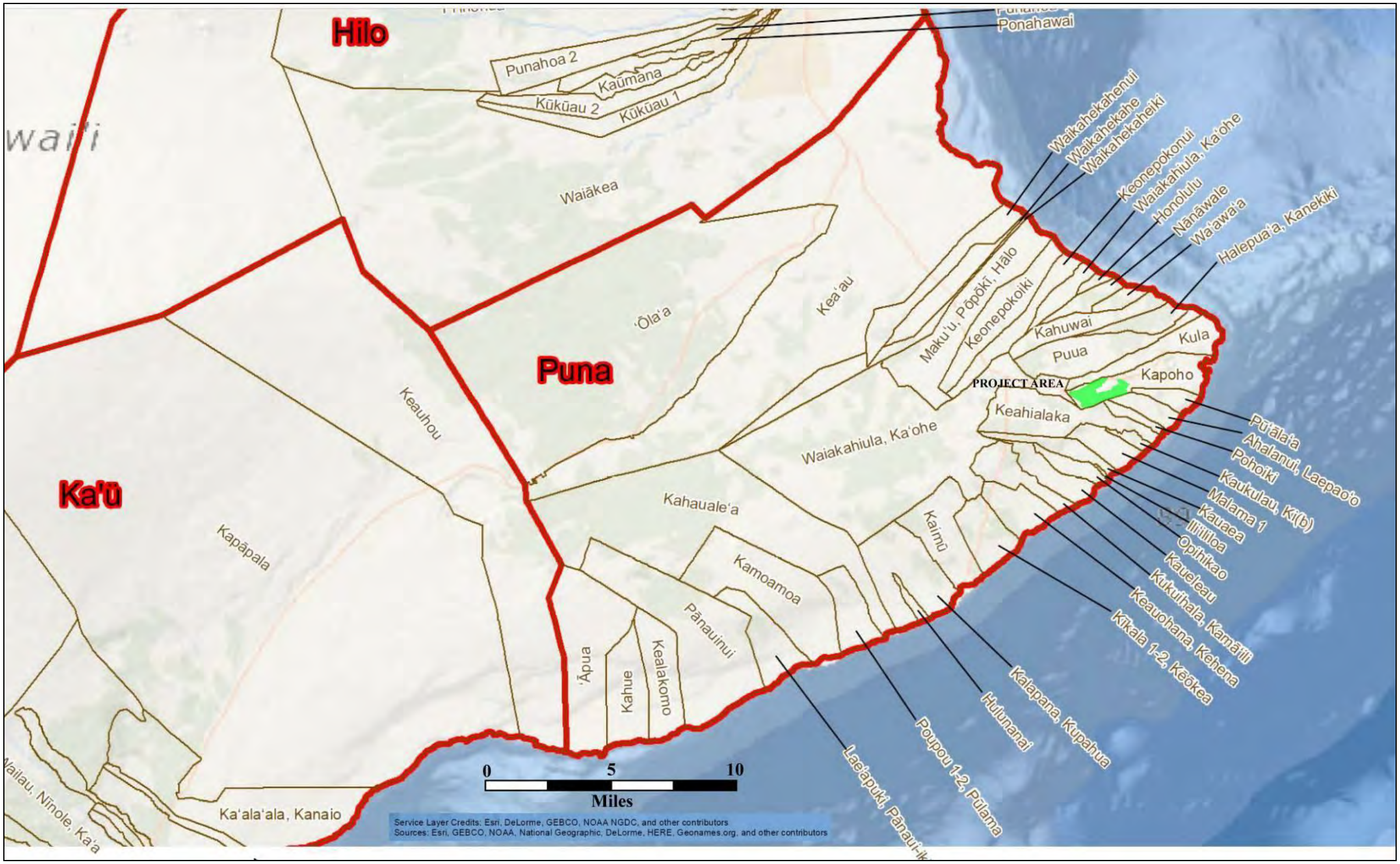

Figure 8: Portion of Hawaii Ahupaʻa Map Showing Puna Ahupuaʻa Locations.

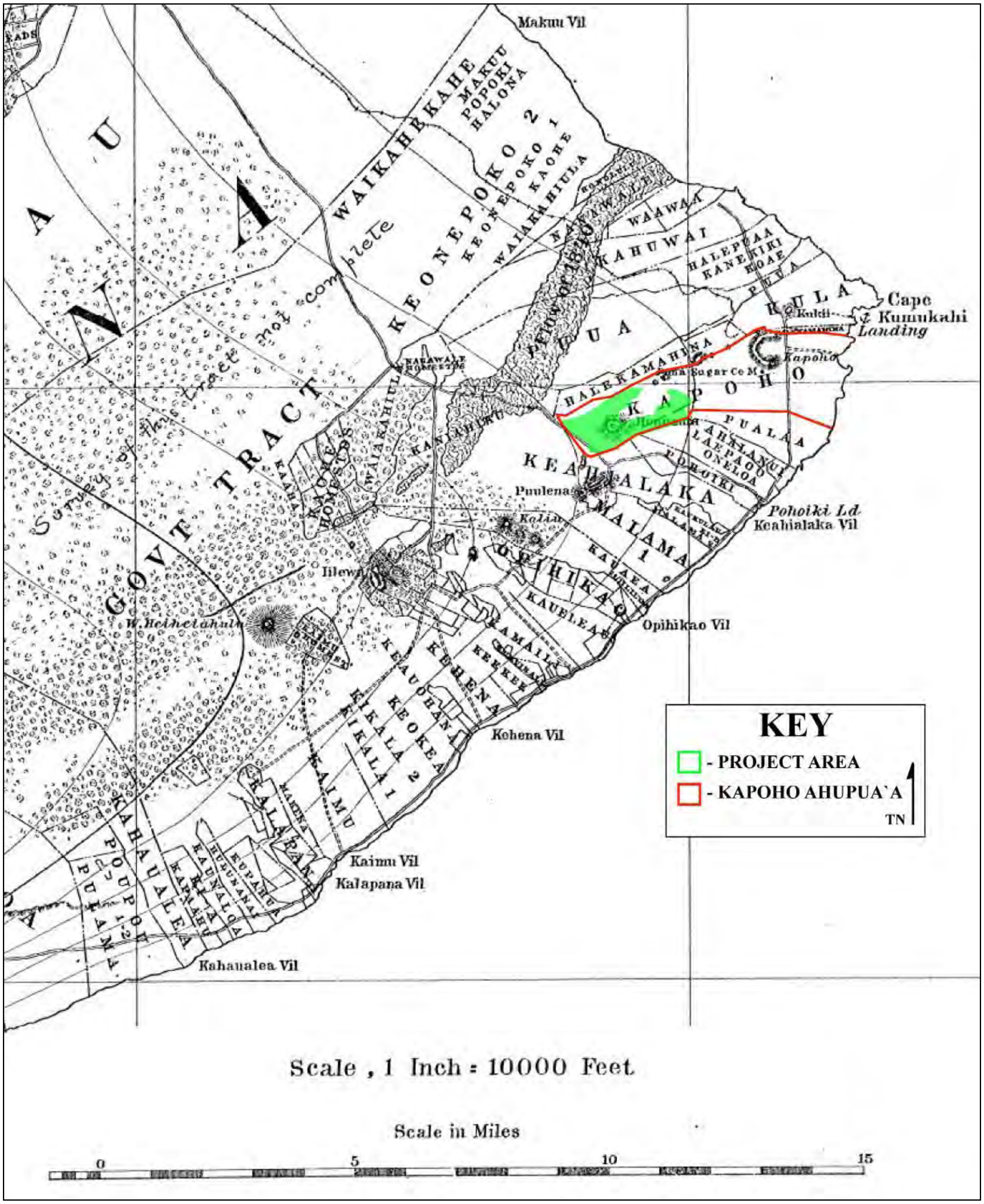

Figure 9: Portion of Hawai‘i Island Map Showing Kapoho Ahupua‘a and the Project Area (Donn 1901).

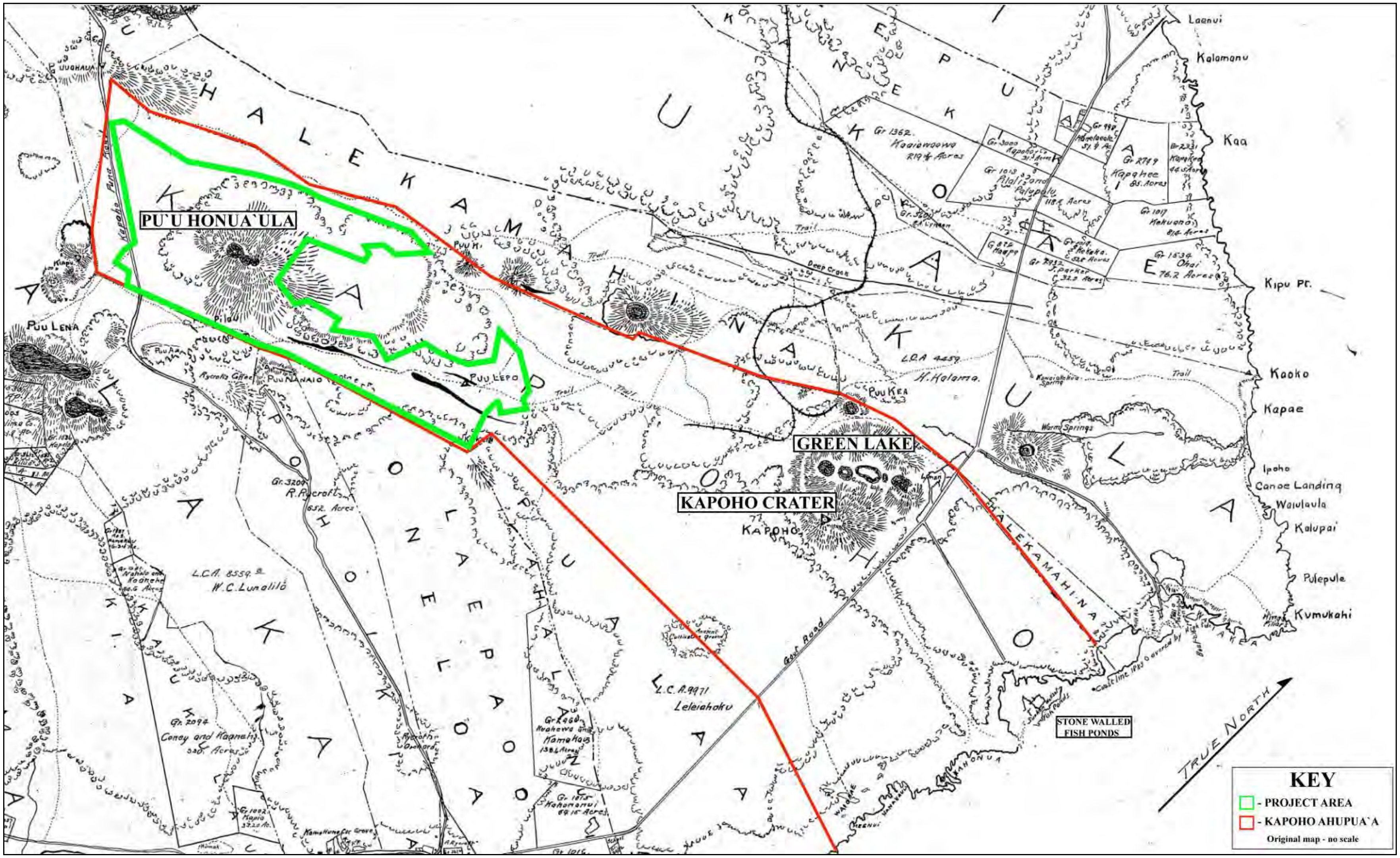

Figure 10: Portion of Puna District Map Showing Kapoho Ahupuaʻa and Project Area (Baldwin 1902).

TRADITIONAL ACCOUNTS (*MOʻOLELO*) OF PUNA AND KAPOHO

There are numerous *moʻolelo* and *ʻōlelo noʻeau* (proverbs and sayings) that tell of Puna's natural beauty, its gods (*akua* and *aumakua*) and places, and its inhabitant's practices. A detailed list and descriptions of *akua* and *aumakua* associated with Puna can be found ion Uyeoka et al. (2014). An in-depth ethnographic study for the Hawaii Geothermal Project documenting traditional accounts and beliefs can be found in Matsuoka et al. (1996).

Puna is closely associated with Kāne, god of the verdant forests of Puna and the Hawaiian god of sun light, also known as Kāne-i-ka-nohi-o-ka-l (Kāne-in-the-eyeball-of the sun) (Maly 1999:9). Kāne is foremost among the great gods and is associated with procreation, regeneration, the dawn, sunlight, lightning, refreshing spring water, irrigated agriculture, and fishponds (Uyeoka et al. 2014:65-66). Kāne and Lono were the deities most commonly addressed by those who offered prayers for the restoration of any one to health" (Uyeoka et al. 2014:72). Westervelt recounts that

> When Hawaiians, who had been ill, recovered, they frequently vowed to make a "journey of health." This meant that they came to the place now known as Hilo Bay. There they bathed by the beautiful little Coconut Island, fished up by the demi-god Maui. There they swam around a stone known as Moku-ola (The-island-of-life). Then they walked along the seashore day after day until they were below the volcano of Kilauea. They went up to the pit of Pele, offered sacrifices, and then followed an overland path back to Hilo. It was an ill omen if for any reason they went back by the same path. They must make the "journey of health" with the face forward. Hopoe (The dancing stone), Kapoho (The green lake), and Kumu-kahi were among the places which must be visited. {Westyervelt 1916:27]

One *ʻōlelo noʻeau* says "*Puna, ka ʻāina i ka haupo o Kāne* – the land [held] in the bosom of Kāne (Maly 1999:9). Another says of Puna "*Ke one lauʻena a Kāne* – the rich, fertile land of Kāne (Uyeoka et al. 2014:173). Puna is known through traditional oral accounts and proverbs for its groves of *pū hala* (pandanus trees) with their fragrant clusters of *hua hala* (pandanus fruit born on the female trees) and the *hīnano* (blossoms of the male pandanus) (Maly 1999:9).

The traditional oral accounts of early Puna recognize the presence of a volcanic god of fire, called ʻAi-lāʻau (the devourer of forests) that live within Kīlauea, before the arrival of Pele to the island (Westervelt 1916:1). While ʻAi-lāʻau lived within Kīlauea, he also inhabited the East Rift Zone craters for a time, before returning to his main residence within Kīlauea. It was there he resided when Pele first arrived.

Pele first landed on the island along the shore of Puna and proceeded inland to meet ʻAi-lāʻau and to find a new home with him. ʻAi-lāʻau, seeing Pele coming, was filled with fear, ran away, became utterly lost, and vanished (Westervelt 1916:1). Pele made her new home within Kīlauea.

Ke One Lauʻena A Kāne, The Great Sands of Kāne

Traditional *moʻolelo* describe early Kaʻū and Puna as beautiful lands without lava beds (Uyeoka et al. 2014:86). It was said that there was only earthen soil from one end to the other. The *moʻolelo* tell of the existence of a very long sandy stretch called Keonelauenaakāne (ʻKāne's great sand stretch') in the district of Puna that was covered by lava and that transformed Puna into a land of lava rock (McGregor 2007:147).

> The *moʻo*, Wakakeakaikawai and Punaʻaikoaʻe were destroyed by Pelehonuamea of the eternal fires. According to this legend, the fight between these *moʻo* and Pelehonuamea began in Punaluʻu in Kaʻū, continued in Puna, and ended in Waiākea in Hilo. Through the course of the battle, a long stretch of sand extending from Waiākea, Hilo, to Pānau in Puna, called Keonelauenaakāne, was covered with lava. Because Waka ran through Puna, with Pelehonuamea in pursuit, most of the land in Puna became covered with rough and smooth lava and remains so to this day. The famous stretch of sand disappeared. Only traces of it can be seen in small pockets, scattered here and there from Waiākea to Puna (McGregor 2007:147-148).

Pelehonuamea and Keliʻikuku

In the nineteenth century, Frenchman Jules Remy recorded a story told to him by an *aliʻi* of Kona called Kanuha. According to the story (Westervelt 1993:33-34), an *aliʻi* from Puna named Keliʻikuku was boasting of Puna to a prophet of Pele from Kauai named Kane-a-ka-lau. Keliʻikuku boasted of Puna's charms, abundance, and rich sandy plains where everything grows luxuriantly. Pele, hearing Keliʻikuku's boasting, covered the fertile plains and forests of Puna with burning lava. Kanuha believed the story might have taken place during the seventeenth century (McGregor 2007:149).

