~~REVISED DRAFT~~ FINAL ENVIRONMENTAL ASSESSMENT

North Valley Geothermal Development Project at the San Emidio Geothermal Field

DOI-BLM-NV-W030-2020-0003-EA

US Department of the Interior
Bureau of Land Management
Winnemucca District
Black Rock Field Office
5100 East Winnemucca Boulevard
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It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

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ACRONYMS AND ABBREVIATIONS

	Full Phrase
°F	degrees Fahrenheit
ABS	Artificial Burrow Systems
AOI	area of interest
APE	area of potential effect
BAPC	Bureau of Air Pollution Control
BLM	United States Department of the Interior, Bureau of Land Management
BMP	best management practice
BRFO	Black Rock Field Office
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
dBA	A-weighted decibels
DOI	US Department of the Interior
EA	environmental assessment
EGS	enhanced geothermal systems
EMPSi	Environmental Management and Planning Solutions, Inc.
ESA	Endangered Species Act of 1973, as amended
gen-tie	generation tie
GHMA	general habitat management area
GIS	geographic information system
gpm	gallons per minute
HA	herd area
HMA	herd management area
IDT	BLM interdisciplinary team
KOP	key observation point
kV	kilovolt
LADWP	Los Angeles Department of Water and Power
NAAQS	National Ambient Air Quality Standards
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NHT	National Historic Trail
NRHP	National Register of Historic Places
OHMA	other habitat management area
PEIS	programmatic environmental impact statement
PFYC	potential fossil yield classification
pH	potential of hydrogen

PHMA	priority habitat management area
PLPT	Pyramid Lake Paiute Tribe
project	North Valley Geothermal Development Project at the San Emidio Geothermal Field
RMP	resource management plan
ROW	right-of-way
SEGU	San Emidio Geothermal Unit
SWReGAP	Southwest Regional Gap Analysis Project
US	United States
USACE	US Army Corps of Engineers
USC	United States Code
USFWS	US Fish and Wildlife Service
VRM	visual resource management
WSA	wilderness study area

Chapter 1. Introduction

The United States (US) Department of the Interior (DOI), Bureau of Land Management (BLM) Black Rock Field Office (BRFO) has prepared this ~~revised draft~~ final environmental assessment (EA) in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) regulations[1] and BLM regulations for implementing NEPA. The BLM also has prepared it in accordance with DOI Secretarial Order 3355 for streamlining NEPA.

1.1 Project Setting and Background

~~USG Nevada~~ ORNI 36 LLC, a subsidiary of Ormat Nevada, Inc. (hereinafter collectively referred to as Ormat), is proposing the North Valley Geothermal Development Project at the San Emidio Geothermal Field (project). The project is within an area of interest (AOI; see **Section 2.1.1**) in Washoe County and includes an associated overhead generation-tie (gen-tie) line that would cross portions of Churchill, Pershing, and Lyon Counties and connect with an existing substation near Fernley, Nevada. Collectively, the AOI and gen-tie right-of-way (ROW) make up the project area (**Appendix A, Figure A-1**, Project Area).

The project proposes geothermal development in the San Emidio Geothermal Unit (SEGU; NVN-85820X), which encompasses approximately 20,400 acres of BRFO-administered public lands and private lands in the San Emidio Desert in Washoe County, Nevada, in all or portions of Sections 19-22 and 27-34, Township 30 North, Range 23 East, Sections 3-10, 15-22, and 27-34, Township 29 North, Range 23 East, Mount Diablo Baseline and Meridian. The unit covers federal geothermal leases NVN-42707, NVN-57437, NVN-63004, NVN-63005, NVN-63006, NVN-63007, NVN-74196, NVN-75552, and NVN-75557 (**Figure A-2**, Geothermal Lease Areas).

The project proposes to construct two closed-loop binary geothermal power plants, geothermal fluid production and injection wells, well pads, access roads, geothermal fluid pipelines, and ancillary support facilities (**Figure A-3**, Project Overview—San Emidio Geothermal Lease Unit). A 58-mile-long 120 kilovolt (kV) overhead gen-tie line with associated facilities is also proposed. The line would mostly parallel an existing 500 kV transmission line.

Existing and previous geothermal development activities in the San Emidio Desert, including BLM's establishment of the SEGU, is discussed in BLM's 2010 EA for the San Emidio Geothermal Exploration Project (BLM 2010, pp. 6-8). In summary, the San Emidio geothermal power plant and existing substation have been operating since 1988. Ormat previously constructed the AMOR II power plant, which is now decommissioned and has been removed. The existing San Emidio plant has a current design capacity of 11.8 megawatts. The purpose of the 2010 EA was to provide Ormat the opportunity to construct access roads, temporary pipelines, and well pads for exploration drilling activities that would allow them to test the geothermal reservoir and evaluate the geothermal power development potential of the

[1] In July 2020, the CEQ updated its NEPA regulations (see 40 Code of Federal Regulations [CFR] 1500–1508). The changes became effective September 14, 2020. The BLM issued the first public draft of this EA in June 2020; for consistency, this EA relies on the regulations in effect before September 14, 2020.

resource. Existing facilities are depicted on **Figure A-4**, Existing Geothermal Utilization and Electrical Transmission Facilities.

As noted above, the proposed 120 kV gen-tie line would mostly parallel an existing 500 kV transmission line. This is the 846-mile Pacific DC Intertie, which distributes electricity from the Pacific Northwest to the Los Angeles area using high voltage direct current. It originates near the Columbia River at the Bonneville Power Administration Celilo Converter Station near The Dalles, Oregon, and is connected to the Los Angeles Department of Water and Power (LADWP) Sylmar Converter Station north of Los Angeles. The section of line in Nevada and California is owned and operated by LADWP.

1.2 Cooperating Agencies

The BLM invited the US Fish and Wildlife Service (USFWS), the Nevada Department of Wildlife (NDOW), the Pyramid Lake Paiute Tribe (PLPT), Washoe County, and the Truckee Meadows Regional Planning Agency to be cooperating agencies in preparing this EA. They were included because of their jurisdiction by law or special expertise. The USFWS~~,~~ and NDOW~~, PLPT, and Washoe County~~ accepted the invitation to be cooperating agencies. The BLM is the lead federal agency in the NEPA process and for the Endangered Species Act (ESA) Section 7 consultation process and National Historic Preservation Act (NHPA) Section 106 consultation process.

1.3 Purpose and Need

The BLM's purpose for the federal action is to respond to Ormat's application to develop geothermal energy resources on public lands in the San Emidio Desert through the construction of geothermal power production facilities and to connect those facilities via transmission line to the Eagle Substation near Fernley, Nevada.

The need for action is established by the BLM's responsibility under the Mineral Leasing Act of 1920, the Geothermal Steam Act of 1970, and the implementing regulations provided under 43 CFR 3200. The need for action is also established by the BLM's responsibility to process a ROW application under the Federal Land Policy and Management Act of 1976 and ROW procedures at 43 CFR 2800.

1.4 Decision to be Made

The BLM would decide to grant, grant with modification, or deny Ormat's proposal, in compliance with BLM leasing regulations and other federal laws. Conditions of approval would be applied to the applicable permits and authorizations. Any activities outside the scope of the Proposed Action would be subject to further NEPA analysis.

1.5 Resource Management Plan Conformance

The Proposed Action, described below, would be in conformance with the BLM Winnemucca District Resource Management Plan (RMP; BLM 2015a), as amended. Specifically, the Proposed Action is consistent with Objective D-MR 4 (BLM 2015a, p. 2-172), which states, in part, that "Lands within the WD would be open to geothermal and oil and gas leasing and development except where incompatible with important resource values."

1.6 Relationship to Laws, Regulations, Policies, and Plans

The alternatives analyzed in this EA are consistent with federal laws and regulations; state and local government laws and regulations; and other plans, programs, and policies, to the extent practicable within federal law, regulation, and policy.