Pele was known to become impatient with the misdeeds of others and would often

> [S]end a flood of lava in her anger and burn everything up. Earthquakes came when Pele stamped the floor of the fire-pit in anger. Flames thrusting themselves through cracks in a breaking lava crust were the fire-spears of Pele's household of au-makuas or ghost-gods. Pele's voice was explosive when angry. Therefore it was called "pu." [Westervelt 1916:14]

There are numerous traditional accounts of Pele punishing arrogant and impudent chiefs, including chief Kahawali (Matsuoka et al. 1996:39-40), chief Kumu-kahi (Westervelt 1916:27), chief Papalauahi (Westervelt 1916:28), Kapapala (Westervelt 1916:30), and Kealohalani (Uyeoka et al. 2014:90). Pele punished them by sending out rivers of lava that often chased the offenders to the sea where they or their families and lands were covered and destroyed. Pele would also reward those who treated her with generosity and proper respect (Uyeoka et al. 2014:90). According to Westervelt, offerings made to appease Pele include fruits, flowers, lei, pigs, chickens, fish, and men (Westervelt 1916:14).

Pōhaku-o-Hanalei and Pōhaku-o-Lēkia

Pōhaku-o-Hanalei and Pōhaku-o-Lēkia are *pōhaku* (stones) that reside within the *ahupuaʻa* of Kapoho in Puna. These *pōhaku* are situated on either side of the lake called Wai a Pele, also known as Green Lake today (Pukui; Elbert; Moʻokini 1974:221) (Uyeoka et al. 2014:81). When Pele and her immediate family came from Tahiti, certain rock *kupua* accompanied her to the islands of Hawaiʻi, namely…Pōhakuolēkia lived in Kapoho, Puna (Uyeoka et al. 2014:81)

HISTORIC ACCOUNTS OF PRE-CONTACT ERA PUNA

Historical accounts pertaining to lands of the project area region are scarce but provide some information on traditional residence patterns, land-use, and subsistence.

Situated along the windward coast of Hawaiʻi Island, Puna is a verdant and abundant district with good rainfall and rich soils. However, it is also subject to volcanic eruptions and has been covered by new lava in many places over the last 1,000 years (Cordy 2000:17, and 22). Much of the district's coastal areas have thin soils, and there are no good deep water harbors. The ocean along the Puna coast is often rough and wind-blown.

As a result of these two factors, settlement patterns in Puna tend to be dispersed and without major population centers in contrast to North and South Kona, North and South Kona, and Hilo and Hāmākua (Figure11). Villages in Puna tend to be spread out over larger areas and often are inland, sometimes away from the coast, where the soil is better for agriculture (Cordy 2000: 45). At this time, a strict social hierarchy and a system of *kapu* (taboo) regulating hierarchical social interactions did not exist.

The lack of population centers had an effect on the development of a hierarchy of district rulers. Puna was often not strongly tied together by a tight web of allegiances between *ali'i* and *konohiki*. As a result, Puna was often conquered and ruled by stronger district leaders in Hilo or Kaʻū (Kamakau 1992:17 and 77; Matsuoka et al. 1996:41).

The earliest written historical accounts of Puna include the arrival of Pāʻao, a priest, prophet, chief and navigator from Tahiti or Samoa. Pāʻao landed in Puna sometime o the 11th cnetury and built his first *heiau* in Pulama Ahupuaʻa, dedicated to ʻAhaʻula, called Wahaʻula (Thrum 1908:38; Kamakau 1991:100). Wahaʻula was a walled *luakini heiau* approximately 132 ft by 72 ft with walls that were between eight and ten feet in height. The structure was oriented along the cardinal points of the compass.

The earliest account of Hilo appears in ʻUmi-a-Līloa's (1600–1620) conquest of the Island of Hawaiʻi, which establishes Hilo as a royal center by the sixteenth century. In the account, ʻUmi-a-Līloa began his conquest of the Island of Hawaiʻi by defeating chief Kulukuluʻā, who lived in Waiākea, the other chiefs of Hilo, ʻImaikalani, chief of Kaʻū, and Huaʻā, the chief of Puna (Kamakau 1992:16–19). ʻUmi-a-Līloa's second son, Keawe-nui-a-ʻUmi, ruled Hāmākua, Hilo, and Puna from his residence at Hilo (Kamakau 1992: 34). It was from Hilo that he waged war on the Kona chiefs and unified the island. Keawe-nui-a-ʻUmi's descendants single handedly continued rule for many generations from Hilo though Puna at times rebelled and was controlled by Puna and Kaʻū chiefs (Kamakau 1992:106; Matsuoka et al. 1996:42-43).

After the death of Keawe-nui-a-ʻUmi the kingdom was divided into three parts and was established under warring chiefs; Hilo was ruled by Kumalae-nui-puʻawa-lau and his son Makua *(*Kamakau 1992: 45). It was during the period of time and the following period of Kalaniʻōpuʻu's rule that Puna continued to be ruled the rebellious chief Imakakoloa. It was during this time also that Kamehameha I was born.

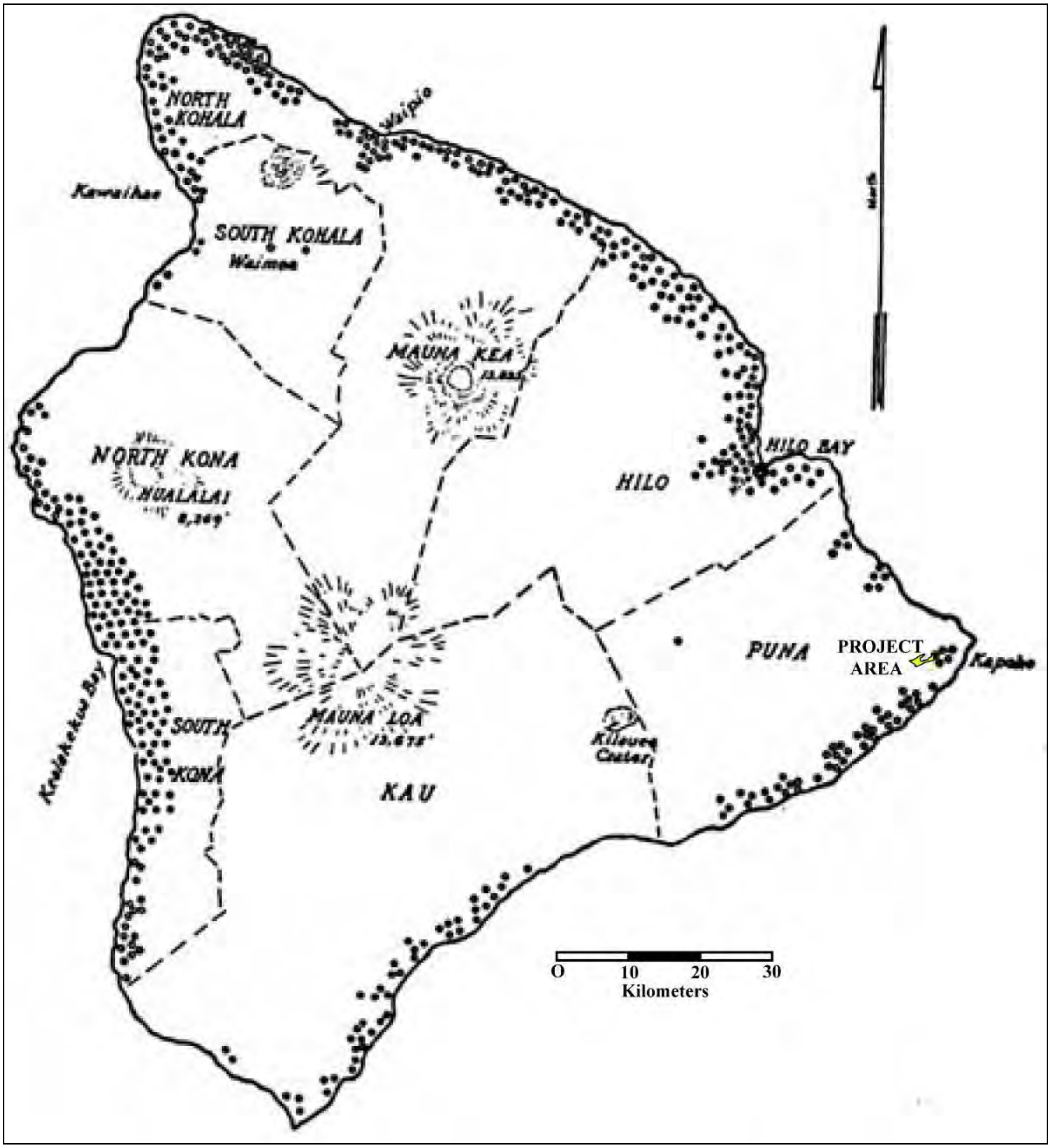

Figure 11: Map of Hawaii Island Population Concentrations by District (Coulter 1853).

Kalaniʻōpuʻu and his warriors travelled to Puna and defeated Imakakaloa (Kamakau 1992:108-109). Kalaniʻōpuʻu's grandson, Keoua Kuahuʻula and nephew Kamehameha I vied for control over the six chiefdoms constituting the island kingdom and Keoua conquered Hilo chief Keawe-mau-hili and harvested the benefits for a short time only to be vanquished by Kamehameha I late in 1791.

Puna District was famous for its valuable products, including "hogs, gray *kapa* cloth (*ʻeleuli*), tapas made of *māmaki* bark, fine mats made of young pandanus blossoms (ʻ*ahuhinalo*), mats made of young pandanus leaves (*ʻahuao*), and feathers of the *ʻōʻō* and *mamo* birds" Kamakau 1992:106). Puna was also famous for its abundant *ulu* (breadfruit).

HISTORIC ACCOUNTS OF CONTACT ERA PUNA

William Ellis passed through Puna in 1823 while travelling along the coastal trail from Kīlauea to Waiākea Ahupuaʻa in Hilo (Figure 12). Ellis' journey took him along the coast near past Kapoho Crater and Green Lake. Lengthy excerpts from his journal are reproduced below, as his descriptions of the villages and landscape he passed through, descriptions of gardens and the availability and quality of drinking water, population estimates, and *moʻolelo* are the most detailed and complete from the Contact Era accounts of Puna. It should be noted that Ellis' own western religious and cultural values sometimes distort his representations of traditional Hawaiian cultural values and beliefs he encountered. As Ellis descended from Kīlauea through Pānauinui Ahupuaʻa, he wrote

> As we approached the sea, the soil became more generally spread over the surface, and vegetation more luxuriant.
>
> About two p. m. we sat down to rest. The natives ran to a spot in the neighbourhood, which had formerly been a plantation, and brought a number of pieces of sugar-cane, with which we quenched our thirst, and then walked on through several plantations of the sweet potato, belonging to the inhabitants of the coast, until about three o'clock, when we reached the edge of the high ground, which, at a remote period, probably formed the south-east coast.
>
> We stopped at a solitary cottage, where we procured a copious draught of fresh water, to us a most grateful beverage, as we had travelled ever since the morning without any refreshment, except a few berries and a piece of sugar-cane.
>
> We descended 300 or 400 feet, by a narrow winding path, covered with overhanging trees, and bordered by shrubs and grass. We then walked over a tract of lava, broken and decomposed, and about four or five miles wide, at the end of which another steep appeared.
>
> These steep precipices form concentric ridges of volcanic rock round the greater part of this side of the island. Down this we descended by following the course of a rugged current of ancient lava, for about 600 feet perpendicular depth, when we arrived at the plain below, which was one extended sheet of lava, without shrub or bush, stretching to the north and south as far as the eye

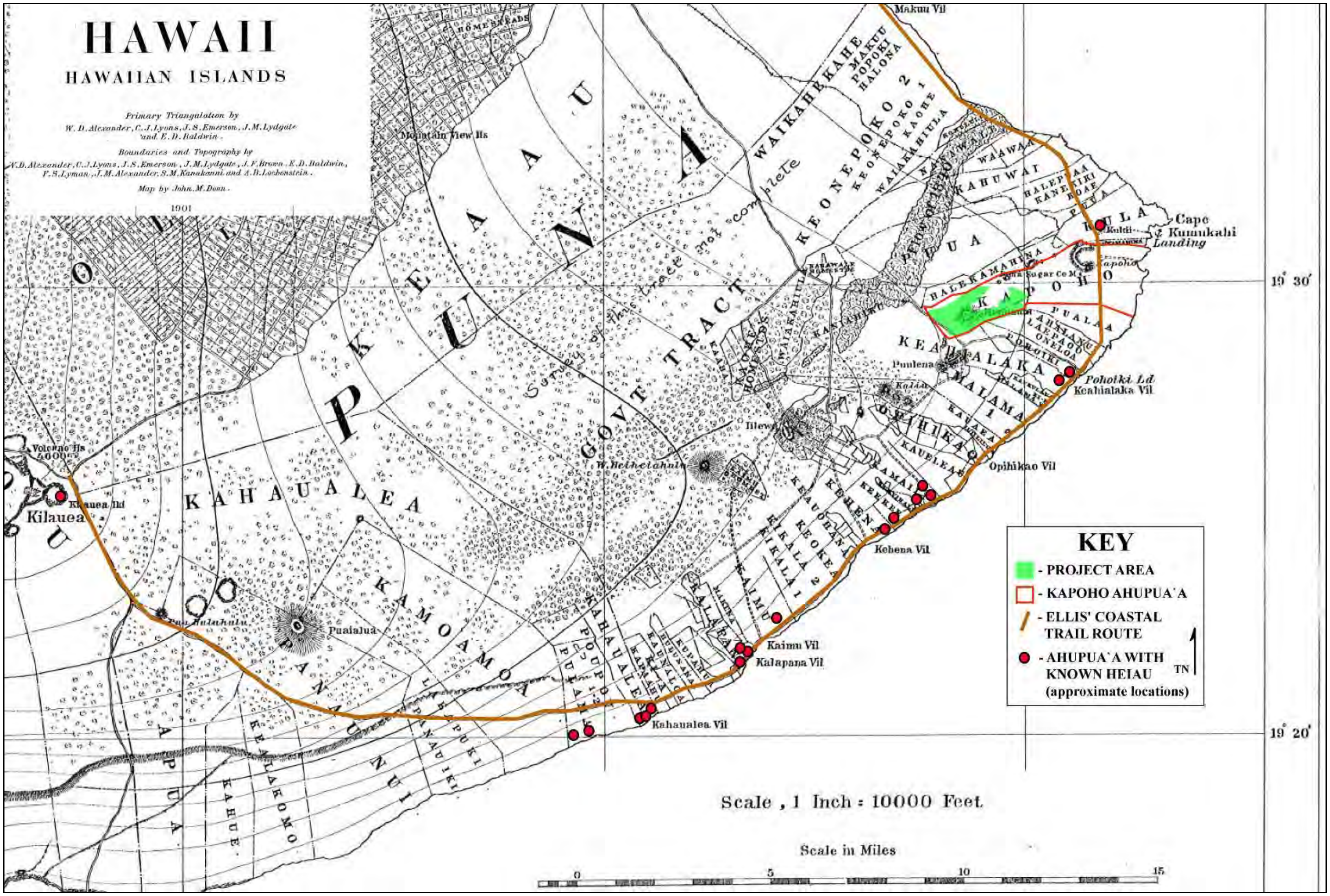

Figure 12: Portion of Hawai'i Island Map Showing Ellis' Route Along the Puna Coastal Trail, Ahupua'a with Known *Heiau*, and the Project Area (Donn 1901).

could reach, and from four to six miles across, from the foot of the mountain to the sea.

This vast tract of lava was black, shining, and cellular, though not very brittle, and was more homogeneous than that which covered the southern shores of the island.

We crossed it in about two hours, and arrived at Kearakomo [Kealakomo], the second village in the division of Puna. We stopped at the first house we came to, and begged some water. The natives brought us a calabash-full, of which we drank most hearty draughts, though it was little better than the water of the sea, from which it had percolated through the vesicles of the lava into the hollows from nine to twelve feet distant from the ocean. It barely quenched our thirst while we were swallowing it, but it was the best we could procure, and we could hardly refrain from drinking at every hollow to which we came.

After walking about a mile along the beach, we came to a house, which our guide pointed out as our lodgings.

The village is populous, and the natives soon thronged around us.

About sunset we sent to the head man of the village for some refreshment, but he was intoxicated; and though we had walked upwards of twenty miles since morning, and had subsisted on but scanty fare since leaving Kapapala, we could only procure a few cold potatoes, and two or three pieces of raw salt fish.