The BLM has prepared this EA in accordance with the following statutes and implementing regulations, policies, and procedures that govern the BLM's actions:

- Mineral Leasing Act of 1920 (30 United States Code [USC] 181), as amended
- Geothermal Steam Act of 1970 (30 USC 23), as amended
- The Federal Land Policy and Management Act of 1976 (43 USC 35)
- BLM NEPA Handbook (H-1790-1), as updated (BLM 2008)
- Energy Policy Act of 2005 (42 USC 149), as amended

1.7 Scoping and Issue Identification

The BLM received nine comment submissions during the public scoping period, which occurred from January 6, 2020, through February 10, 2020. Comments were submitted by the NDOW, Nevada State Clearinghouse, the PLPT, US Environmental Protection Agency, USFWS, Western Watersheds Project, and a private citizen. From these letters, there were 42 substantive comments. All comments received are summarized in the Public Scoping Report, which is available on the BLM project website (https://bit.ly/38ShWp7). Concurrent with public scoping, the BLM interdisciplinary team (IDT) and cooperating agencies held two internal scoping workshops to discuss issues to be carried forward for analysis in **Chapter 3**, Affected Environment and Environmental Consequences.

1.8 Changes from the Draft Environmental Assessment

The BLM released ~~the~~ a draft EA on June 11, 2020, and received 11 comment submissions during the 30-day draft EA comment period. Comments were submitted by the Nevada State Clearinghouse, the PLPT and its consultants, the US Environmental Protection Agency, the US Navy, Ormat, and private citizens. From these letters, there were 71 substantive comments, primarily regarding the potential impacts of the proposed geothermal development project on nearby hydrologic and geothermal resources, especially those on the PLPT Reservation. Other comments expressed concern over potential impacts on solid mineral interests, cultural resources, air quality, and wildlife. Commenters also requested more information on proposed monitoring, mitigation measures, and adaptive management strategies. **Appendix H** is the comment summary report from the draft EA.

Based on the comments received on the June 2020 draft EA and the BLM's review of information received from the PLPT through a data-sharing agreement, the BLM revised the Hydrogeologic Evaluation (BLM 2020b) to clarify the known characteristics of the San Emidio hydrologic and geothermal systems. The BLM revised **Sections 3.2.1**, **3.2.2**, **3.3.3**, and **3.3.6** of this EA to reflect the Hydrogeologic Evaluation revisions.

Working with the NDOW and Ormat, the BLM also prepared a draft Pale and Dark Kangaroo Mouse Monitoring ~~and Mitigation~~ Plan (see **Appendix F**). In response to feedback from the USFWS, Ormat also revised the Eagle Act Compliance Document; the revised document is **Appendix D**. The BLM updated required stipulations and proposed mitigation measures in **Section 3.2**, including **Table 3-9**, to reflect these changes.

Other changes were made in **Chapter 2** to reflect minor changes to the location and disturbance acres of proposed project elements. Changes in **Chapter 3** also address comments received regarding mineral claims, air quality, and cultural resources. Minor revisions in **Chapter 4** provide updated agency consultation and coordination status. Other minor editorial changes were also made throughout the document.

The BLM published a second public draft EA on November 27, 2020, and received six submission letters during the 16-day draft EA comment period. Comments were submitted by the LADWP, Nevada State Clearinghouse, NDOW, PLPT and its consultants, and US Environmental Protection Agency. From these letters, there were 116 substantive comments, primarily regarding the potential impacts of the proposed geothermal development project on nearby hydrologic and geothermal resources, especially those on the PLPT Reservation. In response to the PLPT concerns, the BLM participated in consultation meetings with the PLPT on December 18, 2020; January 20, 2021; March 2, 2021; and March 17, 2021. Based on those consultation meetings and subsequent coordination with the PLPT and Ormat, the BLM developed a draft groundwater monitoring goals and objectives document (**Appendix G**), which replaces the draft groundwater monitoring plan included in the second draft EA.

Changes made from the first draft EA to the second draft EA are in gray highlighted text. Changes from the second draft EA to the final EA are in blue highlighted text.

Chapter 2. Proposed Action and Alternatives

2.1 ALTERNATIVE A: PROPOSED ACTION

Alternative A (the Proposed Action) includes construction and operation of two 20-megawatt, closed-loop binary geothermal power plants, geothermal fluid production and injection wells, well pads, access roads, geothermal fluid pipelines, ancillary support facilities, and an electrical substation. It also includes construction and operation of an overhead gen-tie power line with associated facilities that would connect the proposed electrical substation to the Eagle Substation near Fernley, Nevada. Unless otherwise noted, all information describing the elements of Alternative A other than the proposed gen-tie line and ROW are from the Project Utilization Plan (Ormat 2020); the details of the proposed gen-tie line and ROW are in Ormat's Plan of Development (Ormat 2019a).

2.1.1 Area of Interest

The AOI consists of approximately 3,938 acres of public lands administered by the BLM and private lands in the SEGU.

All proposed surface disturbance associated with project geothermal utilization components would be in the AOI. The AOI does not include proposed surface disturbance associated with the gen-tie line (see **Section 2.1.2**, Gen-tie Line). Proposed surface disturbance in the AOI would be associated with two new geothermal power plants, well pads, geothermal fluid pipelines, new and upgraded access roads, an aggregate pit, an electrical substation, and ancillary features, such as office buildings and storage facilities (see **Table 2-1**, below).

Table 2-1
Proposed Disturbance in the AOI

Component	Acre Disturbance	
	Temporary	Permanent
Power Plants[1]	30	30
Pipelines	36.~~8~~7	18.48
Well Pads	105	~~63~~62.5
Access Roads[2]	13~~.1~~	13
Aggregate Pit	5	5
Total	**189.~~9~~7**	**129.~~5~~3**

Source: Ormat 2020
[1]The substation and ancillary features, such as offices, restrooms, a control room, a maintenance building, and smaller auxiliary buildings, would be constructed within the power plants' footprints.
[2] Includes acres of disturbance from new roads and upgrades to existing roads.

2.1.1.1 Site Preparation

Site preparation would commence with grubbing and clearing the proposed areas of surface disturbance as summarized in **Table 2-1**. Following this, topsoil would be removed and stockpiled for later use in revegetation and reclamation. Subsequently, slopes would need to be cut, where necessary. As much as possible, native materials, derived from grading to balance cut and fill, would be used for site and road building. Approximately 100,000 cubic yards of surfacing material may be needed for power plant and pipeline construction. Aggregate material would be obtained from an existing pit in the AOI (**Figure A-3**). The existing pit would be expanded by up to approximately 5 acres.

2.1.1.2 Geothermal Power Plants

The two proposed geothermal power plants would be located in Sections 16 and 21, Township 29 North, Range 23 East, Mount Diablo Base~~line~~ and Meridian. (**Figure A-3**), respectively. Each would be approximately 20-megawatt net rated (24-megawatt gross) geothermal power generation facilities. The combined footprint of the power plants would be approximately 30 acres.

An approximately 0.5-acre substation, used to transform generated low-voltage electrical power to the higher voltage required for a transmission line, would be constructed within the northern power plant boundary, or the existing substation from the decommissioned AMOR II Geothermal Power Plant would be expanded and upgraded. It would still be within the southern power plant boundary. The choice to locate the proposed substation at the northern or southern power plant would depend on which power plant was constructed first; the substation would be located at that plant. Whether the northern or southern plant was constructed first would depend on results of production and injection well performance and the expected balance of geothermal fluid production and injection when completed. A new control room, separate of the existing San Emidio control room, would be included in whichever power plant footprint is constructed first and would be staffed 24 hours a day, 7 days a week.

The power plants would use a binary design with an air-cooled heat rejection system. The geothermal fluids for the binary power plants would be pumped from the production wells (see **Section 2.1.1.3**, Well Field). Once delivered to the power plant, the heat in the geothermal fluid would be transferred to the binary (i.e., secondary) fluid in multiple-stage, noncontact heat exchangers. The binary turbine units would use pentane (C_5H_{12}), a flammable but nontoxic hydrocarbon, as the binary fluid, which would circulate in a closed loop. The heat from the geothermal fluid would vaporize the binary fluid, which would turn the binary turbine and generator to make electricity. Pentane containment failure and subsequent fire prevention measures will be included in the emergency action plan after engineering is completed. Pentane totals for the system also cannot be determined until engineering is complete. For context, Ormat's Tungsten Mountain geothermal plant, a 27-megawatt rated air-cooled binary design plant, contains 603,000 pounds of pentane in the system at any given time. Each of the proposed plants would likely contain similar amounts of binary fluid.