Between six and seven o'clock, about two hundred of the people collected in front of our house.

About nine a. m. a friend of Mauae brought us a bundle of potatoes and a fowl. We procured another; our native boys cooked them in an oven of stones under ground, and they made us a good breakfast. All that we wanted was fresh water, that which we were obliged to drink being extremely brackish.

At 12 o’clock, about three hundred of the people again assembled near our dwelling, and we held a religious exercise similar to that which they had attended in the morning.

The head man of the village was present during the service. He came into our house after it was over, and told us all his provisions were at his farm, which was some distance inland, and that tomorrow he intended to bring us a pig, and some potatoes. We thanked him, but told him probably we should proceed on our way early in the morning. He went away, and in a short time returned with a raw salted albicore, and a basket of baked sweet potatoes, which he said was all he could furnish us with to-day.

In the evening, we were so favoured as to procure a calabash-full of fresh water from the caves in the mountains, where it had filtered through the strata of lava, and was received into vessels placed there for that purpose. It tasted bitter, from standing long in the calabashes; but yet it was a luxury, for our thirst was great, notwithstanding the quantities of water we had drank during the day.

About sunset we ate some of our raw fish and half-baked potatoes.

Leaving Kearakomo, we travelled several miles in a north-easterly direction along the same bed of lava that we had crossed on Saturday evening. The population of this part of Puna, though somewhat numerous, did not appear to possess the means of subsistence in any great variety or abundance; and we have often been surprised to find the desolate coasts more thickly inhabited than some of the fertile tracts in the interior; a circumstance we can only account for, by supposing that the facilities which the former afford for fishing, induce the natives to prefer them as places of abode; for they find that where the coast is low, the adjacent water is generally shallow.

'We saw several fowls and a few hogs here, but a tolerable number of dogs, and quantities of dried salt fish, principally albicores and bonitos. This latter article, with their poe and sweet potatoes, constitutes nearly the entire support of the inhabitants, not only in this vicinity, but on the sea-coasts of the north and south parts of the island.

Besides what is reserved for their own subsistence, they cure large quantities as an article of commerce, which they exchange for the vegetable productions of Hiro and Mamakua, or the mamake and other tapas of Ora and the more fertile districts of Hawaii.

When we had passed Punau, Leapuki, and Kamomoa, the country began to wear a more agreeable aspect. G-roves of cocoa-nuts ornamented the projecting points of land, clumps of kou-trees appeared in various directions, and the habitations of the natives were also thickly scattered over the coast.

At noon we passed through Pulana, where we saw a large heiau called Wahaura [Waha‘ula], Bed Mouth, or Bed-feather Mouth, built by Tamehameha, and dedicated to Tairi, his war-god. Human sacrifices, we were informed, were occasionally offered here.

Shortly after, we reached Kupahua, a pleasant village, situated on a rising ground, in the midst of groves of shady trees, and surrounded by a well-cultivated country. Here we stopped, and, having collected the people of the village, I preached to them. They afterwards proposed several interesting inquiries connected with what they had heard, and said it was a good thing for us to aroha, or have compassion on them. They also asked when we would come again.

Leaving this interesting place, we passed on to Kalapana, a small village on the sea-shore, distingished as the residence of Kapihi, the priest, who, in the days of Tamehameha, told the king, that after death he and all his ancestors would live again on Hawaii.

We saw a large heiau, of which he was chief priest, but did not see many people in the houses as we passed by. Kapihi had many disciples, who believed, or pretended to believe, his predictions.

Frequent offerings were made to Kuahairo, his god, at other parts of the island more frequently visited by the king, and this probably drew away many of the people from Kalapana.

About three p. m, we approached Kaimu. [Ellis 1963:196-204]

[At Kaimu], we passed through their plantations, and groves of coconut trees… We had been sitting in the house about an hour, when a small hog, baked under-ground, with some good sweet potatoes, was brought in for dinner, of which we were kindly invited to partake. As there was also plenty of good fresh water here, we found ourselves more comfortably provided for than we had been since leaving Kapapala on Thursday last.

At six o'clock in the evening, we sent to collect the people of the village to hear preaching. Between three and four hundred assembled, under a clump of shady cordia trees, in front of the house, and I preached to them from Psalm xxii. verses 27 and 28. [Ellis 1963:207]

In the afternoon, Messrs. Thurston and Bishop walked over to Makena, a pleasant village about a mile to the southward of Kaimu, where they collected about one hundred people, to whom Mr. Thurston preached in one of their houses. A greater number would probably have attended, but for the rain which fell during most of the afternoon. Mr. Bishop numbered the houses in the village, and found them, including Makena, to be 145.

Kaimu is pleasantly situated near the sea shore, on the S. E. side of the island, standing on a bed of lava considerably decomposed, and covered over with a light and fertile soil. It is adorned with plantations, groves of cocoa-nuts, and clumps of kou-trees. It has a fine sandy beach, where canoes may land with safety; and, according to the houses numbered to-day, contains about 725 inhabitants.

Including the villages in its immediate vicinity, along the coast, the population would probably amount to 2000; and, if water could be procured near at hand, it would form an eligible missionary station.

There are several wells in the village, containing brackish water, which has passed from the sea, through the cells of the lava, undergoing a kind of filtration, and is collected in hollows scooped out to receive it.

The natives told us, that, at the distance of about a mile there was plenty of fresh water.

After travelling nearly two hours, we arrived at Keouohana, where we sat down to rest beneath the shade of some cocoa-nut trees.

Makoa, our guide, spoke to the head man, and he directed the people to collect near his house. About 100 soon assembled, and when we had explained to them in few words, the object of our visit, we requested them to sit down, and listen to the tidings we had brought. They immediately obeyed.

The head man brought us some ripe plantains, of which we ate a few, and then proceeded on our way, leaving them busy in conversation about the news they had heard; which, in all probability, were strange things to their ears.

After travelling a mile and a half along the shore, we came to Kehena, a populous village; the people seemed, from the number of their canoes, nets, &e. to be much engaged in fishing. Their contrivance for launching and landing their canoes, was curious and singular.

The bold coast is formed of perpendicular or overhanging rocks, from forty to sixty feet high, against which, this being the windward part of the island, the swell beats violently.

In one place, where there were a few low rocks about thirty feet from the shore, they had erected a kind of ladder. Two long poles, one tied to the end of the other, reached from these rocks to the top of the cliffs. Two other poles, tied together in the same manner, were fixed parallel to the first two, and about four or five feet distant from them. Strong sticks, eight or ten feet long, were laid across these at right angles, and about two or three inches apart, which being fastened to the long poles with ie, (the tough fibrous roots of a climbing sort of plant, which they find in the woods,) formed the steps of this ingenious and useful ladder.

The canoes of the place were light and small, seldom carrying more than one man in each. A number were 3ust landing, as we arrived at the place. Two men went down, and stood close to the water's edge, on the leeward or southern side of the rock.

The canoes were paddled up one at a time. The person in each, then watching a convenient opportunity, rowed swiftly to shore, when the rolling billow carried the canoe upon the rock, and it was seized by two men who stood there to receive it. At the same instant that it was grasped on each side by the men on the rock, the one in the canoe, who steered it, jumped into the sea, swam to the shore, and assisted them in carrying it up the ladder to the top of the cliff, where they placed it upon curiously carved stools, made of the wood of the erythrina, and returned to the rock to await the arrival of another canoe. In this way five or six were brought up while we stood looking at them, and I took a sketch of their useful contrivance.

Leaving Kehena, we walked on to Kamaili, a pleasant village, standing in a gently sloping valley, cultivated and shaded by some large cocoa-nut trees. Here we stopped to take breakfast, having travelled about four hours and a half. The hospitable inhabitants, at the request of our guide, soon brought us some fresh fish, a nice pig, with potatoes and taro, and a calabash of good water.

The people who were not employed on their plantations, or in fishing, afterwards assembled, and were addressed from Psahn Ixvii. 7. Considerable conversation followed, and they detained us some time to answer their questions, or to explain more fully the things that had been spoken. It was truly gratifying to notice the eagerness with which they proposed their inquiries. After spending about half an hour in endeavouring to satisfy 200 or 300 of them, we took leave, and pursued our journey.

Our path from Kaimu had been smooth and pleasant, but shortly after leaving Kamaili, we passed a very rugged tract of lava nearly four miles across. The lava seemed as if broken to pieces as it cooled; it had continued to roll on like a stream of large scoria, or cinders. Our progress across it was slow and fatiguing.

On our way, our guide pointed out Karepa, an ancient heiau, formerly dedicated to Tu and Rono, and built in the days of Teavemauhiri, or Tanakini, king of this part of the island. We could not learn whether this was the heiau of Rono, in which the bones of Captain Cook were deposited, and worshipped.

About half -past one, we arrived at Opihikao, another populous village, situated within a short distance of the sea.

We then proceeded about two miles, principally through cultivated grounds, to Kauaea. About 300 people, excited by curiosity, soon collected around us, to whom Mr. Thurston preached.

We afterwards sat down and talked with them, and then resumed our journey through the district of Malama, the inland part of which was inundated by a volcanic eruption about thirty years since. The part over which we passed, being nearer the sea than that which the lava had overflowed, was covered with soil, and smiling with verdure.

Fear five p. m. we reached Keahialaka, the residence of Kinao, chief or governor of Puna We found him lying on a couch of sickness, and felt anxious to administer to his comfort, yet did not like at so early an hour to halt altogether for the night. I therefore remained with the sick chief, while Messrs. Thurston and Bishop went on to a village at the east point, about two miles distant.

When they reached Pualaa, the above-mentioned village, they were kindly welcomed by the head man, who soon had the people of the place collected at their request, and to them Mr. Thurston proclaimed the news of salvation through Jesus Christ. The chief furnished the travellers with a hospitable supper and comfortable lodgings. [Ellis 1963:210-214]

It was about eight o'clock in the morning of the 7th when I joined Messrs. Thurston and Bishop at Pualaa, where we took breakfast, and afterwards spent the forenoon in conversation with the natives who thronged around us.

Two or three old men, whom we afterwards learned were priests, seemed to dispute what we said about Jehovah's being the only true God, and the Christian the only true religion. They said they thought their tao (traditions) respecting Tu, Tanaroa, Rono, or Orono, and Tairi, were as authentic as the accounts in our book, though ours, from the circumstance of their being written, or, as they expressed it, "hana paia i ka palapala," (made fast on the paper,) were better preserved, and more akaaka, clear, or generally intelligible.

To this we replied at some length, after which the old men ceased to object, but continued to withhold their assent. Numbers sat around, and seemed interested in the discussion. We continued talking to them on the subject of their traditions, one of which we wrote down as they repeated it.

About half-past eleven we took leave of them, and directed our way across the eastern point. A most beautiful and romantic landscape presented itself on our left, as we travelled out of Pualaa. The lava was covered with, a tolerably thick layer of soil, and the verdant plain, extending several miles towards the foot of the mountains, was agreeably diversified by groups of picturesque hills, originally craters, but now clothed with grass, and ornamented with clumps of trees.

The natives informed us, that three of these groups, Honuaura, Malama, and Mann, being contiguous, and joined at their base, arrested the progress of an immense torrent of lava, which, in the days of Taraiopu, the friend of Captain Cook, inundated all the country beyond them. We soon left this cheerful scenery, and entered a rugged tract of lava, over which we continued our way till about two p.m. when we reached Kapoho.

A cluster, apparently of hills three or four miles round, and as many hundred feet high, with deep indented sides, overhung with trees, and clothed with herbage, standing in the midst of the barren plain of lava, attracted our attention.

We walked through the gardens that encircled its base, till we reached the S. E. side, where it was much lower than on the northern parts. Here we ascended what appeared to us to be one of the hills, and, on reaching the summit, were agreeably surprised to behold a charming valley opening before us. It was circular, and open towards the sea.

The outer boundary of this natural amphitheatre was formed by an uneven ridge of rocks, covered with soil and vegetation. Within these there was a smaller circle of hills, equally verdant, and ornamented with trees. The sides of the valley, which gradually sloped from the foot of the hills, were almost entirely laid out in plantations, and enlivened by the cottages of their proprietors.

In the centre was an oval hollow, about half a mile cross, and probably two hundred feet deep, at the bottom of which was a beautiful lake of brackish water, whose margin was in a high state of cultivation, planted with taro, bananas, and sugar-cane.

The steep perpendicular rocks, forming the sides of the hollow, were adorned with tufts of grass, or blooming pendulous plants, while, along the narrow and verdant border of the lake at the bottom, the bread-fruit, the kukui, and the ohia trees, appeared, with now and then a lowly native hut standing beneath their shade.

We walked to the upper edge of the rocks that form the side of the hollow, where we viewed with pleasure this singularly beautiful scene.

The placid surface of the lake, disturbed only by the boys and girls diving and sporting in its waters, the serpentine walks among the luxuriant gardens along its margin, the tranquil occupations of the inhabitants, some weaving mats, others walking cheerfully up and down the winding path among the steep rocks, the sound of the cloth-beating mallet from several directions, and the smiling gaiety of the whole, contrasted strongly with the panorama we had recently beheld at Kirauea. Yet we felt persuaded, that this now cheerful spot had once presented a similar spectacle, less extended, but equally grand and appalling.

The traditions of the people informed us, that the valley itself was originally a crater, the indented rocks along the outer ridge forming its rim, and the opening towards the sea its mouth. But had tradition been silent, the volcanic nature of the rocks, which were basaltic, or of compact lava in some parts and cellular in others, the structure of the large basin in which we were standing, and the deep hollow in the centre which we were viewing, would have carried conviction to the mind of every beholder, that it had once been the seat of volcanic fires.

We asked several natives of the place, if they had any account of the king in whose reign it had burned; or if they knew any songs or traditions, in which it was stated how many kings had reigned in Hawaii, or how many chiefs had governed Puna, either since it first broke out, or since it became extinct; but they could give us no information on these subjects.

They told us the name of the place was Kapoho (the sunken in,) and of the lake, Ka wai a Pele (the water of Pele).

The saltiness of the water in this extinguished volcano proves the connection of the lake with the sea, from which it is about a mile distant; but we could not learn that it was at all affected by the rising or falling of the tides.

The natives also told us that it was one of the places from which the volcanic goddess threw rocks and lava after Kahavari, for refusing his papa, or sledge, when playing at holua.

The holua has for many generations been a popular amusement throughout the Sandwich Islands, and is still practiced in several places. It consists in sliding down a hill on a narrow sledge, and those who, by strength or skill in balancing themselves, slide farthest, are considered victorious.

The papa, or sledge, is composed of two narrow runners, from seven to twelve or eighteen feet long, two or three inches deep, highly polished, and at the foremost end tapering off from the underside to a point at the upper edge. These two runners are fastened together by a number of short pieces of wood laid horizontally across. To the upper edge of these short pieces two long tough sticks are fastened, extending the whole length of the cross pieces, and about five or six inches apart.

Sometimes a narrow piece of matting is fastened over the whole upper surface, except three or four feet at the foremost end, though in general only a small part for the breast to rest on is covered.

At the foremost end there is a space of about two inches between the runners, but they widen gradually towards the hinder part, where they are distant from each other four or five inches.

The person about to slide grasps the small side-stick firmly with his right hand, somewhere about the middle, runs a few yards to the brow of the hill, or starting-place, where he grasps it with his left hand, and at the same time with all his strength throwing himself forward, falls flat upon it, and slides down the hill, his hands retaining their hold of the side-sticks, and his feet being fixed against the hindermost cross-piece of the sledge.

Much practice and address are necessary, to assume and keep an even balance on so narrow a vehicle, yet a man accustomed to the sport will throw himself, with velocity and apparent ease, 150 or 200 yards down the side of a gradually sloping hill.

About three o'clock we resumed our journey, and soon reached Kula, a romantic spot, where Kahavari took leave of his sister.

The hill on which he was sliding when he incurred the displeasure of the terrible goddess, the spot where he rested, and first saw her pursuing him, were visible, and the traditional story of his encounter with Pele is so interesting, that we think we shall be pardoned for inserting it.

In the reign of Keariikukii, an ancient king of Hawaii, Kahavari, chief of Puna, and one of his punahele, (favourite companions,) went one day to amuse themselves at the horua on the sloping side of a hill, which is still called Ka horua-ana o Kahavari, (the sliding place of Kahavari).

Vast numbers of the people collected at the bottom of the hill, to witness the game, and a company of musicians and dancers repaired to the spot, to add to the amusement of the spectators. The buskined youths had begun their dance, and, amidst the sound of the drums and the songs of the musicians, the holua commenced between Kahavari and his favourite.

Pele, the goddess of the volcano, came down from Kirauea to witness the sport.

She stood on the top of the hill, in the form of a woman, and challenged Kahavari to slide with her. He accepted the offer, and they set off together down the hill. Pele, less acquainted with the art of balancing herself on the narrow sledge than her rival, was beaten, and Kahavari was applauded by the spectators as he returned up the side of the hill.

Before they started again, Pele asked him to give her his papa. He, supposing from her appearance that she was no more than a native woman, said, Aore, no! “Are you my wife, that you should obtain my sledge?’’ and, as if impatient at being delayed, adjusted his papa, ran a few yards to take a spring, and then, with all his strength, threw himself upon it, and shot down the hill.

Pele, incensed at his answer, stamped on the ground, and an earthquake followed, which rent the hill in sunder. She called, and fire and liquid lava arose, and, assuming her supernatural form, with these irresistible ministers of vengeance, she followed down the hill.

When Kahavari reached the bottom of the hill, he arose, and, on looking behind, saw Pele, accompanied by thunder and lightning, earthquake, and streams of burning lava, closely pursuing him. He took up Ms broad spear, which he had stuck in the ground at the beginning of the game, and, accompanied by Ms friend, fled for his life.

The musicians, dancers, and crowds of spectators, were instantly buried beneath the fiery torrent, which bearing on its foremost wave the enraged goddess, continued to pursue Kahavari and his friend.

They ran till they came to an eminence, called Buukea. Here Kahavari threw off his tuirai, cloak of netted ti leaves, and proceeded towards his house, which stood near the shore.

He met his favourite hog Aroipuaa, saluted him by touching noses, and ran to the house of Ms mother who lived at Kukii, saluted her by touching noses, and said, Aroha ino oe, eia ihonei paha oe e make ai, ke ai mainei Pele: Compassion great to you, close here perhaps is your death, Pele comes devouring.

Leaving her, he met his wife, Kanakawahine. He saluted her. The burning torrent approached, and she said, “Stay with me here, and let us die together.” He said, “No; I go, I go.”

He then saluted Ms two children Paupouru and Kaohe, and said “Ke ue nei au ia orua,” I grieve for you two.

The lava rolled near, and lie ran till a deep chasm arrested his progress. He laid down his spear, and on it walked safely over. His friend called out for his help; he held out his spear over the chasm; his companion took hold of it, and he drew him securely over.

By this time Pele was coming down the chasm with accelerated motion. He ran till he reached the place where we were sitting.

Here he met his sister Koae, but had only time to say, Aroha oe! “Alas for you!’" and then ran on to the sea-shore. His younger brother had just landed from his fishing canoe, and had fastened to his house to provide for the safety of his family, when Kakavari arrived; he and his friend leaped into the canoe, and with his broad spear paddled out to sea.

Pele perceiving his escape, ran to the shore, and hurled after him, with prodigious force, huge stones and fragments of rock, which fell thickly around, but did not strike his canoe.

When they had paddled a short distance from the shore, the Kumukahi (east wind) sprung up. He fixed his broad spear upright in the canoe, which answering the double purpose of mast and sail, he soon reached the island of Maui. Here they rested one night, and proceeded to Ranai. On the day following he removed to Morokai, and from there to Oahu, the abode of Koronokairaau his father, and Kanewakinekeako his sister, to whom he related his disastrous perils, and with whom he took up his permanent abode. [Ellis 1963:217-222]

After travelling a short distance, we saw tie Bu o Kahavari, (Hill of Kahavari) the place where he stopped, after sliding down-hill, and perceiving tie goddess pursuing him. It was a black frowning crater, about 100 feet high, with a deep gap in its run on the eastern side, from which the course of the current of lava could be distinctly traced.

Our way now lay over a very rugged tract of country. Sometimes for a mile or two we were obliged to walk along on the top of a wall four feet high and about three feet wide, formed of fragments of lava that had been collected from the surface of the enclosures which these walls surrounded. We were, however, cheered with a beautiful prospect; for the land, which rose gradually towards the mountains, a few miles to the westward of us, presented an almost enchanting appearance.

The plain was covered with verdure; and as we advance, a woody eminence, probably some ancient crater, frequently arose from the gently undulated surface, while groups of hills, clothed with trees of various foliage, agreeably diversified tie scene.

The shore, which was about a mile to the eastward of us, was occasionally lined with the spiral pandanus, tie waving cocoa-nut grove, or the clustering huts of the natives.

At half -past four we reached Kahuwai, where we sat down and took some refreshment, while Makoa was engaged in bringing the people of the place together. About one hundred and fifty assembled around the door, and were addressed.

After conversing some time, we travelled in an inland direction to Honoruru, a small village situated in the midst of a wood, where we arrived just at the setting of the sun.

Whilst the kind people at tie house where we put up were preparing our supper, we sent and invited tie inhabitants of the next village to come and hear the word we had to speak to them. They soon arrived; tie large house in which we had taken up our lodgings was filled, and a discourse was delivered from John xii. 46. “I am come a light into the world, “ &e.

We afterwards spent a hour in conversation and prayer with the people of these sequestered villages, who had perhaps never before been visited by foreigners, and then lay down on our mats to rest.

We arose early on the 8th, and Mr. Thurston held morning worship with the friendly people of the place. Although I had been much indisposed through the night, we left Honoruru soon after 6 a. m. and, travelling slowly towards the sea-shore, reached Waiakaheula about eight, where I was obliged to stop, and lie down under the shade of a canoe-house near the shore. Messrs. Thurston and Bishop walked up to the settlement about half a mile inland, where the former preached to the people.

We had seen the eastern division of Hiro yesterday afternoon; and Mr. Bishop hoping to reach Waiakea in a few hours, left Mr. Thurston and the natives with me, and proceeded thither. He was much deceived as to the distance; for it was three o’clock in the afternoon when he arrived at Kaau (Keaau), where the natives tried to persuade him to stay till morning, as they did not think he could reach Waiakea before night. However, he kept on with increased speed, in hopes of getting at least a sight of Waiakea before dark. But in this he was disappointed, for the sun sunk behind Mauna-Kea, and darkness overshadowed the landscape before he had passed the wilderness of Pandanus, that stretched along the eastern shore, between Keaau and Hilo. He began to think of resting for the night beneath the shelter of the surrounding bushes; but the path becoming more beaten, indicated his approach to a village. Encouraged by this, he pursued his way, about nine in the evening reached Waiakea, and entered the house of Maaro, where he found Messrs. Goodrich and Harwood, by whom he was gladly welcomed.

Being somewhat recovered by noon, I was able to proceed with Mr. Thurston, The country was populous, but the houses stood singly, or in small clusters, generally on the plantations, which were scattered over the whole country. Grass and herbage were abundant vegetation in many places luxuriant, and the soil, though shallow, was light and fertile.

Soon after five p. m. we reached Keaau, the last village in the division of Puna. It was extensive and populous, abounding with well cultivated plantations of taro, sweet potatoes, and sugar-cane; and probably owes its fertility to a fine rapid stream of water, which, descending from the mountains, runs through. it into the sea. It was the second stream we bad seen on the island.

Having quenched our thirst, we passed over it by stepping on some large stones, and directed our way to the house of the head man, where we put up for the night. He was absent in the mountains, with most of his people, and Makoa could procure us no provisions. We, however, succeeded in purchasing a fowl and some potatoes, and made a comfortable supper. While our boys were preparing it, Mr. Thurston preached to a considerable number of people, who had collected outside of the house. We were afterwards joined in evening worship by the family, who at night furnished us with a comfortable and clean mat for our bed, an accommodation we did not always enjoy.

Early on the 9th the house was crowded with natives, and a little before sun-rise morning worship was performed as usual.

Some of the natives observed, in conversation, "We shall never obtain the things of which you have told us, for we are a wicked and unbelieving people. "

Before we left the place, the people offered for sale some curious deep oval baskets, with covers, made of the fibrous roots of ie. We purchased two, intending to preserve them as specimens of native ingenuity.

Leaving the village of Keaau, we resumed our journey, and after walking between two and three hours, stopped in the midst of a thicket to rest, and prepare some breakfast.

The natives produced fire by rubbing two dry sticks, of the hibiscus tiliaceus, together; and having suspended over it a small iron pot, in gipsy style, upon three sticks, soon prepared our food. At half -past ten we resumed our walk, and passing about two miles through a wood of pretty large timber, came to the open country in the vicinity of Waiakea. At one p. m. we reached the house of the chief, where we were welcomed by our companions, and Maaro, the chief, who, though very ill, was glad to see us

As our party was now all together, and intended to spend several days in his district, we applied to him for lodgings, and he directed one of his men to conduct us to a comfortable house by the sea-side, where he said we could be accommodated so long as we should find it necessary or agreeable to stay. We removed into it, and employed the afternoon in narrating the incidents of our respective journeys, and preparing for the coming Sabbath. [Ellis 1963:217-226]

TESTIMONY BEFORE THE COMMISSION TO QUIET LAND TITLES

Article IV of the Board of Commissioners to Quiet Land Titles was passed in December 1845 and began the legal process of private land ownership. The Māhele (1848-1850) established a board of five commissioners to oversee land claims and to issue patents and leases for valid claims. Many scholars believe that Kauikeaouli (Kamehameha III) established laws intended to protect Hawaiian sovereignty and crown lands from foreigners who had already begun claiming ownership of land they were granted permission to use for homes and business interests (Daws 1968:111; Kame'eleihiwa 1992: 169-70, 176; Kelly 1983: 45; Kuykendall 1938(1): 145 footnote 47, 152, 165-6, 170). Among other things, the foreigners were demanding private ownership of land to secure their island investments, particularly agricultural and ranching ventures (Kuykendall 1938(1): 138, 145, 178, 184, 202, 206, 271; Kame'eleihiwa 1992: 178).

As legal statutes defining the Māhele continued to be enacted from 1845 to 1850, the lands of the kingdom of Hawai'i were divided among the king (crown lands), the *ali'i* and *konohiki*, and the government. Once lands were thus divided and private ownership was instituted, the *maka`āinana* (commoners), if they had been made aware of the procedures, were able to claim the plots on which they had been cultivating and living as stipulated in the *Kuleana* Act (1850). These claims, however, could not include any previously cultivated or presently fallow land, '*okipu'u* (forest clearing created to allow sunlight to reach the forest floor), stream fisheries, or many other resources traditionally necessary for survival (Kame'eleihiwa 1992:295; Kelly 1983:45-76; Kirch and Sahlins 1992 vol.1:3, 135-137, and vol. 2:2).

The right of claimants to land was based on the written testimony of at least two witnesses who could corroborate the claimant's long-standing occupation and use of the lot(s) in question. The claimant was then awarded a patent for the property, subsequently called Land Commission Awards (LCAs) (Chinen 1961:16).

The *ahupua'a* of Kapoho was awarded to Charles Kanaina as part of Land Commission award (LCA) 8559-B. Charles Kanaina was the father of William Charles Lunalilo (King Kamehameha III), a grandnephew of King Kamehameha I. There were no Land Commission awards made in KapohoAhupua'a.

CHANGING RESIDENTIAL AND LAND-USE PATTERNS (1845-1865)

Between 1845 and 1900, traditional land-use and residential patterns changed drastically. In particular, the regular use of Hilo Bay by foreign vessels, including whaling merchant and inter-island vessel, the growth of tourism, the establishment of missions in the Hilo area, the legalization of private land ownership, the introduction of cattle ranching, the introduction of sugar cane cultivation, and the construction of Government Roads and railroad lines all brought about changes in settlement patterns and long-established land-use patterns (Kelly *et al*. 1981:111-112). Much of the change in residential location and the growth of towns in Puna District were driven by the availability of arable land suited to commercial crops and the location of newly constructed roads.

The traditional travel route through Puna was along the coast (see Figure 12). The trip was made along a foot trail that led through the coastal and near coastal villages. That trail extended from the modern day Liliʻuokalani Gardens area to Kīlauea. The trail is often called the old Puna Trail and/or Puna Road, the Puna Trail (*Ala Hele* Puna) and/or the Old Government Road. Lass (1997) also refers to the entire route from Hilo to Kaʻū as the Puna-Kaʻū trail.

Whatever name the trail/cart road alignment is called by, it likely incorporated segments of the traditional Hawaiian trail system often referred to as the *ala loa* or *ala hele* (Hudson 1932:247, Kuykendall 1966:23-25, Lass 1997:15, and Maly 1999:5). Lass suggests the full length of the Puna Trail, or Old Government Road, might have been constructed or improved just before 1840 (Lass 1997:15). The trail was called the Old Government Road, or *Ala Nui Aupuni* (Maly 1999:5). The alignment was first mapped by the Wilkes Expedition of 1804-41.

A general description of the area of the Old Government Road and the newer upper road from Hilo through Keaʻau to Pahoa was recorded in 1889 by the Surveyor General of the Hawaiian Government Survey. The description affords a glimpse into inland and coastal settlement patterns and land-use.

> The first settlement met with after leaving Hilo by the sea coast road, is at Keaau, a distant 10 miles where there are less than a dozen inhabitants; the next is at Makuu, distant 14 miles where there are a few more, after which there is occasionally a stray hut or two, until Halepuaa and Koae are

> reached, 21 miles from Hilo, at which place there is quite a village; thence to Kaimu there are only a few scattered settlements here and there. A good many of those living along the lower road have their cultivating patches in the interior, along or within easy accessibility to the new road (Alexander 1891, cited in Maly 1999:107).

The 1889 description contrasts with Ellis' in which he described numerous villages just sixty-six years earlier. The 1889 description suggests depopulation along the majority of the Puna near-coastal area. In both descriptions, the people in this area appear to have lived somewhat inland, between the coast and the inland gardens. In 1889 people were cultivating small patches of *kalo*, ‘*awa*, and coffee as well as other food items in the inland gardens. The patches were placed in pockets of soil in holes amidst the lava flows. Additionally, sweet potatoes were grown on rock mounds. By 1889, it appears that very few people lived along the Old Government Road (Maly 1999:6). The Surveyor General stated,

> The old sea coast road cannot be kept in repair with the means now at its disposal and its condition each year is becoming more unsafe and ruinous, there is but little travel over it; it has been shown that there is little land capable of cultivation or development either side of it and whatever travel there is now over it would soon be entirely diverted to the upper road (Alexander 1891, cited in Maly 1999:107).

The new road being constructed in 1891 from Hilo through Kea‘au to Pahoa was designed to allow access to the more arable inland areas. People who traditionally had lived along the Puna coast were moving toward Hilo and into the more fertile upland areas of Puna in order to find paid work and to produce cash crops for local markets and for export. In particular, people began to work in the inland areas to grow sugarcane.

The same was true of the trail from Hilo, through Kea‘au, and on to Kīlauea Crater (Volcano Road). An improved Volcano Road was built from Hilo to Kīlauea between 1889 and 1893 partly to accommodate tourism, but also to increase access to forest products and agricultural land. Numerous small field parcels belonging to the ‘Ōla‘a Sugar Company and the ‘Ōla‘a Coffee Company were located along this route. The improved Volcano Road is Route 11, though it has been straightened and improved several times since its initial construction.

The modern history of land-use in Kapoho Ahupuaʻa is tied to the development of commercial agriculture and the construction of transportation routes. The potential to use Kapoho's rich arable land for commercial prospects was recognized in the late 1800s and early 1900s when it was purchased for commercial sugarcane and coffee growing, as well as for cattle pasture. In 1881, large tracts of land in north and south Puna were purchased at auction by Samuel Damon, William H. Shipman, and E. Elderts from trustees of the deceased William C. Lunalilo Estate. Shipman bought out the two partners within three years of purchasing the land.

William H. Shipman operated a cattle ranch in Kapoho Ahupuaʻa and was the owner of the Waiākea Stock Ranch. Shipman was also co-owner of the Shipman Meat Market, later the Hilo Meat Company. He also established the ʻŌlaʻa Sugar Company in Puna District in 1899 and leased large portions of his land in Puna to the newly formed company.

SUGARCANE, RAILROADS AND COMMERCE

The ʻŌlaʻa Sugar Company, established in 1899, became the largest sugarcane plantation and milling operation in Puna District. By the 1950s the ʻŌlaʻa Sugar Company was in debt and sugar production and sales were stagnant. The company stockholders changed the company name to the Puna Sugar Company, Ltd. and sold off land to invest in new equipment and upgrade their facilities. By 1966, the company was debt free and making a good profit. American Factors (AMFAC) bought out the minority shareholders in 1969 and Puna Sugar Company became a subsidiary of AMFAC.