The vaporized binary fluid would exit the turbine and condense back into a liquid in a shell-and-tube, noncontact, air-cooled condenser. The condensed binary fluid would then be pumped back to the heat exchangers for reheating and vaporization, completing the closed cycle. The residual geothermal fluid from the heat exchangers would be pumped under pressure to the geothermal injection wells through the injection pipelines and then injected back into the geothermal reservoir. Before being reinjected, the water would be air-cooled using condensers, minimizing loss of water.

There would be no emissions of pentane to the atmosphere during normal plant operation. Some pentane emissions would occur due to the escape of binary working fluid from rotating seals and flanges on the heat exchangers and during maintenance on the binary power plant units (Ormat 2020).

Pentane emissions are estimated to average 12 tons per year per plant, which would be regulated through a permit issued by the Nevada Bureau of Air Pollution Control (Ormat 2020).

The most prominent features of the power plants, both in height and mass, would be the air-cooled condensers. Each plant would be 28–35 feet tall and approximately 1,300 feet long and 100 feet wide. The balance of the plant would be an array of pipes and a small building to house electrical equipment. The perimeter of the site and main facility areas would be fenced with chain link to prevent unauthorized entry, and to exclude wildlife from the facility and electrical generation area. The 8-foot chain-link fence would be topped with barbed wire and equipped with controlled-entry gates to allow vehicles onto the facility.

Ancillary facilities and power plant components that would be constructed on the power plant sites would be offices, restrooms, the electrical room and control room, the maintenance building, condensing fan equipment, and other smaller ancillary structures. If the existing electrical substation is used, it would be located within the footprint of the southern power plant.

All buildings, including those housing the offices, electrical room, control room, and auxiliary buildings would be rigid, steel-frame, pre-engineered structures with steel-panel walls and a steel roof. The buildings' exteriors would be painted consistent with BLM visual color guidelines to blend with surrounding areas.

Two 500-gallon diesel fuel and one 500-gallon unleaded gas, aboveground storage tanks would be within each power plant footprint. The diesel tanks would be used for backup generators, and the gasoline tanks would be used for fueling equipment. These tanks would be double-walled construction and placed in concrete secondary containment basins, which will follow a design criterion of 110 percent of the largest tank (in this case, 500 gallons) requiring containment. For on-site storage of diesel and gasoline, a spill prevention, control, and countermeasure plan would be developed, in accordance with 40 CFR 112, and authorized by the BLM (Ormat 2020). Prior to a formal notice to proceed from the BLM, Ormat would develop a formal emergency action plan for the facility (Ormat 2020).

2.1.1.3 Well Field

The number of geothermal production and injection wells required for the project principally depends on the productivity (or injectivity) of the wells and the temperature and pressure of the produced geothermal fluid, which is composed of steam and water. Production wells flow geothermal fluid to the surface. Injection wells are used to inject geothermal fluid from the power plant into the geothermal reservoir, which produces geothermal fluid. Injection ensures the longevity and renewability of the geothermal resource by returning geothermal fluid back to the geothermal reservoir.

Ormat is proposing 25 production and injection wells, all located on public lands administered by the BLM in the AOI. **Figure A-3** shows the locations of these proposed production and injection wells. Exact well locations could be adjusted as additional geologic, geophysical, and geothermal reservoir information is obtained during the drilling of each well.

During normal well field operations, total geothermal fluid production rates are expected to be approximately 8,400 gallons per minute (gpm) at 320 degrees Fahrenheit. Individual production well flow rates are expected to be approximately 4,200 gpm, with a wellhead pressure of about 100 pounds per square inch. Geothermal fluid injection rates are approximately 7,740 gpm. Individual injection wells are expected to receive approximately 2,600 gpm of 135 degrees Fahrenheit geothermal fluid, with wellhead injection pressures of about 60 pounds per square inch.

Temporary surface disturbance for the 25 proposed well pads would be approximately 4.2 acres per pad, or approximately 105 acres in total. After interim reclamation, there would be approximately 2.5 acres of permanent disturbance at each well pad, or approximately 63 acres in total (see **Table 2-1**). See **Section 2.1.4**, Reclamation, for more details on interim reclamation.

Drill pad preparation would include clearing, earthwork, drainage, and other improvements necessary for efficient and safe operation and for fire prevention. Clearing before drilling would involve brush removal, which would either be taken to an appropriate dump site or piled and left on-site. Topsoil would be stripped, typically to the rooting depth, and salvaged during pad construction, as feasible. Salvaged topsoil and any cleared organic material, if saved, would be stockpiled on the pads for use during subsequent reclamation of the disturbed areas.

Each drill pad would be prepared to be level for the drill rig and a graded surface for the support equipment. Stormwater runoff from undisturbed areas around the drill pads would be directed into ditches surrounding the drill pad and back onto undisturbed ground, consistent with best management practices (BMPs) for stormwater. The site would be graded to prevent stormwater runoff from the pad. The site itself has been designed for a 100-year storm.

Reserve pits would be constructed on each pad for the containment and temporary storage of water, drill cuttings, and circulating drilling mud, in accordance with BMPs identified in the Gold Book (BLM and Forest Service 2007) and the NDOW's *Design Features and Tools to Reduce Wildlife Mortalities Associated with Geothermal Sumps*. Geothermal fluid produced from the well during flow testing (additional details on flow testing are provided below) would also drain to the reserve pit. The pits would be fenced once drilling has been completed to prevent access by people, wildlife, and livestock. The fence would remain in place until pit reclamation begins. For the drilling of each well, the reserve pit would measure approximately 75 feet wide by 200 feet long by 10 feet deep.

Wells would be completed at depths between 300 and 8,000 feet, with an average of approximately 3,500 feet deep. Casing depth would vary depending on the total depth of the well but would comply with Geothermal Resources Operational Order No. 2 and Nevada Department of Minerals requirements as applicable (Ormat 2020). Once a well is drilled and a wellhead completed, an industrial grate would be placed over the hole to prevent people and wildlife from falling into it. After interim reclamation is completed, the approximately 2.5-acre well pads would be fenced to limit access.

Each of the production wells would be equipped with a line shaft pump to bring the geothermal fluid to the surface under pressure. An insulated electric conductor installed from the power plant to the wellheads along the connecting pipelines would supply the electricity to the wellhead pump motors.

Wellhead dimensions for the production wells are not expected to exceed a height of 15 feet above the ground surface or 4 feet in diameter. Wellhead dimensions for the injection wells would be smaller (approximately 4 feet high); this is because they would not have wellhead pump motors.

An approximately 15-foot by 15-foot by 10-foot-high motor control building may be constructed on each well pad within approximately 50 feet of the production well. It would house and protect the auxiliary well control systems, motor switch gear controls and sensors, transmitters, and geothermal fluid treatment systems. The well control systems, data transmitters, and geothermal fluid treatment systems used for the injection wells would be placed inside a smaller structure on the injection well pads.

Sensors would collect key temperature, pressure, and flow rate data from each well. These data would be measured for use in process control, resource data acquisition, safety, and environmental protection.

Short-Term Well Testing

One or more short-term flow test(s) of each well drilled would likely be conducted to estimate long-term well and geothermal reservoir productivity. Each test, lasting approximately 3 to 5 days, would consist of flowing the well into the reserve pit or portable steel tanks while monitoring geothermal fluid temperatures, pressures, flow rates, chemistry, and other parameters. Each short-term flow test is expected to discharge approximately 1.5 million gallons per well. Injectivity tests may also be conducted by injecting the produced geothermal fluid from the reserve pit or steel tanks back into the well and the geothermal reservoir.

Long-Term Well Testing

One or more long-term flow test(s) of each well drilled would likely be conducted following the short-term flow test(s) to more accurately determine long-term well and geothermal reservoir productivity. Each long-term flow test would last approximately 7–30 days, or potentially longer as determined by Ormat in coordination with the BLM. Each long-term flow test is expected to discharge approximately 15 million gallons.