AMFAC expanded sugarcane processing in the 1970s through new extraction facilities upgrades at the mill in Keaʻau (ʻŌlaʻa Mill) and by building a 15KW bagasse and trash burning power plant next to the mill. Hilo Electric Light Company (HECO) agreed to purchase 12.5KW of power for their customers.

Puna Sugar Company, like many other sugar companies, struggled in the late 1970s and early 1980s due to changes in the sugar market that made sugar production less profitable. By the start of 1982, AMFAC had decided to close Puna Sugar Company. The work of selling off assets and preparing severance packages took three full years. The sugar mill was sold to Fiji Sugar Corporation in 1988 and the power plant operation taken over HECO.

The Hilo Railroad Company

One of the largest concerns for early sugar plantations was the task of hauling processed raw sugar and molasses from the mill to the coast at Waiākea (Reed's Landing and Reed's Bay area), and later to the Hilo Railroad terminal next to the Wailoa River, and finally to Hilo Port (Kūhiō Bay), for shipment (Kelly et al. 1981: 93, 110, 144). In 1879 and 1880, Waiākea Plantation laid the first two miles of track in Hilo (*ibid*. 93). Ten years later, eight miles of Hilo Railroad Company track were constructed from Waiākea to the ʻŌlaʻa Sugar Company Mill. The rail line was constructed under an 1899 charter held by Dillingham and was completed in 1900 with assistance from the ʻŌlaʻa Sugar Company Mill (*ibid*. 110, 119, 142, 143, 297-307). Railroad track was next laid from the ʻŌlaʻa Sugar Company Mill to Kapoho (Figure 13) and Pāhoa (completed 1902) to service sugar plantations and the Pāhoa Lumber Mill established in 1909 (*ibid*. 114, 146-149, 162).

The Hilo Railroad Company also transported passengers, both locals and tourists. The company built a spur line up to Glenwood to carry tourists heading up to see the volcano, as well as to service the small farmers that lived in the ʻŌlaʻa Lots subdivision. The company issued an increasingly number of bonds over the years to fund their construction (Kelly et al. 1981: 163). By fiscal year 1914-1915 the company was obligated to pay $269,700.00 annual interest on bonds (*ibid*. 165). As the company was failing to meet its annual bond interest obligations, in 1915, the bondholders forced the foreclosure of the company (*ibid*. 165).

The Hilo Railroad Company holdings were reconsolidated into the Hawaiʻi Consolidated Railway, Ltd in 1916. The new board of directors consisted of prominent sugar plantation owners (Kelly et al. 1981: 165). Additional rail lines were constructed past Kapoho to ʻOpihikao. The railroad was just south of the current project area (Figure 14). The 1924 USGS Kalapana Quadrangle map shows sugarcane railroad spur extending just south of Puʻu Honuaʻula (Figure 15). Hawaiʻi Consolidated Railway continued to operate for thirty years, despite the increasing use of automobiles, and a small number of droughts, blights and tsunamis (*ibid*. 166-175). The 1946 tsunami that damaged Hilo Town, also destroyed much of the railroad infrastructure in coastal Hilo, so much so that, despite record earnings, the company decided to liquidated its assets rather than pay the cost to repair (*ibid*. 175). The railroad tracks and ties were removed sometime after 1946.

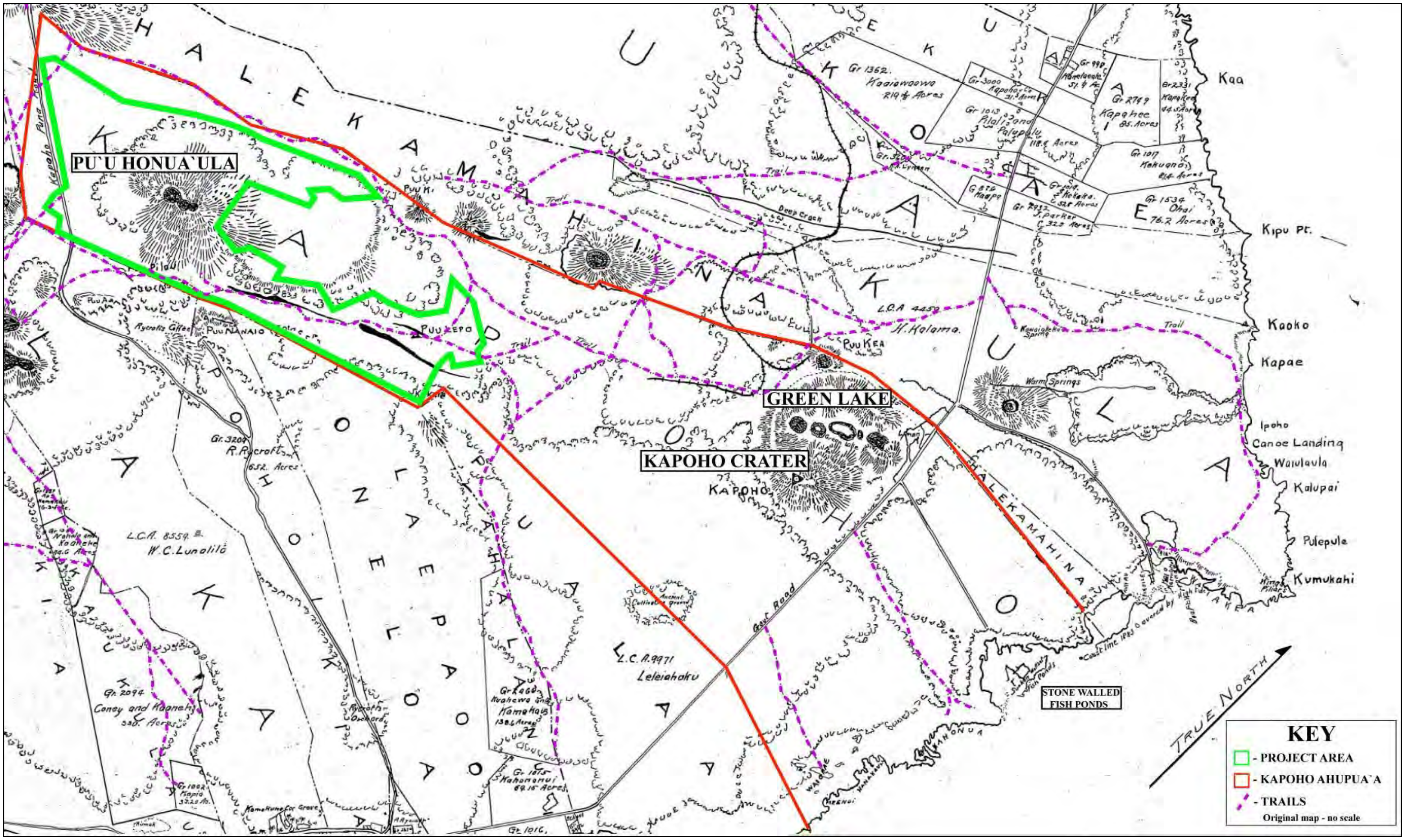

Figure 13: Portion of Puna District Map Showing Railroad Tracks and Trails in Kapoho Ahupuaʻa (Baldwin 1902).

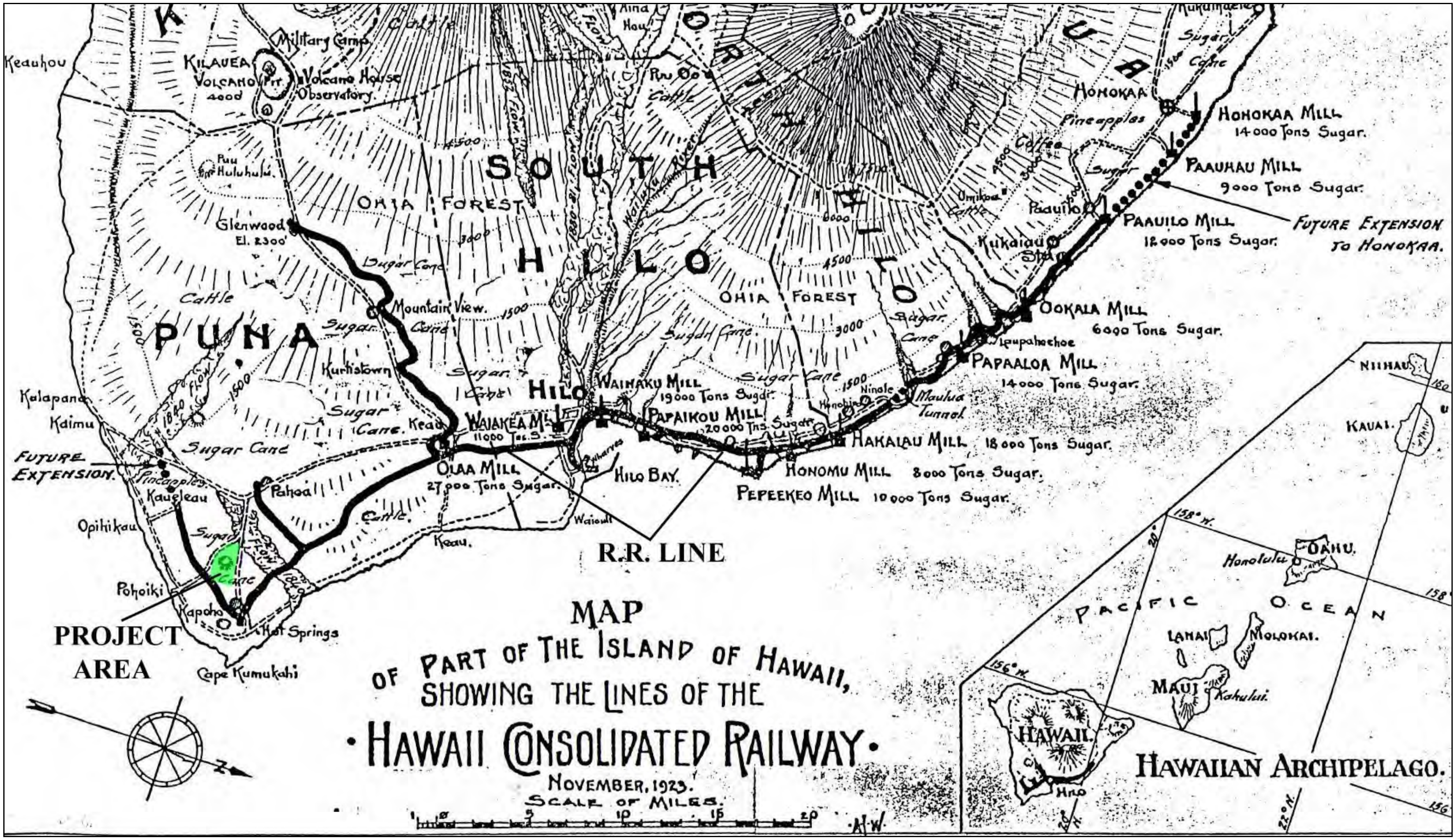

Figure 14: Map Showing Locations of Hawaiian Consolidated Railway Main Railroad Lines in Bold Black Line and Project Area Shaded Green (H.C.R. Annual Report November 1923; adapted from Kelly et al. 1983: 164).

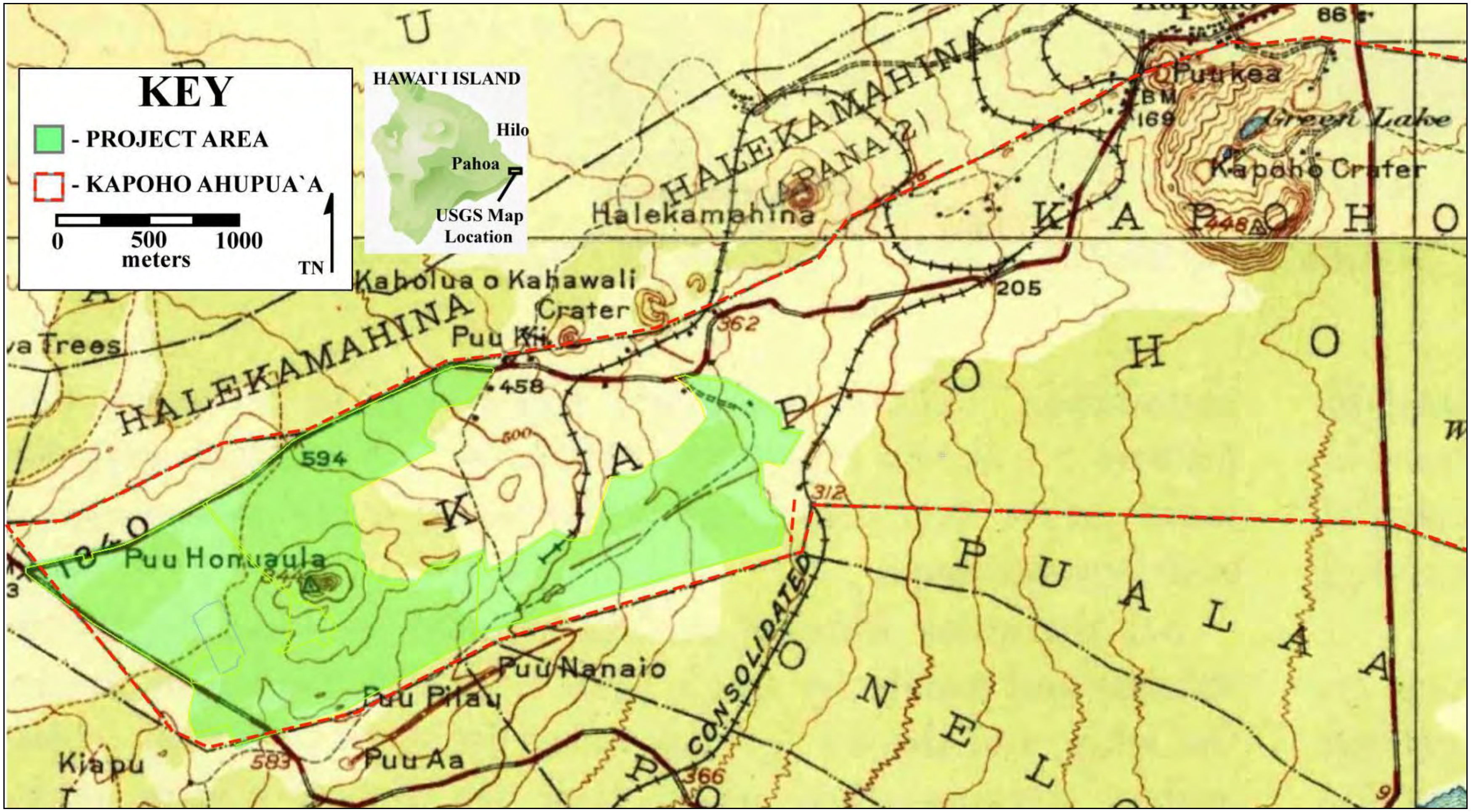

Figure 15: 15-Minute Series USGS 1924 Topographic Map Showing Location of Project Area and Railroad Tracks (ESRI, 2013. Sources: USGS. Kalapana Quadrangle).

MODERN LAND USE

During the modern era, lands surrounding the project were used primarily for private residences and small privately owned farms.

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

There are very few previous archaeological studies within Kapoho Ahupuaʻa. Thrum (1908) published a list and descriptions of *heiau* identified in Puna (Table 1 and Figure 16). Many of the *heiau* were abandoned and in disrepair at the time they were recorded. There were no *heiau* identified in Kapoho Ahupuaʻa.

Table 1: Heiau Recorded by Thrum (1908) in Puna District.

DISTRICT OF PUNA.

Names.	Location and Remarks.
Wahaula	Pulama.—The first constructed temple of Paao, built, according to tradition, in the 11th century; rebuilt by Imaikalani, and later by Kalaniopuu who dedicated it to Kukailimoku. A walled structure of luakini class, 132x72 ft. in size; stands practically N. E. and S. W.; its walls still 8 to 10 ft. high. The last of the temples to give up its heathen worship upon the overthrow of idolatry in 1819. It is still one of the best conditioned heiaus in all the islands. See "Tales from the Temples" and plan.
Makaiwa	Pulama.—A small heiau, paved, of ipu olono class; its walls now fallen.
Waiaka	Kahaualea.—A small heiau 85 ft. long by 44 ft. wide on its upper end and 36 ft. on the lower end; near the cave of Luamakini, whose makai entrance is said to be in the adjacent pond of Waikupanaha. Class uncertain.
Makaoiki	Kahaualea.—A medium sized heiau now all destroyed; its stones taken for graves, of which a number adjoins its site on the east side.
Punaluu	Near spring of same name, in Kahaualea. A medium sized heiau 119x37 ft. with walls 3 to 5 ft. thick, of heavy lava slabs. Its south end wall is 17 ft. thick, standing 3 ft. above main floor, well leveled off with shore pebbles. Badly shattered by earthquake. Parts of walls yet standing are 4 to 8 ft. high, according to slope of the land.