The process would be conducted by pumping the geothermal fluids from the well through on-site test equipment to the reserve pit on the well pad, or the ground surface away from the well. The produced geothermal fluid would then be pumped through a temporary 8-inch to 10-inch-diameter pipeline to either inject the fluid into one of the other geothermal wells drilled within the project area, or to the ground surface in a direction that would not flow back to the well or facilities. The temporary pipeline would be carried by workers and hand-laid either "cross country" or on the surface of the disturbed shoulders on the access roads connecting the well pads. If required, roads would be crossed by either trenching and burying the temporary pipe or by elevating the pipe over the road using pipe ramps. The second option may be done because the shallow aquifer at the San Emidio geothermal field is not freshwater, but rather geothermal fluid (BLM 2020b).

Well testing would comply with the State of Nevada Underground Injection Control Program (Nevada Administrative Code 445A.908) administered by the Nevada Division of Environmental Protection. Injection and flow testing would also comply with other applicable state and federal permitting requirements, including the Nevada Division of Minerals Geothermal Permit.

2.1.1.4 Geothermal Fluid Pipelines

The geothermal fluid production and injection pipelines would bring the geothermal fluid from the production wells to the power plant and would deliver the cooled geothermal fluid from the power plant to the injection wells. Ormat proposes approximately 7.6 miles of production and injection pipeline routes. Pipes would have flow rates between 4,000 gpm and 25,000 gpm and diameters between 8 and 30 inches, depending on the wells they service (Ormat 2020). The maximum fluid pressure that could go through the system is dependent on the flow rate, but would be maintained and monitored throughout the system to prevent the fluid from changing to a gas in the pipelines.

During pipeline construction, approximately 36.~~8~~7 acres of the surface would be temporarily disturbed (**Table 2-1**), assuming that an approximately 40-foot-wide construction corridor would be temporarily disturbed during installation. After interim reclamation, the permanent disturbance would be approximately 18.48 acres. This assumes an approximately 20-foot-wide corridor around the pipeline would be maintained.

The production and injection pipeline routes generally would follow the shortest distance from each well pad to the next well pad or the power plant. This would be done to minimize the amount of pipe required, to reduce heat losses and the power required to move the fluids, and to minimize the amount of ground disturbance. In addition, the proposed pipeline routes generally would follow existing or proposed roads to facilitate ongoing monitoring and future maintenance.

The final pipeline alignments would be dictated by the specific wells completed for the project and the need to match fluid characteristics and balance fluid volumes in these pipelines. The pipelines would be painted to blend with the surroundings.

Construction would include drilling 24-inch-diameter holes to a 3- to 5-foot depth, at approximately 30-foot intervals. Steel pipe supports would be placed in the hole, which would then be filled with concrete to an elevation slightly above the ground. The supports would extend approximately 1 foot above the ground. When completed, the top of the new geothermal pipelines would average 3 feet above the ground; however, a number of pipeline lengths could be up to 6 feet above the ground to accommodate terrain undulations and to facilitate movement of wildlife and livestock through the well field.

2.1.1.5 North Valley Substation

Ormat proposes to locate the North Valley Substation at the northernmost end of the 120 kV gen-tie, next to the new power plant (see **Figure A-3**). The substation would be built within the power plant footprint. The gen-tie line would originate here. The proposed substation would have a fenced area of 250 feet by 175 feet; the proposed fence would be 8 feet tall.

Work at the substation site would begin by clearing vegetation and grading a level pad for installing the substation. Once the pad is prepared, the site would be secured with chain-link fencing. Holes for the structure footings and underground utilities would then be excavated. The footings and underground utilities would be installed, including electrical conduits and additions to the ground grid, and the excavations would be backfilled. Aboveground structures and equipment would then be installed.

Once the equipment is installed, gravel would be spread over the site to a depth of approximately 4 inches. The gravel would be obtained from within the boundaries of an existing lease, an existing aggregate pit, or from a private source near the project area.

2.1.1.6 Access Roads

New Access Roads

New access roads would be constructed using a dozer or road grader, or both. Approximately 4.2 miles of new access roads are proposed. The total estimated area of surface disturbance required for new access road construction, assuming a 25-foot-wide area of disturbance, would be approximately 12.~~8~~7 acres (**Table 2-1**).

Access roads that cross drainages may require culvert installation. Installers would follow BLM design criteria and standards in the Gold Book (BLM and Forest Service 2007).

Existing Road Improvements

Approximately 0.5 miles of existing roads may be improved to facilitate project access, including widening, grading, or blading. The total estimated area of surface disturbance required to improve existing access roads, assuming approximately 5 feet of disturbance along the road shoulders, is approximately 0.3 acres (**Table 2-1**).

2.1.1.7 Water Use

Construction

Approximately 50,000 gallons per day would be used during the first 2 months of construction for compaction and dust control, and 5,000 gallons per day would be used for dust control thereafter for approximately 6 months. This water would be supplied from geothermal fluid, the Sweetwater Well via a private ranch source, or one or more shallow water wells drilled from one or more of the proposed drill sites (Ormat 2020).

As necessary, a temporary construction water pipeline may be placed on existing and new access roads. No additional surface disturbance would be required for this feature.

Operation

Facility operation would use up to approximately 325 gallons per day, or 0.37 acre-feet per year. This water would be obtained from the off-site sources identified above and would be trucked to the power plants and stored on-site. Drinking water would be purchased from a commercial bottled water source.

2.1.1.8 Personnel

Construction

Project construction would likely require a maximum of 50 workers. After grading and excavation, this would drop to an average of 3 to 4 workers.

Operation

Once operating, the project would have a staff of approximately 15 to 20. The power plant would be staffed, and approximately 1 to 2 employees may be on-site at a given time.

2.1.1.9 Schedule

Project construction would take approximately 8 months and is anticipated to begin in the third quarter of 2020. Commercial operations are anticipated to begin in 2021. The estimated project lifespan is 50 years.

2.1.2 Gen-tie Line

Electricity generated from the project would be connected to the NV Energy power grid via a proposed 58-mile-long overhead 120 kV gen-tie line. The gen-tie line would connect from the North Valley Substation to the existing Eagle Substation near Fernley, Nevada. The gen-tie line route would cross approximately 40 miles of BLM-administered lands and 18 miles of private land. The route would parallel an existing alignment of the LADWP's 500 kV direct current transmission line and would be within a designated utility corridor per the Winnemucca RMP (BLM 2015a) and west-wide energy corridor per Section 368 of the Energy Policy Act of 2005.

The gen-tie would consist of a single 120 kV circuit on direct-buried and guy-wired, wood, H-frame, and three-pole structures. All structures would be preassembled, and insulators would be attached to the pole before installation. A truck-mounted crane would lift and set the structure after it is assembled.

The gen-tie would consist of a single conductor, using aluminum-conductor, steel-reinforced cable; one 0.375-inch steel-shield wire; and one optical ground wire. The overhead conductors would be of a material that would reduce sunlight reflection and minimize their visibility.

Each structure would carry a shield wire and an overhead ground wire/fiber-optic cable for lightning protection and fiber-optic communications. The overhead ground wire would be approximately 0.5 inches in diameter and would be constructed of concentric layers of galvanized steel wires surrounding a hollow core, which would contain 12 to 48 fiber-optic strands (depending on final requirements). Metering and communications equipment would be required at the generator site. **Table 2-2** provides a summary of the gen-tie components.

Table 2-2
Gen-Tie Summary

Component	Description
Length	57.7 miles
Pole structure type	Wood H-frame, direct embedded
Structure height	52 to 79 feet above ground level (60- to 90-foot pole length)
Structure base diameter	1.5 to 2 feet
Average span length	960 feet (100 feet minimum to 2,000 feet maximum)
Number of structures per mile	5.5
ROW width	300-foot-wide ROW (a 100-foot permanent ROW with an extra 200-foot temporary ROW for construction), plus an additional 50 feet (100-foot radius) on the guy wire side of the outermost line angle pole for anchor easements
Voltage	120 kV
Conductor ground clearance	Minimum 21 feet above ground level

Source: Ormat 2019a

In order to accommodate gen-tie construction equipment and activities, temporary work areas, approximately 300 feet by 300 feet, would be necessary at each gen-tie structure site. Several stringing sites and angle points, which would each have an area of approximately 300 by 300 feet, would also be necessary to install the conductor for the 120 kV gen-tie. Stringing sites would be located approximately every 10,000 to 15,000 feet along the gen-tie.

Temporary material storage yards would be required for gen-tie construction materials. These staging areas would be located at existing well pads or the power plant site at the gen-tie northern end. Construction water would be obtained as described in **Section 2.1.1.7**, Water Use, above.

To establish work areas where poles and conductors would be installed, vegetation clearing and grading within the ROW could be necessary. In all locations, Ormat would use overland travel to the extent possible and would minimize vegetation removal to the extent possible. In order to stage equipment and conduct work, the structure access, work areas, and the stringing sites would require a relatively flat surface; therefore, the areas could be graded, and gravel or soil could be imported to achieve the necessary elevation. Proposed work areas would be located away from potentially sensitive sites and would be approved by the BLM Authorized Officer prior to work beginning in these areas.

After construction, the temporary work areas would be reclaimed and restored, with the exception of a 20-foot by 30-foot pad, which would be used for future maintenance on gen-tie infrastructure. The temporary work areas would be revegetated, as described in **Section 2.1.4**, Reclamation. After gen-tie construction is complete, all roads would be left in a condition equal to or better than their preconstruction condition, as directed by the BLM and as applicable.

In accordance with the Federal Land Policy and Management Act and a Nevada BLM Instruction Memorandum, electric transmission and distribution facility ROW holders have the authority to conduct routine operations and maintenance activities within their ROW (see 43 CFR 2805.14(a)). ROW holders must also do everything reasonable to prevent and suppress wildfires within or near the ROW area, 43 CFR 2805.12 (a)(4), and comply with project-specific terms, conditions, and stipulations, including any requirements to control or prevent damage to property, and public health and safety 43 CFR 2805.12(a)(8)(iii).

Wildfire risk management strategies incorporated within the proposed ROW would include vegetation management within 4 feet surrounding all power poles. This would primarily include the periodic trimming of shrubs through manual methods and treatment of annual grasses using manual or herbicide treatments. Any chemical treatments would be consistent with the BLM's 2007 Final Programmatic Environmental Impact Statement National Vegetation Treatments Using Aminopyralid, Fluroxypyr, and Rimsulfuron (Final PEIS) on BLM Lands (BLM 2007). There would be no mechanical treatments, prescribed fire, or targeted grazing. Treatments would take place concurrent with regular ROW maintenance, or more frequently as warranted by vegetation conditions and potential wildfire risk.

Should the geothermal plant be decommissioned and the interconnection no longer be needed, the gen-tie, including support structures, would be removed and all disturbed areas would be reclaimed, as described in **Section 2.1.4**. As with construction, decommissioning would be accomplished using overland travel, and no new routes would be created.

2.1.3 Applicant-Committed Environmental Protection Measures

All construction, operation, and maintenance in the AOI and for the proposed gen-tie would be conducted in compliance with all relevant federal, state, and local regulations and permits. They also would be conducted in accordance with the requirements and conditions specified in the NEPA decision record and BLM ROW grant for the gen-tie. In addition to these requirements, Ormat has committed to implementing environmental protection measures to further avoid or minimize potential adverse environmental impacts. These measures are summarized below.

Prevent or Control Fire

Ormat would equip all construction and operating equipment with applicable exhaust spark arresters. Fire extinguishers would be available on-site. Water that is used for construction and dust control would be available for firefighting. Personnel would be allowed to smoke only in designated areas.

Ormat has prepared a fire contingency plan (**Appendix B**) should a fire start in the AOI or along the gen-tie.

Prevent Soil Erosion and Noxious Weeds

Ormat would follow BLM stormwater BMPs, as applicable, on public lands, as described below.

Cut and fill activities would be minimized when selecting the power plant site and pipeline routes. Off-site stormwater would be intercepted in ditches and channeled to energy dissipaters as necessary to minimize erosion around the power plant. To minimize erosion from stormwater runoff, access roads would be maintained, consistent with road development BMPs.

Before construction, Ormat would submit an invasive plant management plan to the BLM to monitor and control noxious weeds. To prevent the spread of invasive, nonnative species, all contractors would be required to power wash their vehicles and equipment, including the body and undercarriage, before bringing them onto BLM-administered lands. All gravel and fill material used would be certified as weed free.

Protect Surface Water and Groundwater

Geothermal fluids would not be discharged to the ground under normal operating conditions. Controls such as frequent inspections, ultrasonic pipeline testing, flow and pressure monitoring, and well pump and pipeline valve shutdown features would minimize the potential for accidental discharges of geothermal fluids. A spill prevention, control, and countermeasure plan would also be developed (**Appendix B**).

Protect Wildlife

Ormat would commit to conducting pre-construction biological surveys to supplement those conducted for the biological baseline report (see Section 3.1.2 of BLM 2020a). If pre-construction surveys indicate the presence of the same species of concern as documented in the biological baseline report, then the same measures to avoid, minimize, or mitigate impacts would be applied.

If pre-construction surveys indicate the presence of a species of concern not already documented in the report, then additional NEPA documentation would occur. Measures to avoid, minimize, or mitigate impacts would be developed during that NEPA process.

Temporarily disturbed areas would be reclaimed as soon as is feasible. Revegetation and periodic maintenance would prevent erosion and protect habitat. Suitable, BLM-approved revegetation methods would be used. Topsoil would be stockpiled and applied to enhance revegetation success.

To prevent undue degradation and the removal of habitat, cover, and food, existing roads would be used whenever possible; cross-country travel would be restricted to designated construction areas.

Power plant sites, permanent well pads, and pits would be fenced to prevent wildlife entry and reserve pits would be operated in accordance with the NDOW's *Design Features and Tools to Reduce Wildlife Mortalities Associated with Geothermal Sumps*. Wellhead cellars would be covered by industrial grates to prevent wildlife entry and entrapment.

Effects on golden eagles would be avoided by implementing measures described in the project's USFWS-approved eagle plan. The plan would be approved by the USFWS before construction begins on the proposed gen-tie. The draft plan is included as **Appendix D** of this EA.

The proposed gen-tie would comply with raptor protection standards described in the Suggested Practices for Raptor Protection on Power Lines, The State of the Art in 2006 (APLIC 2006). All power poles would be equipped with BLM-approved raptor deterrents.

Ormat would minimize construction noise by avoiding or minimizing actions that may typically generate greater noise levels or generate distinctive impact noise.

Protect Cultural Properties and Visual Resources

All National Register of Historic Places (NRHP)-eligible and unevaluated resources would be avoided. Employees, contractors, and suppliers would be instructed that all cultural resources are protected, and that if previously undiscovered resources are encountered, they will be left in place and reported to the responsible Ormat representative.

The paint used on the power plant, pipelines, wellheads, pump motors, and motor control buildings would be consistent with BLM visual guidelines to blend with the area and minimize their visibility. The overhead conductors used on the gen-tie power poles would have a matte surface to reduce sunlight reflection and glare.

Minimize Air and Noise Pollution

Ormat would comply with air quality requirements prescribed by the Nevada Department of Environmental Protection (NDEP), Bureau of Air Pollution Control (BAPC). Fugitive dust control measures include compacting construction-disturbed areas, placing gravel on access roads, and watering construction areas. Ormat would use state-of-the-art equipment and design to ensure minimal pentane emissions during plant construction. Ormat does not anticipate emissions during normal plant operation.

Ormat would use mufflers on all drilling rig engines to reduce noise generation. Operational practices to avoid or minimize high noise level generation or distinctive noise impacts would be used.

Minimize Hazards to Public Health

Ormat would conduct construction and operation in a manner to avoid creating any hazards to public health and safety. The project is remotely located and would not likely be hazardous to public health and safety. A power plant operations and maintenance manual would be developed in parallel with site construction. This manual would be available on-site once the plant commences operations.

Ormat has prepared a spill or discharge contingency plan that addresses potential sources of accidental spills or discharges. It also includes a plan for cleanup and abatement (**Appendix B**).

2.1.4 Reclamation

Once drilling is complete, approximately half of the drill pad area would be reclaimed. The remaining half, typically including the drill sump, would be kept clear for ongoing operations and the potential need to work on or re-drill the well. Areas to be reclaimed would be recontoured to a final or intermediate contour that would blend with the surrounding topography to the extent possible. Areas to be reclaimed would be ripped, tilled, or disked on contour, as necessary; stockpiled topsoil would be applied. A BLM-approved seed mixture would be applied.