Niukukahi.............Kalapana.—One of the noted Puna heiaus, of which Kapihe was priest and Kuahailo its deity. Of pookanaka class. It is in a thick grove of coconut, breadfruit and other trees; its foundations and parts of walls still to be seen though in a jungle of undergrowth; said to be 150 ft. square.

Napalua................Near Waiokolea, Kalapana, a walled heiau about 80x100 ft. in size, said to have been under Kapihe's jurisdiction. Its walls were thrown down by the earthquake of 1868.

Kikoa.................. Kalapana, a small sized heiau of which little could be ascertained.

Kumakaula............Kaimu, a medium sized heiau of unknown class, a part of which only now remains. It was an ancient temple of the "truncated pyramidal" type, but destroyed in the fifties by one Kahuluhulu and his father, for their house site. In early years the tide came up to its base, and at its front was the noted place for akule. It is now one-eighth mile from the sea, the main road running by it, though this coast line for quite a distance subsided in 1868.

Mahinaakaka........... Keahialaka, near Pohoiki, a platform heiau 41x75 ft. built up six ft. high on sea side of the road, standing practically east and west. Its north wall shows double construction for about half its height nearly the whole length, and the eastern end rounded out some ten or more feet, not quite the height of the main structure, but whether a feature for its ceremonies, or a protection from the sea, could not be determined. Its walls and floor in a much disturbed condition.

Oolo.................. Pohoiki, said to have been an important heiau; now entirely destroyed.

Kalepa.................Or Kalelepa, near Kamaili, a heiau of the time of Keawemauhili, dedicated to Ku and Lono: of large size. Noted by Ellis as the probable Puna heiau where Cook's bones were deposited and worshipped. Almost wholly dedestroyed; its stones taken for roads.

Kue....................At Kehena. Nothing left to mark its site.

Aliipalala...............Kamaili, a small heiau of ipu olono class said to have had connection with Wahaula (listed below.) Entirely destroyed.

Wahaula.............. Kamaili. A reported verv large heiau of ancient time; nothing now remains but a portion of its smooth pebbled floor. The Kamaili people claim that part of the well known heiau

	of same name, at Pulama, was built with stones from this temple, hence its name Wahaula.
Pulena................	Keekee. No particulars gathered; now in ruins in a tangle of bushes.
Kukii..................	On hill of same name, at Kapoho, 67x120 ft., built by Umi of lava blocks, or slabs, well fitted. Now in ruins; portions of walls only remaining. Some of its stones were brought down by Kalakaua, in 1879, which went into the foundation walls of the palace.
Oalalauo...............	Kilauea-iki: on summit of precipice; temple of Pele, Kamakaakeakua its priest. In ruins in 1825.

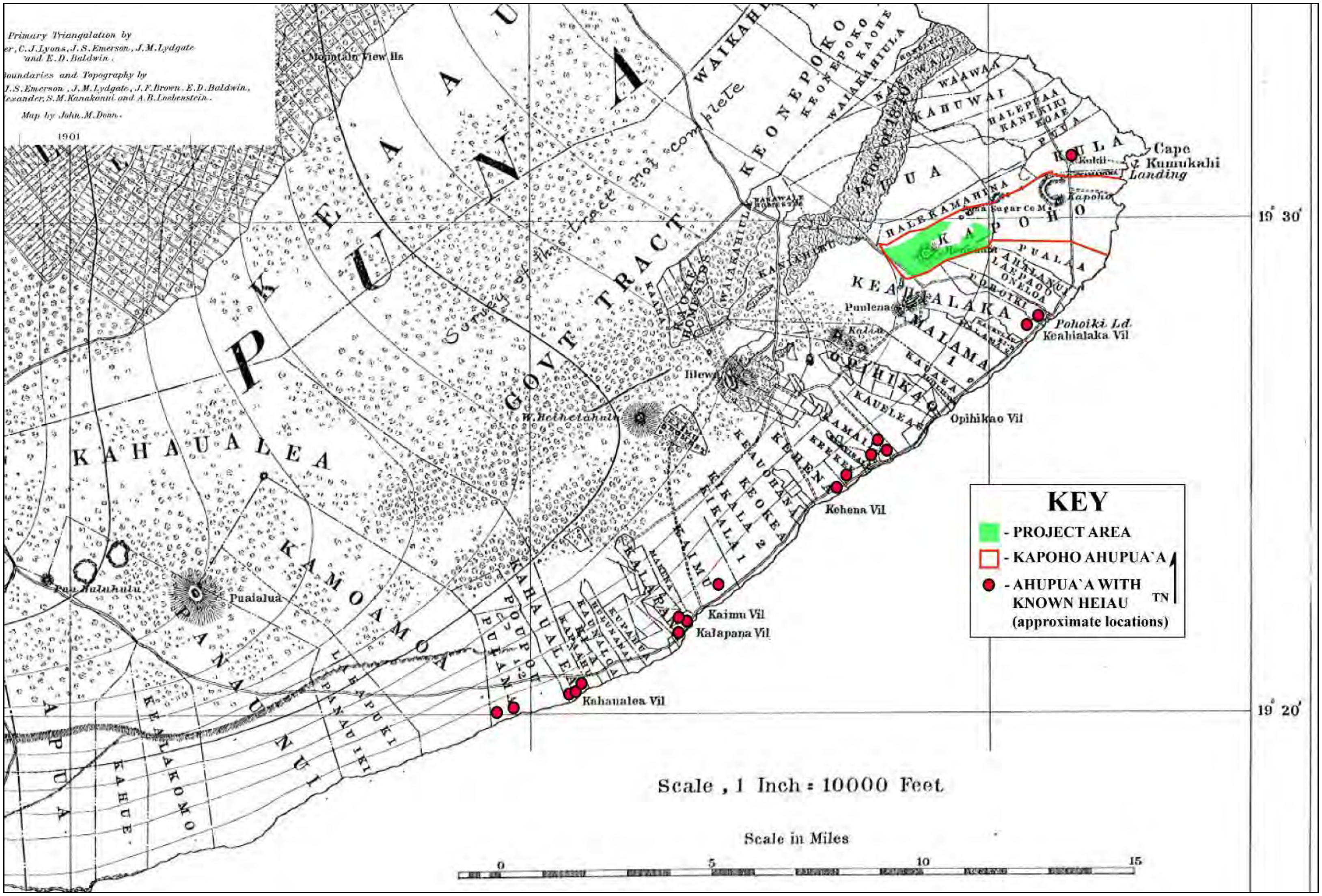

Figure 16: Portion of Hawai'i Island Map Showing *Heiau* Identified by Thrum (1908) in Puna District (Donn 1901).

Five archaeological studies were conducted within the current PGV property (Escott 2023; Kennedy 1990; Rechtman 2000; Rogers-Jourdane 1984; Rosendahl 1981). Paul H. Rosendahl, PhD, Inc. (PHRI) conducted an archaeological reconnaissance survey of Kapoho Well Site 1 and Kapoho Well Site 2 within the currently existing PGV facility (Rosendahl 1981). There were no archaeological remains identified within the project area.

Bishop Museum archaeologists conducted an archaeological reconnaissance survey of approximately 12.0 acres within the currently existing PGV facility (Rogers-Jourdane 1984). The survey included an intensive pedestrian survey of Area A, Area B and an Expansion Area and a less intensive pedestrian survey of the area within a one mile radius of the three intensively surveyed areas (Figure 17). Kapoho Well Site 1 in the Rosendahl (1981) study was the same as Area A in the Rogers-Jourdane (1984) study and Kapoho Well Site 2 was the same as Area B. There were no archaeological remains identified within the project area.

Archaeological Consultants of the Pacific conducted an archaeological reconnaissance survey of approximately 12.0 acres within the currently existing PGV facility (Kennedy 1990). The project area was similar to the Bishop Museum project area, though perhaps slightly larger (Figure 18). There were no archaeological remains identified within the project area.

Rechtman Consulting, LLC conducted an archaeological survey (Rechtman 2000) of a proposed cellular tower site 450 meters east of Puʻu Honuaʻula. The survey area is not within the current PGV project area. The survey report does state the size of the project area, though it appears to be less than half an acre. There were no archaeological remains identified within the project area.

Scientific Consultant Services, Inc. (SCS) conducted an archaeological field inspection (AFI) of approximately 9.0 acres of the TMK: (3) 1-4-001:002 within the PGV property (Figure 20). The project area is dominated by two 1955 spatter cones and is surrounded to the north, south, and west by the 2018 lava flow. The east side of the project area is bounded by an existing dirt road. There were no archaeological remains identified within the project area.

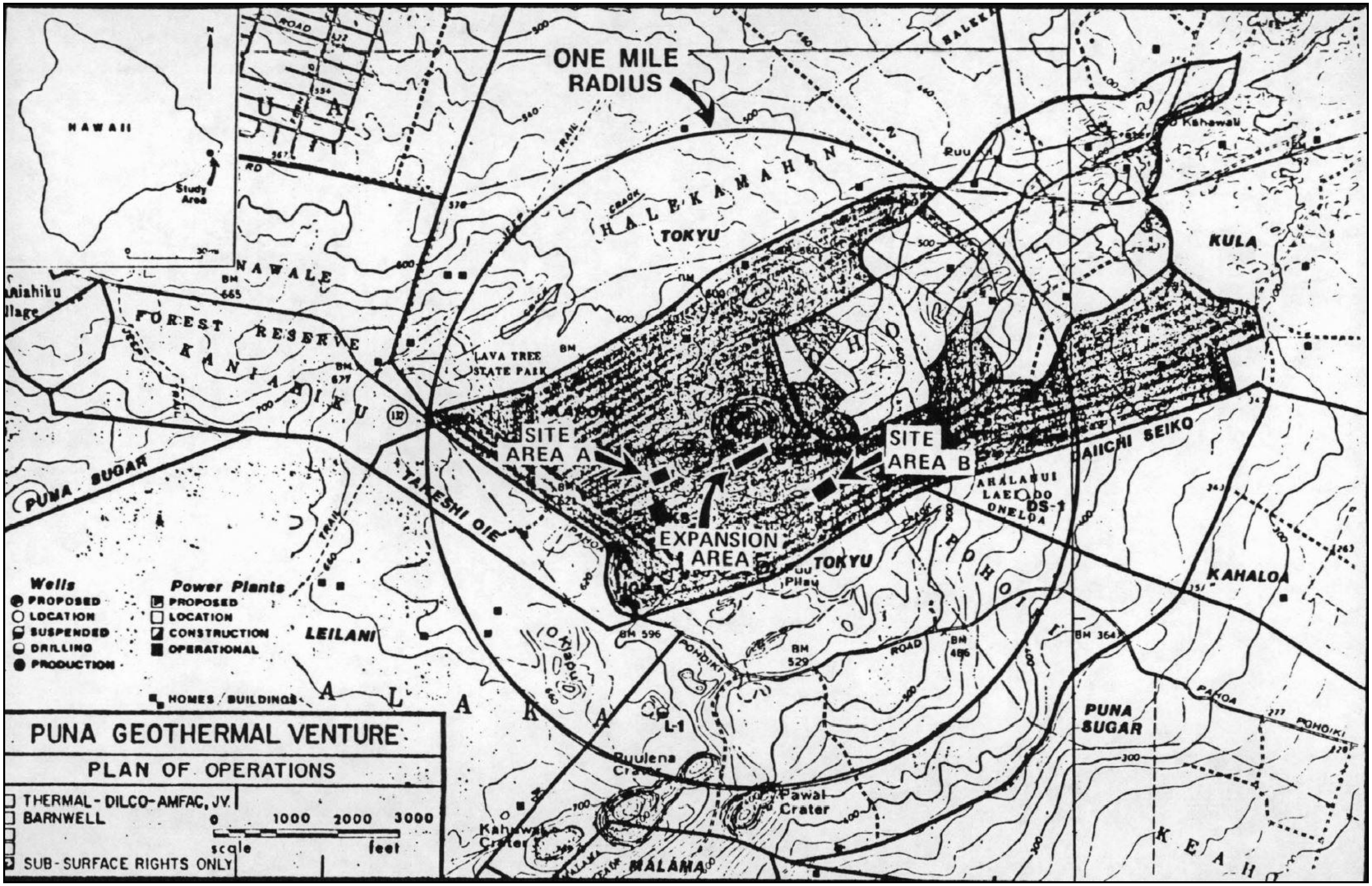

Figure 17: Bishop Museum Archaeological Reconnaissance Survey Project Area Map (Rogers-Jourdane 1984, Figure 1).

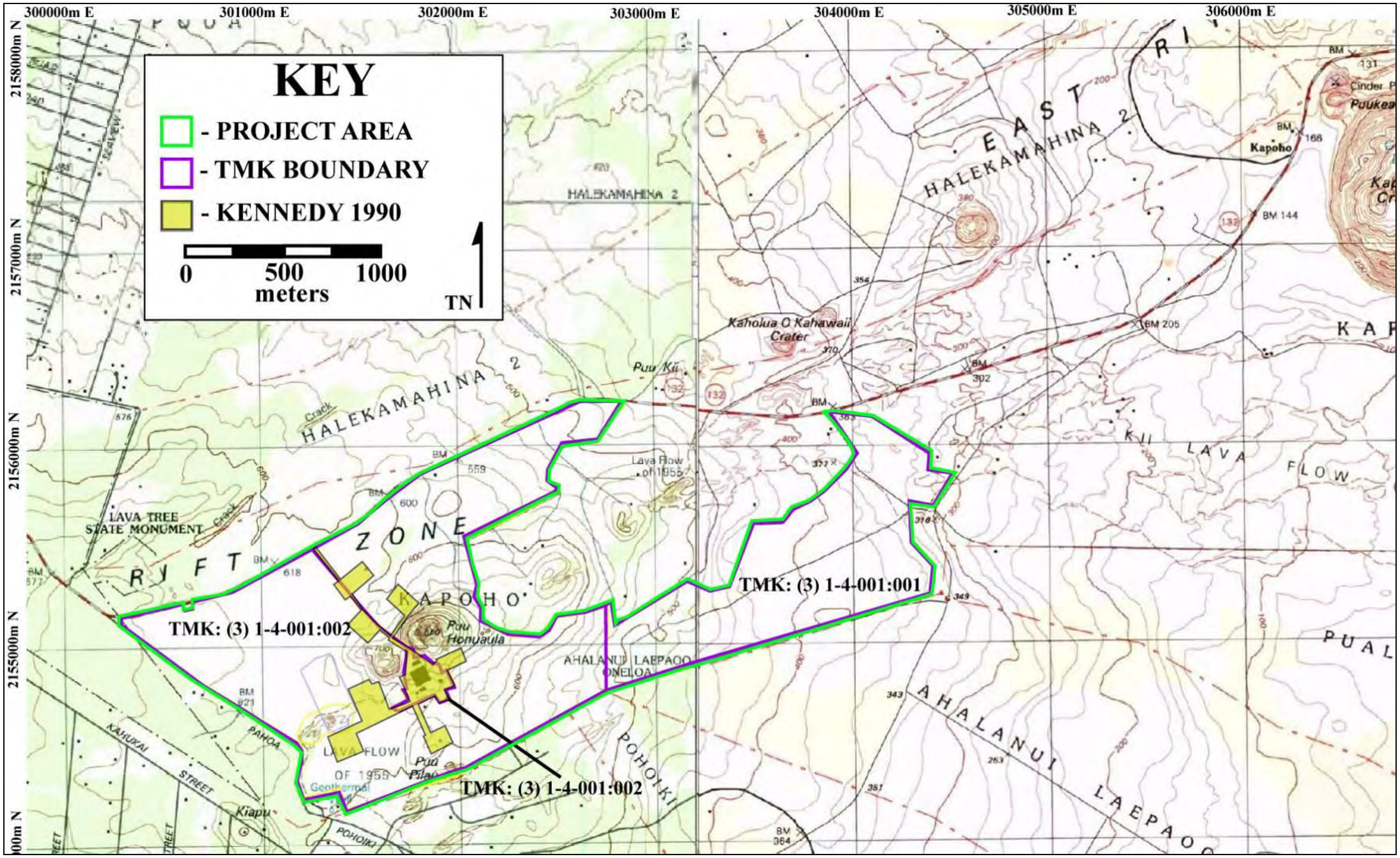

Figure 18: 7.5-Minute Series USGS Topographic Map Showing the Location of Kennedy (1990) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai'i Planning Department, 2022).