At the end of operations, wells would be plugged and abandoned, as required by Nevada Division of Mineral regulations. Abandonment typically involves filling the well bore with clean, heavy abandonment mud and cement, until the top of the cement is at ground level. The wellhead and other surface equipment would then be removed, the well casing would be cut off well below ground surface, and the hole would be backfilled to the surface. As described above, the surface would be reclaimed.

Road reclamation would involve recontouring the roads back to the original contour and seeding with a BLM-approved seed mix. Other techniques to improve reclamation success, such as ripping, scarifying, replacing topsoil, pitting, and mulching, may be conducted if determined necessary.

Pipeline reclamation would include removing all pipeline and supports, and breaking up and burying support foundations in place. As described above, the surface would be reclaimed.

Ormat would completely remove all other aboveground facilities from the site, and would break down concrete foundations and bury them in place. As described above, the surface would be reclaimed.

Ormat would attempt to close or restrict vehicle access to areas that have been seeded until reclamation success criteria have been achieved. Stormwater diversion measures would remain in place until successful revegetation is attained.

2.2 Alternative B: No Action Alternative

Under Alternative B, the No Action Alternative, the BLM would not approve the application by Ormat to construct and operate two power generation facilities with associated production and injection wells, access roads, geothermal fluid pipelines, and ancillary support facilities, and a 58-mile-long overhead 120 kV transmission line on public lands.

2.3 Alternatives Considered but Eliminated from Detailed Study

No alternatives other than Alternative A, the Proposed Action, and Alternative B, the No Action Alternative, were proposed during public scoping; however, during internal scoping and issues development, the BLM considered alternative alignments for the proposed gen-tie.

One alternative considered locating the line parallel to an existing power line that crosses the PLPT Reservation. This alternative was eliminated from detailed analysis because it would have increased the potential for impacts on cultural and tribal resources in the reservation.

Another alternative considered locating the line outside of ROW avoidance area in the Nightingale Mountains. This alternative was eliminated from detailed analysis because it would have required locating the proposed gen-tie outside of a designated utility corridor.

Chapter 3. Affected Environment and Environmental Consequences

3.1 INTRODUCTION

This chapter describes the affected environment, which is the existing or baseline conditions relevant to each issue identified during scoping. Following the affected environment is a description of the direct and indirect effects relative to each issue; these effects are analyzed under both Alternative A, the Proposed Action, and Alternative B, the No Action Alternative. The cumulative effects of Alternative A and Alternative B are described following the analysis of the direct and indirect effects.

3.1.1 Supplemental Authorities and Resource Areas Considered

The CEQ regulations under 40 CFR 1500 and the BLM NEPA Handbook require that the BLM identify significant issues for analysis and focus only on those issues. The BLM NEPA Handbook defines an issue as, "a point of disagreement, debate, or dispute with a proposed action based on some anticipated environmental effect (BLM 2008, page 40). In addition, an issue: has a cause and effect relationship with the proposed action and alternatives; is within the scope of analysis; has not be [sic] decided by law, regulation, or previous decision; and is amenable to scientific analysis rather than conjecture (BLM 2008, page 40)."

For this project, the issues identified during scoping and carried forward for analysis include those elements of Alternative A that would cause or have the potential to cause significant environmental effects. This chapter provides an analysis of identified issues and the resources affected by those issues. **Table 3-1**, below, provides a summary of issues and affected resources. Resources not significantly affected under Alternative A are summarized in **Table 3-2**.

Table 3-1
Supplemental Authorities and Resource Areas Analyzed by Issue

Issue Number	Issue Statement	Supplemental Authorities and Resources Analyzed
1	How would ambient noise levels change, and what would be the effect on sensitive resources?	Migratory Birds;* Range; Recreation; Wild Horses and Burros; Wildlife (General and Sensitive Species)
2	How would geothermal fluid utilization affect geology, water resources, and use of water rights?	Cultural;* Environmental Justice;* Geology and Soil Resources; Range; Socioeconomics; Water Resources–Surface and Ground;* Wild Horses and Burros; Wildlife (General and Sensitive Species)
3	How would sensitive resources be affected by surface disturbance during construction, operations, and maintenance?	Cultural;* Geology and Soil Resources; Migratory Birds;* Native American Religious Concerns;* Range; Recreation; Socioeconomics; Vegetation and Invasive, Nonnative Species; Visual Resources; Water Resources–Surface and Ground;* Wilderness Study Areas; Wild Horses and Burros; Wildlife (General and Sensitive Species)
4	How would the physical presence and design of the proposed infrastructure influence resources and resource use conditions?	Cultural;* Migratory Birds;* Native American Religious Concerns;* Range; Land Use and Infrastructure; Recreation; Visual Resources; Wilderness Study Areas; Wild Horses and Burros; Wildlife (General and Sensitive Species)

*Indicates supplemental authority (see BLM NEPA Handbook H-1790-1)

Table 3-2
Resource Effects Determination and Rationale for Analysis

Supplemental Authority[a] or Other Resource Area	Issue 1	Issue 2	Issue 3	Issue 4
Air*	***Present/Not Affected***[b] Alternative A, which would result in the construction of new access roads and vehicle use, would have the potential to generate particle pollution (dust), carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. The US Environmental Protection Agency sets National Ambient Air Quality Standards (NAAQS; 40 CFR 50) for these criteria air pollutants. The NDEP BAPC ensures compliance with the NAAQS. To avoid, minimize, and mitigate air quality impacts from the Proposed Action and ensure compliance with the NAAQS, this EA incorporates by reference the best management practices and mitigation measures contained in Appendix D of the Geothermal PEIS (BLM and Forest Service 2008), including those for air quality and climate. These include an air quality monitoring plan (page D-6) and equipment emissions mitigation plan (pages D-10 and D-11). Additional measures for roads and pads (pages D-6 and D-14) and traffic management (page D-14) would minimize fugitive dust emissions. Further, Ormat would continue to maintain its Surface Area Disturbance permit with the NDEP BAPC, which is required for the existing geothermal operations, and continue to implement the required actions to minimize fugitive dust emissions. These measures include compacting construction-disturbed areas, placing gravel on access roads, and watering construction areas. Other strategies could include wind fencing, vehicle-specific speed limits, and the application of dust palliatives. These measures would mitigate or avoid air quality impacts from ground-disturbing activities and equipment operations associated with Alternative A. See analysis for Issue 3 (**Section 3.3.4**) for more information. The proposed binary turbine power plants would use pentane (C_5H_{12}), a flammable but nontoxic hydrocarbon, as the binary fluid, which circulates in a closed loop. During normal operations and maintenance, an average of approximately 12 tons/year of pentane per plant would be released into the atmosphere. Releases would be regulated through a Class II permit issued by NDEP BAPC, to ensure emissions do not result in ambient concentrations of ozone (which can be created from the reaction of ambient concentrations of hydrocarbons and nitrogen oxides) in excess of the applicable ~~Ambient Air Quality Standards~~ NAAQS (Ormat 2020). Thresholds for Class II permits are less than 100 tons per year for any one regulated pollutant. This would mitigate or avoid air quality impacts from equipment operations and maintenance associated with Alternative A.			
Cultural Resources*	***Present/Not Affected*** Changes in ambient noise levels from the project would not affect known cultural sites in the vicinity of the project.	***Present/~~Not~~ May be Affected*** Carried forward in **Section 3.3.3**.~~Geothermal fluid utilization would not affect known cultural sites in the vicinity of the project.~~	***Present/May be Affected***[c] Carried forward in **Section 3.3.4**.	***Present/May be Affected*** Carried forward in **Section 3.3.5**.