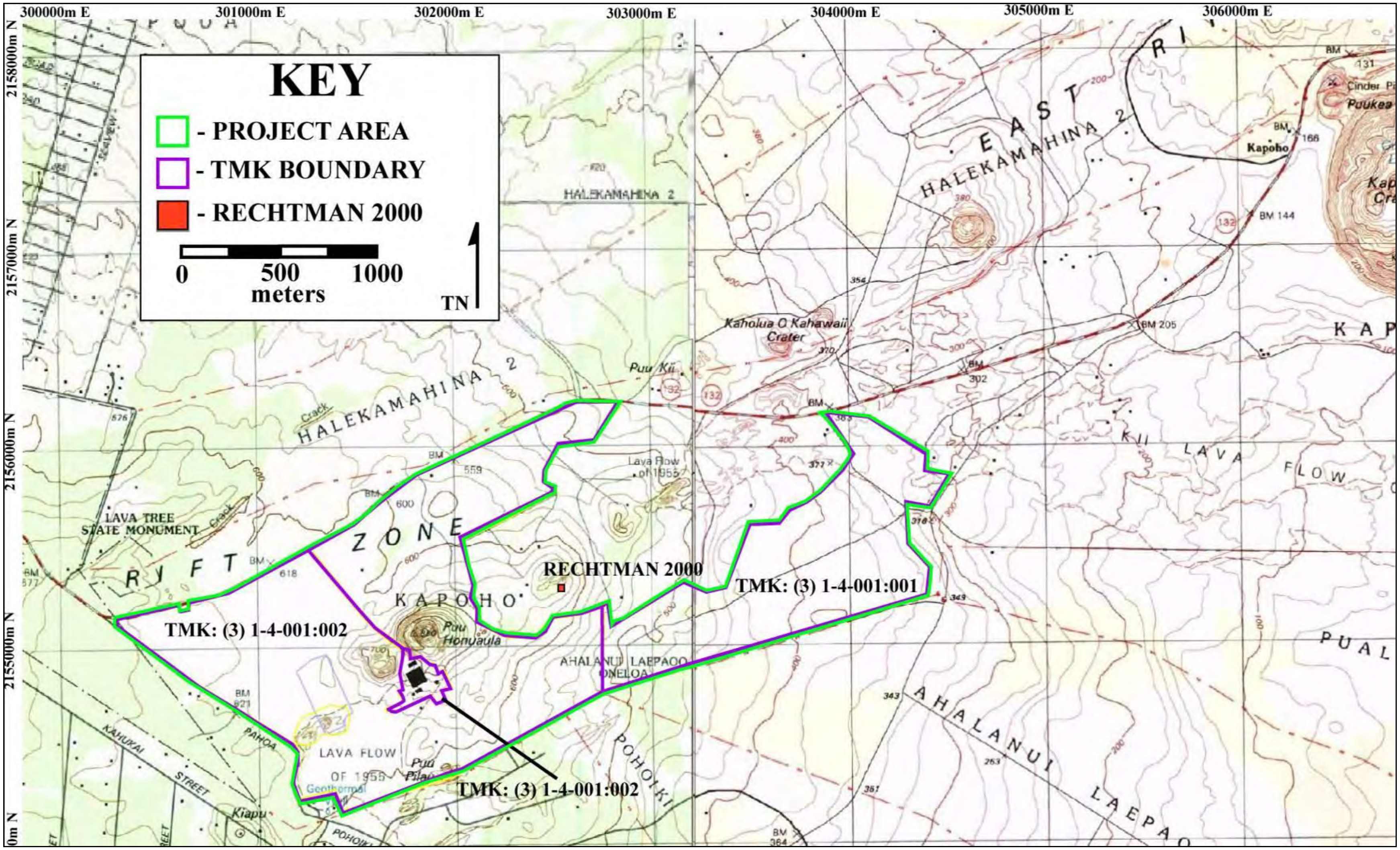

Figure 19: 7.5-Minute Series USGS Topographic Map Showing the Location of Rechtman (2000) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai‘i Planning Department, 2022).

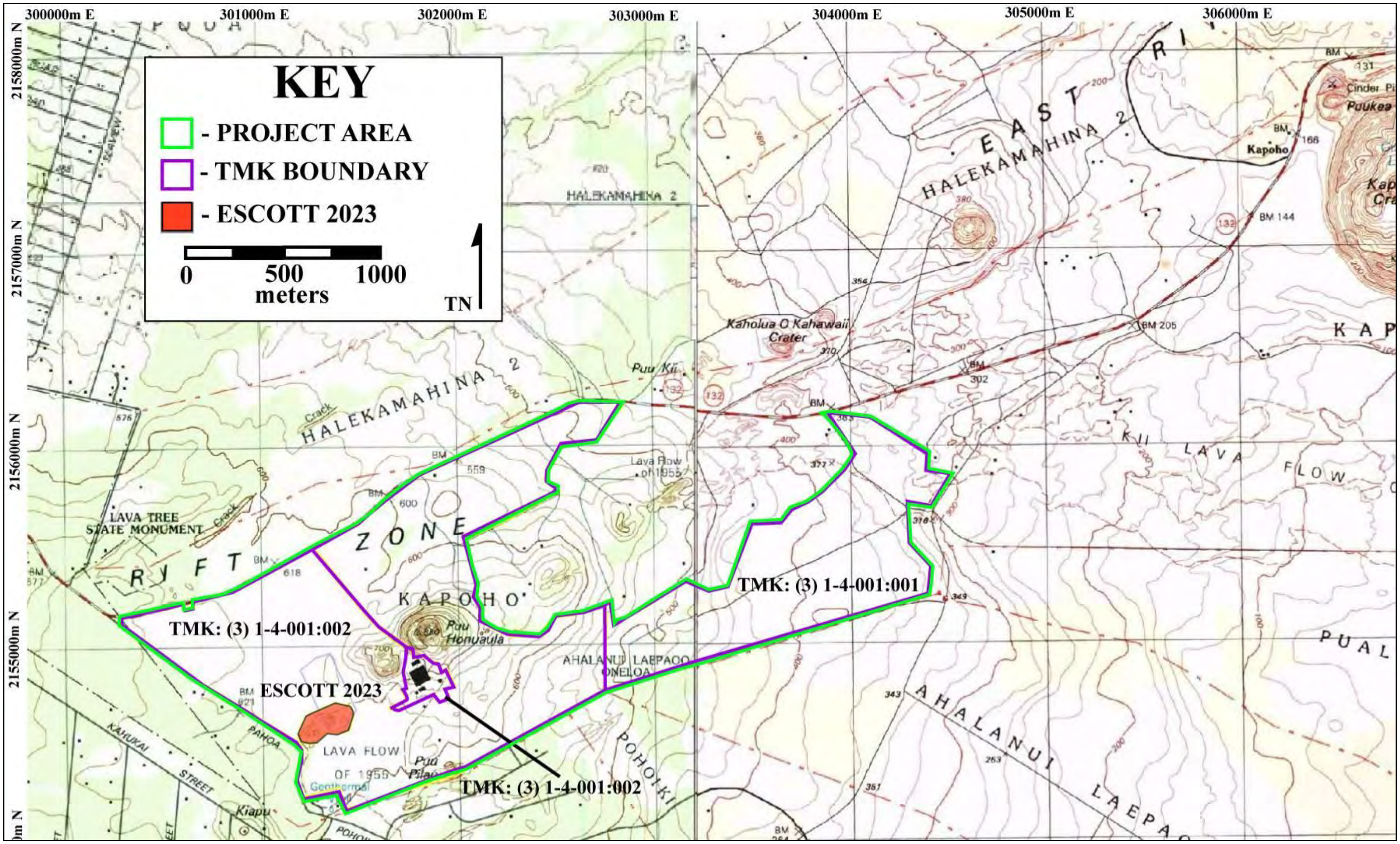

Figure 20: 7.5-Minute Series USGS Topographic Map Showing the Location of Escott (2023) Project Area (Pahoa South 1994 and Kapoho 1995 Quadrangles. ESRI, 2013. Data Sources: National Geographic and County of Hawai'i Planning Department, 2022).

CULTURAL INFORMANT INTERVIEWS

In this case, invitations to consult were sent to individuals and organizations whose jurisdiction includes knowledge of the area with an invitation for consultation. Consultation was sought from Shane Palacat-Nelsen, Office of Hawaiian Affairs (OHA); Jordan Kea Calpito, SHPD Burial Sites Specialist; and Desmond Haumea, Hawaiʻi Island Burial Council (HIBC) Puna Representative (Table 2). Consultation was also conducted as a result of public notices. Public notices (Appendix A) were published in the Honolulu Star-Advertiser, the Hawaiʻi Tribune Herald, and the Office of Hawaiian Affairs (OHA) Ka Wai Ola. Hawaiian traditional cultural practitioner Palikapu Dedman spoke at the public meeting held to discuss the new Environmental Impact Statement (EIS). A copy of the draft CIA will be sent to the OHA compliance team for review and comment.

Table 2: Individuals Responses to CIA Consultation Request.

Name	Affiliation	Responded	Has Knowledge	Cultural Practices
Desmond Haumea	HIBC Puna Representative	Yes	Yes	No
Shane Palacat-Nelsen	OHA East Hawaiʻi	No	-	-
Jordan Kea Calpito	SHPD Burial Sites Specialist	Yes	No	-
Luana Jones	Hawaiian, Area Resident	Yes	Yes	General
Luella Nohea Crutcher	Hawaiian, Area Resident	Yes	Yes	General
Palikapu Dedman	Traditional Hawaiian Culture Practitioner	Yes	Yes	General

CONSULTATION RESPONSES

HIBC Puna Representative Desmond Haumea responded by phone call that he was familiar with the project area lands and PGV. Mr. Haumea is a long-time traditional Hawaiian cultural practitioner. He noted that there are many Hawaiians that both oppose and support the production of electricity by PGV. Those that oppose it do so because of the traditional Hawaiian beliefs and practices surrounding Pele and the natural environment in general. Those that support it feel that geothermal electricity generation is a more environmentally friendly and sustainable means of producing electricity compared to generating electricity by burning fossil fuels. While Mr. Desmond is familiar with cultural beliefs and practices surrounding Pele, he is not aware of any cultural practices associated with the project area lands.

Area resident and Hawaiian Luana Jones responded to the public notice by letter dated August 31, 2022 (Appendix B). Ms. Jones' letter states her opposition to the PGV project as it goes against the traditional Hawaiian cultural belief of the interdependence of all living things and the natural environment, and the practice of responsibly nurturing the land. Her main concern is that the ground temperatures are too hot and will cause blow outs, and release of toxic fluids and gases, thereby poisoning the surrounding environment and communities.

Area resident and Hawaiian Luella Nohea Crutcher responded to the public notice by letter dated September 2, 2022 (see Appendix B). Ms. Crutcher's letter states her opposition to the PGV project as it goes against the traditional Hawaiian belief of respecting the elements of the natural environment and the traditional Hawaiian practices of preserving, protecting, and being one with the elements of the natural environment. Hawaiians show respect and give thanks for all that nature gifts through their traditional practices. Ms. Crutcher states that it is disrespectful, and a desecration, to take from Pele by drilling into the earth. In addition, the drilling causes pollution to the air, land and ocean. The taking of heat from Pele and polluting the environment are not supported by and do not respect traditional Hawaiian cultural beliefs and practices.

Hawaiian traditional cultural practitioner Palikapu Dedman testified at the public community meeting held at the Pāhoa Neighborhood Facility in Pāhoa on August 17, 2022. Mr. Dedman began by asking what happens to Hawaiians when foreigners impose their beliefs on Hawaiians and alter the traditional beliefs of Hawaiians. He continued by stating traditional Hawaiian beliefs are in danger and there should be more respect for Hawaiians, including traditional beliefs about Pele. Hawaiians hold these traditional beliefs and there are federal laws and the state constitution that protect their rights to traditional beliefs and practices. Mr. Dedman stated that everybody should respect Hawaiian traditional beliefs.

SUMMARY

The "level of effort undertaken" undertaken in connection with a CIA to identify potential effect by a project to cultural resources, places or beliefs (OEQC 1997) has not been officially defined and is left up to the investigator. A good faith effort can mean contacting agencies by letter, interviewing people who may be affected by the project or who know its history, research identifying sensitive areas and previous land use, holding meetings in which the public is invited to testify, notifying the community through the media, and other appropriate strategies based on the type of project being proposed and its impact potential.

As suggested in the "Guidelines for Accessing Cultural Impacts" (OEQC 1997), CIAs incorporating personal interviews should include ethnographic and oral history interview procedures, circumstances attending the interviews, as well as the results of this consultation. It is also permissible to include organizations with individuals familiar with cultural practices and features associated with the project area.

The *Ka Pa'akai O Ka 'Aina* Analysis framework included determining: (1) the identity and scope of "valued cultural, historical, or natural resources" in the petition area, including the extent to which traditional and customary native Hawaiian rights are exercised in the petition area; (2) the extent to which those resources-including traditional and customary native Hawaiian rights-will be affected or impaired by the proposed action; and (3) the feasible action, if any, to be taken by the LUC [State agency] to reasonably protect native Hawaiian rights if they are found to exist. [*Ka Pa'akai O Ka 'Aina* v Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 (2000:10)].

In the case of the PGV project, consultation was sought from Shane Palacat-Nelsen, Office of Hawaiian Affairs (OHA); Jordan Kea Calpito, SHPD Burial Sites Specialist; and Desmond Haumea, Hawai'i Island Burial Council (HIBC) Puna Representative. Consultation was also conducted as a result of public notices and through a public community meeting. Public notices (see Appendix A) were published in the Honolulu Star-Advertiser, the Hawai'i Tribune Herald, and the Office of Hawaiian Affairs (OHA) Ka Wai Ola. Area residents and Hawaiians Ms. Luana Jones and Ms. Luella Nohea Crutcher responded to the public notices. Hawaiian traditional cultural practitioner Mr. Palikapu Dedman spoke at the public meeting held to discuss the new Environmental Impact Statement (EIS).

For both studies, Historical and cultural source materials were extensively used and can be found listed in the References Cited portion of the report. Scholars such as I‘i, Kamakau, Chinen, Kame‘eleihiwa, Fornander, Kuykendall, Kelly, Handy and Handy, Puku‘i and Elbert, Thrum, Westervelt, and Cordy have contributed, and continue to contribute to our knowledge and understanding of Hawai‘i, past and present. The Native Hawaiian Ethnographic Study for the Hawai‘i Geothermal Project (Matsuoka et al. 1996) was also researched to determine the cultural sensitivity and traditional Hawaiian cultural beliefs and practices of the PGV project area and surrounding lands of Kapoho Ahupua‘a. The works of these and other authors were consulted and incorporated in the report where appropriate. Land use document research was supplied by the Waihona ‘Aina 2007 Data Base.

All of the research suggests that, in general, there are traditional Hawaiian beliefs recognizing the interdependence of people and the natural environment, and there are important traditional values to protect and nurture the natural environment. There are traditional practices that protect and increase the environment's health and bounty. These beliefs and practices would include not increasing pollution. In addition, there are traditional beliefs that volcanic activity is of and from Pele. In general, traditional beliefs and practices surrounding Pele include reverence, and respect for Pele, and offerings made to Pele.

To the extent that the current PGV project proceeds in a manner that does not disrespect the traditional reverence afforded to Pele and does not pollute the environment, but reduces pollution caused by fossil fuel electricity generosity, it can be said that the proposed project does not violate the general spirit of traditional Hawaiian cultural beliefs and practices. Mitigation measures that will ensure traditional cultural values, beliefs and practices are not adversely affected would be measures to prevent toxic gas and fluid emissions. In addition, PGV could explore means to establish and maintain open communication with Hawaiian cultural practitioners.

Based in the results or consultation, ethnographic research and previous archaeological studies, there are no cultural, historical, natural resources, or past or ongoing cultural practices located specifically on the PGV project property. The area proposed for the installation of new power-generating units and piping is not an area identified in ethnographic, historical or archaeological documents as having had or having cultural, historical, natural resources, or past or ongoing cultural practices.

An analysis of the potential effect of the proposed PVG project on cultural resources, practices or beliefs, its potential to isolate cultural resources, practices or beliefs from their setting, and the potential of the project to introduce elements which may alter the setting in which cultural practices take place has been adequately assessed. Based on the research conducted for this study, the responses from the above listed individuals, and the proposed mitigation measures listed above, it is reasonable to conclude that Hawaiian rights related to traditional cultural beliefs and practices, protected by law, will not be prevented or hindered, or otherwise affected by the proposed PGV project.