Supplemental Authority[a] or Other Resource Area	Issue 1	Issue 2	Issue 3	Issue 4
Environmental Justice*	***Present/Not Affected*** Based on a review of US Census Bureau data (US Census Bureau 2019a) for the project area counties, no minority or low-income populations would be disproportionately affected by noise under Alternative A.	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/Not Affected*** Based on a review of US Census Bureau data (US Census Bureau 2019a) for the project area counties, no minority or low-income populations would be disproportionately affected by the construction, operation, maintenance, or physical presence of the proposed infrastructure associated with Alternative A.	
Fish Habitat*	***Present/Not Affected*** The nearest fish habitat is in the Truckee River, which is approximately 3.8 miles from the southern portion of the proposed gen-tie. Alternative A would have no potential to affect water resources and associated fish habitat in the Truckee River. Pyramid Lake, which contains federally threatened Lahontan cutthroat trout and cui-ui, is approximately 12 miles south of the AOI. The Hydrogeologic Evaluation (BLM 2020b) indicates that the groundwater systems in the San Emidio Desert and Pyramid Lake basin are not interconnected. Geothermal fluid flows northward following fault structures along the eastern boundary of the San Emidio Valley. Accordingly, Alternative A would have no potential to affect water resources and associated fish habitat in Pyramid Lake.			
Forests and Rangelands*	***Not Present*** There are no US Forest Service-managed forests or rangelands in or near the project area. The nearest US Forest Service-managed lands, on the Humboldt-Toiyabe National Forest, are over 30 miles from the project area.			
Floodplains*	***Not Present*** There are no FEMA 100-year flood zones in the project area.			
Geology and Soil Resources	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/Not Affected*** Not applicable to this issue
Land Use and Infrastructure	***Present/Not Affected*** Alternative A would result in the issuance of a ROW for a new transmission line. The BLM would process the request for an SF 299 Permit consistent with agency policies. There would be no changes in land uses or ownership as part of Alternative A.			***Present/May be Affected*** Carried forward in **Section 3.3.5**.
Lands with Wilderness Characteristics	***Present/Not Affected*** Two areas with wilderness characteristics are in the vicinity of the proposed gen-tie in southwestern Pershing County: the North Shawave Mountains, and Bluewing Mountains (BLM 2015). The nearest portions of these areas to the project area are 4.5 miles and 12 miles away, respectively. Given the distance between these areas and the project area, any potential impacts would be small enough to be discountable.			
Migratory Birds*	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**

Supplemental Authority[a] or Other Resource Area	Issue 1	Issue 2	Issue 3	Issue 4
Native American Religious Concerns*	***Present/Not Affected*** Changes in ambient noise levels would be localized. Noise from construction and operation would attenuate rapidly from the noise source, which would result in negligible effects on Native American Religious Concerns.	***Present/Not Affected*** The Hydrogeologic Evaluation (BLM 2020b) indicates that geothermal systems in the San Emidio Desert and Pyramid Lake basin are not interconnected. Geothermal fluid flows northward following fault structures along the eastern boundary of the San Emidio valley. Accordingly, geothermal fluid utilization would not affect Native American Religious Concerns associated with the PLPT, or other Federally-recognized tribe.	***Present/May be Affected*** Carried forward in **Section 3.3.4**.	***Present/May be Affected*** Carried forward in **Section 3.3.5**.
Noise	***Present/May be Affected*** Carried forward in **Section 3.3.1**	***Present/Not Affected*** Not applicable to this issue	***Present/Not Affected*** Not applicable to this issue	***Present/Not Affected*** Not applicable to this issue
Paleontological Resources	***Not Present*** The project area is composed of areas of potential fossil yield classification (PFYC) 1 and 2. PFYCs and recommended management actions for each class are described in the BLM Instruction Memorandum 2016-124. In summary, in these classes, management concerns for paleontological resources are generally nonexistent to low, and further assessment and paleontological mitigation is usually unnecessary.			
Prime or Unique Farmlands	***Present/Not Affected*** Approximately 150 acres of the project area, the Mazuma association, is classified as prime farmland if irrigated and reclaimed of excess salts and sodium (NRCS 2019). No agricultural activities occur in this area. Alternative A could result in conversion to non-farmland, occupied by well pads and access roads, but this would be a small percentage of potential prime farmland in the project area. Further, areas between well pads and access roads could be available for farming, and Alternative A in general would be compatible with agriculture uses and would not reduce opportunities to implement agricultural practices on the remaining prime farmlands.			

Supplemental Authority[a] or Other Resource Area	Issue 1	Issue 2	Issue 3	Issue 4
Range	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/Not Affected*** Dust and isolated soil erosion from surface disturbance would not affect livestock grazing.	***Present/Not Affected*** The placement of infrastructure in the Blue Wing/Seven Troughs, Desert Queen, and Rodeo Creek grazing allotments would displace livestock from those areas. The amount of displacement accounts for approximately 0.0001 percent of the land area in the allotments and would therefore have a negligible effect on grazing opportunities.
Recreation	***Present/Not Affected*** Noise effects would only apply to areas surrounding the AOI. The absence of recreation activity in the San Emidio Desert would result in no effect on recreation.	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Socioeconomics	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/Not Affected*** Not applicable to this issue
Vegetation and Invasive, Nonnative Species	***Present/Not Affected*** Not applicable to this issue	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/Not Affected*** Not applicable to this issue
Visual Resources	***Present/Not Affected*** Not applicable to this issue	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Wastes, Hazardous or Solid*	***Present/Not Affected*** An average of approximately 12 tons of pentane per plant would be released into the atmosphere annually during power plant operation and maintenance; releases are regulated under a permit from the NDEP BAPC (UGS Nevada LLC 2019). The project would not utilize or generate any other hazardous or solid wastes, and no other hazardous wastes or hazardous materials are known to occur in or near the project area.			

Supplemental Authority[a] or Other Resource Area	Issue 1	Issue 2	Issue 3	Issue 4
Water Resources–Surface and Ground*	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.3**.	***Present/May be Affected*** Carried forward in **Section 3.3.4**.	***Present/Not Affected*** Not applicable to this issue
Wetlands – Riparian Zones*	***Not Present*** A project area habitat inventory (BLM 2020a) determined that wetlands and riparian areas are not present.			
Wild and Scenic Rivers*	***Not Present*** The nearest Wild and Scenic River, the Feather River in Lassen and Plumas Counties, California, is over 50 miles from the project area.			
Wilderness*	***Not Present*** The nearest designated Wilderness is the BLM-managed Calico Mountains Wilderness, approximately 40 miles north of the project area.			
Wilderness Study Areas	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/Not Affected*** Not applicable to this issue	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Wild Horses and Burros	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Wildlife (General)	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Wildlife (Sensitive Species)	***Present/May be Affected*** Carried forward in **Section 3.3.2**	***Present/May be Affected*** Carried forward in **Section 3.3.3**	***Present/May be Affected*** Carried forward in **Section 3.3.4**	***Present/May be Affected*** Carried forward in **Section 3.3.5**
Wildlife (Threatened or Endangered Species)*	***Not Present*** No threatened, endangered, candidate, or proposed species or designated critical habitat are present in or near the project area and would therefore not be affected by Alternative A (BLM 2020a). There were concerns raised during scoping regarding the potential connectivity of the San Emidio geothermal reservoir and surface water in Pyramid Lake and that Alternative A could affect Lahontan cutthroat trout and cui-ui in Pyramid Lake. See the analysis for Issue 2 (**Section 3.3.3**) and the Hydrogeologic Evaluation (BLM 2020b), which indicate that the presence or extent of connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unknown ~~geothermal fluid flows northward following fault structures along the eastern boundary of the San Emidio Valley and there is no connectivity between the San Emidio geothermal reservoir and Pyramid Lake~~. Accordingly, Alternative A ~~would have no potential~~ is not anticipated to affect threatened or endangered species in Pyramid Lake or the Truckee River; however, additional monitoring is needed. The purpose of **Appendix G** is to identify potential quantity and quality impacts on the freshwater aquifer in the San Emidio Desert basin, including water resources on the PLPT Reservation, from the Proposed Action. Monitoring results could be used to inform subsequent management decisions related to wildlife.			

[a] See BLM Handbook H-1790-1(BLM 2008), Appendix 1, Supplemental Authorities to be Considered.

[b] Supplemental authorities that are determined to be not present or present/not affected need not be carried forward or discussed further in the document.
[c] Supplemental authorities that are determined to be present/may be affected must be carried forward in the document.
*Indicates Supplemental Authority

3.2 AFFECTED ENVIRONMENT

3.2.1 Water Resources

The project area hydrologic setting is described in detail in the Hydrogeologic Evaluation (BLM 2020b). Brief summaries of descriptions of the project area water budget, surface water and groundwater resources, existing wells, and potentially jurisdictional waters are included below.