CULTURAL ASSESSMEMNT

Based on the results of an Archaeological Assessment of the project area, the results of previous archaeological studies, as well as organizational response, individual cultural informant responses, and archival research, it is reasonable to conclude that, pursuant to Act 50, the exercise of native Hawaiian rights, or any ethnic group, related to gathering, access or other customary activities will not be affected by development activities on this parcel. The property owner will not restrict shoreline access for fishing and gathering purposes, as is protected by law. No specific cultural activities were identified within the project area, and the proposed undertaking will not produce adverse effects to any native Hawaiian cultural practices.

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APPENDIX A: PUBLIC NOTICES AND AFFIDAVITS

STATE OF HAWAII)
) SS.
City and County of Honolulu)

Doc. Date: AUG 1 1 2022	# Pages: 1
Notary Name: COLLEEN E. SORANAKA	First Judicial Circuit
Doc. Description: Affidavit of Publication	
Notary Signature	Date AUG 1 1 2022

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

Lisa Sakakida being duly sworn, deposes and says that she is a clerk, duly authorized to execute this affidavit of Oahu Publications, Inc. publisher of The Honolulu Star-Advertiser, MidWeek, The Garden Island, West Hawaii Today, and Hawaii Tribune-Herald, that said newspapers are newspapers of general circulation in the State of Hawaii, and that the attached notice is true notice as was published in the

Honolulu Star-Advertiser 3 times on:
08/07, 08/10, 08/11/2022

MidWeek 0 times on:

The Garden Island 0 times on:

Hawaii Tribune-Herald 0 times on:

West Hawaii Today 0 times on:

Other Publications: 0 times on:

And that affiant is not a party to or in any way interested in the above entitled matter.

Lisa Sakakida

Subscribed to and sworn before me this 11th day of August A.D. 20 22

Colleen E. Soranaka, Notary Public of the First Judicial Circuit, State of Hawaii
My commission expires: Jan 06 2024

Ad # 0001382099

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

ICSP NO.:

CULTURAL IMPACT ASSESSMENT NOTICE

Information requested by Scientific Consultant Services, Inc. of cultural resources, past and/or ongoing cultural practices on or nearby to TMK: (3) 1-4-001:001, 002, and 019 located in Kapoho Ahupua'a, Puna District, Hawai'i Island, Hawai'i. Cultural practices information provided by respondents will be included in a Cultural Impact Analysis for the proposed Puna Geothermal Venture Repower Project. Please respond within 30 days to Glenn Escott at (808) 938-0968 or ggescott@yahoo.com.
(SA1382099 8/7, 8/10, 8/11/22)

August 2022 Honolulu Star-Advertiser Affidavit

STATE OF HAWAII)
) SS.
City and County of Honolulu)

Doc. Date: AUG 1 1 2022 # Pages: 1
Notary Name: COLLEEN E. SORANAKA First Judicial Circuit
Doc. Description: Affidavit of Publication

Notary Signature AUG 1 1 2022 Date

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

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Hawaii Tribune-Herald 3 times on:
08/07, 08/10, 08/11/2022

West Hawaii Today 0 times on:

Other Publications: 0 times on:

And that affiant is not a party to or in any way interested in the above entitled matter.

Lisa Sakakida

Subscribed to and sworn before me this 11th day of August A.D. 20 22

Colleen E. Soranaka, Notary Public of the First Judicial Circuit, State of Hawaii
My commission expires: Jan 06 2024

Ad # 0001382104

COLLEEN E. SORANAKA NOTARY PUBLIC No. 90-263 STATE OF HAWAII

ICSP NO.: ____________

CULTURAL IMPACT ASSESSMENT NOTICE

Information requested by Scientific Consultant Services, Inc. of cultural resources, past and/or ongoing cultural practices on or nearby to TMK: (3) 1-4-001:001, 002, and 019 located in Kapoho Ahupua'a, Puna District, Hawai'i Island, Hawai'i. Cultural practices information provided by respondents will be included in a Cultural Impact Analysis for the proposed Puna Geothermal Venture Repower Project. Please respond within 30 days to Glenn Escott at (808) 938-0968 or ggescott@yahoo.com.
(HTH1382104 8/7, 8/10, 8/11/22)

August 2022 Hawai'i Tribune-Herald Affidavit.

CULTURAL IMPACT ASSESSMENT NOTICE: PUNA, HAWAIʻI ISLAND

Information requested by Scientific Consultant Services, Inc. of cultural resources, past and/or ongoing cultural practices on or nearby to TMK: (3) 1-4-001:001, 002, and 019 located in Kapoho Ahupuaʻa, Puna District, Hawaiʻi Island, Hawaiʻi. Cultural practices information provided by respondents will be included in a Cultural Impact Analysis for the proposed Puna Geothermal Venture Repower Project. Please respond within 30 days to Glenn Escott at (808) 938-0968 or ggescott@yahoo.com.

August 2022 Ka Wai Ola Notice.

APPENDIX B: CONSULTATION LETTERS

Ms. Luana Jones Letter Dated August 31, 2022

To: Scientific Consulting Services, Inc August 31, 2022
Re: Cultural Impact Statement for PGV Repower Project
Via: Glen Escott, ggescott@yahoo.com

My name is Luana Jones and I am giving input on PGV‘s Enviromental Assessment on behalf of my Family, my Neighbors and Friends, my Ancestors, the Future Generations of Hawai‘i, and my ‘One Hānau - my Birthplace!

Hawai‘i is a very unique, sacred, and finite place! It is said that my kanaka maoli (Native Hawaiian) Ancestors were here since the beginning of time! Our Creation chant, the Kumulipo, consisting of over 2,000 verses and preserved through oration for thousands of years, is similar to the Bible‘s creation story, although it gives a more scientific narrative of how life evolved. Once introduced by early Missionaries, the written language was well received, and over 100 newspapers spanned the Islands, while Hawai‘i achieved almost 100 percent literacy among its citizens.

When Captain Cook came upon these Islands, the population was estimated to be at least several hundred thousand, living isolated from the rest of the world, yet according to Cooke‘s Journals, ‘living remarkably sustainable!‘ (Today‘s 1.4 million people in Hawai‘i depend on imports for more than 85% of goods consumed!)

Vital to sustainability, Kanaka maoli had a very extensive and intricate understanding of the elements of nature and the relationship between all living things. They understood that the natural resources (land, air, water, and ocean) and populations (humans, flora and fauna) are interconnected and interdependent. What affects one, affects all, good or bad! In this context, cultural and natural resources are one and the same; hence the value of “Aloha ‘Aina”~ Love the Land. “When you take care of the land, the land will take care of you.” They were excellent stewards of the ‘aina (the feeder)!

The biggest effect on Hawai‘i since its discovery to the western World was the devastation of the Kanaka maoli population from the transmission of infectious diseases. With no immunity to foreign diseases, the Native Hawaiian population went from a robust several hundred thousand to a mere twenty-four thousand in 1920, a loss of 90% of the Native population. Hundreds of thousands of ‘stewards’ of Aloha ‘Aina ceased to exist(on this realm)! Furthermore, the total ban on Hawaiian language in government and schools after the Overthrow revealed an attempted genocide of Hawai‘i‘s indigenous people and ways.

In times past, the use of resources was determined by the Kānāwai; the layout of the land. It required the nurturing of the resource, to insure its sustainability for future generations. If the resource could not be sustained or nurtured, the Kānāwai (or what we would consider today as the law) prohibited its use. There were two types of Kānāwai; Kānāwai Akua (enforced by Spirit) and Kānāwai Ali‘i (enforced by Man). “He ali‘i ka ‘aina ~ he kauā ke kanaka.” “Land is the chief ~ man is the servant.”

In 1893, Queen Lili’uokalani, the Reigning Monarch of the peaceful Kingdom of Hawai’i was imprisoned, and her Kingdom stolen by an elite band of greedy businessmen, with the help of the United States‘ (US) Marines. Moreover, after the Blount Report (commissioned by the US President) determined that the US participation was illegal, after the Queen‘s Diplomatic Protest, and after the People of Hawai‘i submitted the Ku’e Petition against Annexation, the United States illegally annexed Hawai‘i!

Today we are bound to different Laws! The Laws of the land have been usurped and can be manipulated, too often resulting in exploitation, capitalization, degradation and the continued desecration of Hawai‘i’s resources, and because they are interconnected and interdependent, her people!

Geothermal development may well work in places on earth where the temperatures of the resource is manageable and the toxicity minute; where the system is truly closed and the Best Available Control Technology (BACT) for environmental sustainability as well as health and safety are truly applied. That is not the case in Hawai‘i! Hawai‘i has some of the hottest and most toxic geothermal fluids in the World! The word volatile barely describes what went on in our neighborhoods in the recent 2018 eruption! The skyline above the trees was fiery-red as continuous ground-shaking explosions lit up the sky in what felt like a war zone! Miles below in Kapoho farmlands, rivers of red molten lava moved boat-size boulders, 70 miles-an-hour downhill! The volatility of the resource was traumatizing to all life forms in the vicinity!

Prior to the 2018 lava inundation that left our house under 60-plus feet of lava, we were geothermal neighbors for 36 years. The very first University of Hawai‘i Experimental HGP-A well was an environmental disgrace, with acres of sump ponds leaching into the ground and neighbors complaining of health effects from continuous unregulated emissions. It was finally shut down in around 1989. I was one of six community members who went on a State-sponsored tour of geothermal plants in California and Nevada; it only served to confirm our fears that Hawai'i's resource is dangerously hot and toxic, especially in a neighborhood! After contested case hearings slowed the permitting process for a developer in Wao Kele O Puna, law-makers changed the process and created Rule 12 which eliminated contested case hearings and replaced it with a 60-day-limit-mediation, after which the (PGV) permit was approved. The plant manager repeatedly assured us (families) that a 'blow out' would be a worst-case-scenario and unlikely to happen; on June 12, 1991 a well blew out and the plant was shut down for four years. We were never informed of, nor did we ever receive a community emergency plan. Government regulation and oversight over geothermal in Hawai'i is inadequate for public safety, especially during emergencies as demonstrated in the past.

People in authority need to Ho'olono (listen with obedience) to the Kanawai Akua! If we are to be good stewards of Hawai'i and leave a legacy for the next hundred, or thousand years, we need to Ku Kia'i (stand guard) and take the Kuleana (the responsibility) to make things Pono (Righteous)! Ua mau ke ea o ka 'aina I ka pono! As we continue to raise the generations with the language, the culture, and the truth, we can take courage in the hope for the future! Perhaps Ormat Industries or the Broneki's would consider investing in sustainable, benign, ocean-generated energy production, and contributing to the education of engineers in Hawai'I towards research to create models that would benefit mankind. I pray it so.

Mahalo for the opportunity to comment! E kala mai ia'u e 'olu'olu. Please excuse any offenses and my sometimes obvious attitude. Aloha and Mahalo ke Akua!

Luana Jones
P. O. Box 747
Pahoa, HI 96778
(808)938-0021
August 31, 2022

Ms. Luella Nohea Crutcher Letter Dated September 2, 2022

Luella Nohea Crutcher
P.O. Box 928, Pahoa, HI 96778-0928
email: luellacrutcher@yahoo.com
cell: (808)756-6947

September 2, 2022
Mr. Glenn Escott
Scientific Consultant Services, Inc
Email: ggescott@yahoo.com
Ph: (808)938-0968

Regarding: Cultural past and /or ongoing cultural practices on or nearby to TMK: (3)1-4-001,002, and 019 located in Kapoho Ahupua`a

Dear Mr. Escott,

Prior to the disease brought by the whaling ships, our islands were self sufficient, thriving and the people were healthy. Chrisitanity's new way of seeing things, the restriction of the Hawaiian language in school by this "new culture" caused many of us, especially if we did not speak Hawaiian, to be influenced by these new ideas. Many of us did not have a clear understanding of our Hawaiian spirituality / relationship with the elements. How understanding and respecting our environment, was a part of our daily lives. Now people speak of cultural practices, like it something separate.

You are asking for cultural practices, which for me must include our beliefs and cultural practices that support living on this planet. Cultural practices like being one with and respecting the elements. Our main cultural practice, is to preserve, protect and be one with the elements that *Akua/Wakea* (God) has created and yes that also includes ceremonies of being thankful for our free gifts from *Akua.* Gifts such a fresh water, fresh air, natural food (organic), without pesticides, sun, rain – etc.

Our history / knowledge / science was handed down orally, usually within a family line. We respect science, but respect is also respecting the land and protecting it, not desecrating or destroying. Our ancestors were extremely scientific. All the elements had names. Names for the planets and ocean currents, that were used to guide them while traveling the oceans. Every different cloud, rain, wind, season has a name. They knew when and where to fish or plant and when not to. They understood, had a relationship with and respected the elements. (That is cultural practice at its core). *Akua* freely provided everything we needed, to be alive. Our *kuleana* (responsibility) is to acknowledge it, respect it, have a relationship with, protect it and preserve it.

All mountain tops were *Akua'*s *kuleana* (responsibility, claim), our *kuleana* is to respect it as Akua's and not visit it without following protocol – that allowed us never to contaminate *Akua's Kuleana*. In turn we were provided with clean water, and clean air. When a cultural practitioner goes to the top of *Mauna A Wakea* (Mauna Kea), they are in the *mamao,* the third and highest level of the *Lananu`u mamao (*where the presence of God Dwells) *Lananu`u mamao* is the most sacred Hawaiian temple, created by *Akua*. Cultural practitioners know they are in a very sacred place, and they follow specific sacred protocol.

Some of the elements have been mistaken for Gods.
Example - on *Mauna A Wakea, Poliahu* is the snow, *Lilinoe* is the mist, *Waiau* is the lake. You will notice these elements describe various forms of water. Water that is so important for good health and healthy growing plants.

Tutu Pele is not a god; she is the Lava under us right now. She is everywhere. Yes, there are special cultural practices. As I do not speak the Hawaiian, I choose to leave those practices to the practitioners, to explain to you. My *kuleana,* is to respect the elements around me and acknowledge the free gifts I receive from them AND remembering that on this land, the elements are providing me fresh water, fresh air, healthy food, the things that provide me with a healthy life. We believe that this ʻāina belongs to *Akua/Wakea*, who has given us our free gifts. Our *kuleana,* which is our daily cultural practice, is to take care of the beautiful ʻā*ina*, not destroy it.

If *Tutu Pele* wanted us to have the heat, she would offer it to us for free. We would not drill into her, that is "breaking and entering". It is the same as someone tearing down my door and coming in and taking without me offering it to them. *Tutu Pele* is being desecrated, by "the powers that be". The drilling done to her is causing environmental polution in the air, land and ocean, and maybe the reason for some of the earthquakes and flows. I feel the only reason she did not cover the geothermal is because the poison gases resulting from that could spread 10 miles, and many lives could have been lost. The last flow from a Hawaiian standpoint was also a cleansing. The "powers that be" let people who live in Kapoho use septic systems that polluted the land and ocean and needed to be cleansed. Some of those that lived in Kapoho, did not respect our native culture (protected by law) of hunting and gathering and prevented fishermen from fishing. So that is a demonstration of not respecting daily living cultural practices.

One of the biggest crimes growing in our islands, as well as the rest of the world is stealing and destroying things. When one does not listen to the feedback, the feedback is magnified.
Thus, the looting and destroying of businesses during the riots, and what is known as the "insurgents of the capital". Feedback from the Universe that mankind has lost their integrity and has lost respect.

In the case of geothermal, that the "powers that be "define as clean energy. Are the poisonous gases they are putting back into the earth clean energy? The so-called air testers are placed so high that of course their reports don't show the level of pollution, because the poisonous gases are heavier and lay close to the ground. So much loss of integrity, honesty and respect for nature.

If these projects that do not support this planet and cause more pollution keep getting pushed through by the "powers that be", you'll see more sickness, more unfavorable weather, along with unfavorable behavior among people. We are part of this universe and what happens to our environment affects our health physically, emotionally and spiritually. If you look at how things are progressing, it seems like this planet has gotten more unhealthy, and unsafe to live on and more suicides. All caused by man. In Hawaiʻi we went from a self-sustaining, healthy envionment; to one dependant on outside assistance, more environmental contamination, especially our water souces, that includes the ocean (fish that was once a favorite to eat, now too toxic to eat), lack of respect and more criminal behavior, homelessness, increase in illnesses.

I hope you understand that cultural practices are not just ceremonies. It is our ground of being.

Respectfully,

Luella Nohea Crutcher