Water Budget

The San Emidio Desert and the surrounding mountains experience extreme temperatures and receive little precipitation. As described in the Hydrogeologic Evaluation (BLM 2020b), annual total precipitation (rainfall and snowmelt) averages 8.25 inches and generally occurs throughout the year. Based on data from Gerlach, which is 15 miles away and has similar topographic and climate conditions, the evapotranspiration rate in the San Emidio Desert is estimated to be 4.2 inches per year. In contrast to annual precipitation rates in Gerlach, San Emidio Desert discharge due to evaporation is less than recharge due to precipitation.

The sediments in the center of the valley floor likely receive recharge from the alluvial deposits and from flooding of playa sediments after runoff events. Groundwater is discharged naturally through fine-grained sediments by deep-rooted vegetation and evaporation from bare soil. Groundwater is primarily used for industrial and mining processes and irrigation, which total approximately 7,186 acre-feet per year of discharge in the San Emidio Desert basin. It is also used in lesser amounts (approximately 110 acre-feet per year) for municipal and stock water purposes. These data are based on allocated water rights. It can be inferred that the excess of recharge due to precipitation is counterbalanced by discharge due to groundwater uses and water uptake by vegetation. The perennial yield of the San Emidio Desert basin is 4,600 acre-feet per year.

Surface Water

Surface water in the San Emidio Desert area is principally generated by the combined effect of high-intensity precipitation and melting snows in the mountains (Glancy and Rush 1968). Most of the surface water infiltrates or is removed from the system by evapotranspiration as it moves downstream. During periods of high-intensity rainfall and/or during snowmelt periods, part of the runoff can reach the playas where most is lost by evaporation. Irregularity in the quantity and duration of precipitation results in only small quantities of runoff in the San Emidio Desert. These factors, in addition to the large evapotranspiration losses, preclude the existence of perennial stream reaches (BLM 2020b).

Glancy and Rush (1968) noted three predominant ephemeral stream reaches in the San Emidio Desert area: San Emidio Creek, Rattlesnake Canyon, and Rodeo Creek. A number of springs are also noted on topographic maps in the mountain ranges surrounding the San Emidio Desert. In the Lake Range, named springs include San Emidio Spring and Stag Spring. In the Fox Range, named springs include Sheep Pass Spring, Summit Springs, Jackass Spring, and Bull Basin Spring. These springs, as well as several unnamed springs, occur several hundred feet above the valley floor and are likely derived from local perched water tables. As such, these springs would not be expected to contribute appreciably to runoff or groundwater recharge in the San Emidio Desert.

No springs or seeps are known to occur on or near the valley floor near the proposed project in the San Emidio Desert. There was a warm spring located immediately west of the project area that Empire Farms reportedly used in the 1970s (Garside 2003); however, it is not shown on topographic maps of the area, or described in any geothermal or water resource reports. Sage Hen Springs, located over 20 miles southwest of the AOI in the Nightingale Mountains, and approximately 1 mile west of the gen-tie, is used by wild horses and burros.

~~Three springs are present within 5 miles of the AOI. These include Rodeo Creek, Chimney Spring, and Painted Rock Spring. Surface water may also be briefly present in ephemeral drainages and has the potential to pond on the San Emidio Desert playa and valley floor.~~

~~Sage Hen Springs, located over 20 miles southwest of the AOI in the Nightingale Mountains, and approximately 1 mile west of the gen-tie, is used by wild horses and burros.~~ Pyramid Lake is approximately 11 miles south of the AOI. The lake is one of the two modern remnants of pluvial Lake Lahontan (Morrison 1965). Pyramid Lake Valley is the terminus of the Truckee River, and there is no known surface outflow. The lake level has fluctuated substantially from natural and human-made causes (Trexler and Stewart 2003).

Groundwater

The Basin and Range Province is a range-to-valley flow system. This means aquifer heads are typically highest in the ranges and lowest in the valleys; similarly, there is more recharge in the ranges and more discharge in the valleys (Blackwell 1983). The fresh groundwater resource in the San Emidio Desert generally occurs in an alluvial valley fill aquifer under both confined (artesian) and unconfined (water-table) conditions (Glancy and Rush 1968). Water levels in the alluvial aquifer range from a few feet below to several hundred feet below land surface. Wells having the greatest depths to water are generally nearer the upslope margins of the alluvial fans. Decreasing depth to water generally occurs in the downslope direction toward the valley axes (BLM 2020b).

The principal freshwater resource in the San Emidio Desert resides in an alluvial aquifer along the western margin of the valley and is primarily developed for irrigation and domestic use. The freshwater resource is reported to be separate from the geothermal resource associated with the proposed project (NDWR 1988). The geothermal resource occurs at a greater depth within a narrow, structurally controlled bedrock zone along the eastern edge of the San Emidio Desert, west of the Lake Range (BLM 2020b). As described in the Hydrogeologic Evaluation (BLM 2020b), in the AOI, thermal water flows upward until it encounters impermeable volcanic rock, forcing it to flow laterally along the eastern edge of the San Emidio Desert to the northwest. Thermal waters then encounter Tertiary sands, causing the waters ~~it~~ to flow both westward and upward and mix with cold groundwater. Eventually it encounters an impermeable silica caprock, which forces the thermal waters outward into a shallow outflow zone. Evidence of hydrothermal alteration suggests this outflow zone occurs at a depth between approximately 115 and 328 feet below the ground surface. Within this zone, thermal water flows north toward the Black Rock Desert.

Groundwater movement from valley to valley can occur through alluvium or consolidated rocks. While there is no firm evidence that sizable quantities of groundwater move to, from, or between valleys through consolidated rocks (Van Denburgh 1973), intervalley movement by way of alluvium is known to occur. Glancy and Rush (1968) estimated groundwater underflow (or subsurface flow) only occurs through alluvium from the San Emidio Desert to the Smoke Creek Desert or from the San Emidio Desert to the Black Rock Desert. The total underflow from the San Emidio Desert to the above-named valleys was estimated at less than 300 acre-feet per year. Van Denburgh et al. (1973) likewise identified that no groundwater movement occurs between the San Emidio Desert (Hydrographic Area 22) and Pyramid Lake Valley (Hydrographic Area 81).

Water ~~Wells~~ Rights

There are 13 points of diversion in the San Emidio Desert within 5 miles of the proposed project (NDWR ~~2020~~2021). There are 10 groundwater wells with listed uses, including power, industrial, irrigation, municipal, and stock water, and three springs used for stock watering. Consumptive use in the San Emidio Desert basin is up to 7,~~186~~297 acre-feet per year (NDWR ~~2020a~~2021).

The Nevada State Engineer ruled the geothermal aquifer in the San Emidio Desert is separate and distinct from the freshwater aquifer (NDWR 1988). Consumptive use from the freshwater aquifer associated with the existing water-cooled geothermal power plant includes up to 470.4 acre-feet per year from the Sweetwater Well (Well number 30/22-36a1) on the west side of the valley. Up to 1,303.14 acre-feet per year of additional consumptive use from the geothermal aquifer on the east side of the valley is permitted from existing production wells 76-16 and 75B-16 (BLM 2020b).

The permitted consumptive use of groundwater from the freshwater aquifer in the San Emidio Desert exceeds the current perennial yield. Accordingly, the Nevada Division of Water Resources has listed the San Emidio Desert as a designated basin, meaning it is depleted or in need of additional administration by the State Engineer, or both (NDWP 1999). Relatively steady groundwater level declines of approximately 0.3 feet per year have been occurring in the San Emidio Desert freshwater aquifer since large-scale withdrawals began in the 1960s. The groundwater flow direction and gradient in the alluvial aquifer appear to have remained relatively consistent since that time (BLM 2020b).

The introduction of geothermal power generation to the San Emidio Desert in the late 1980s does not appear to have resulted in an increase in groundwater level declines in the freshwater alluvial aquifer. This is likely because no net increase in consumptive use was required to support geothermal power generation. Irrigation water rights were simply transferred from another point in the basin and put to industrial use by the power plant, and a commensurate area of irrigated farmland was removed from production (Trexler and Stewart 2003; NDWR ~~2020~~2021).

~~There are 10 identified water wells within 5 miles of the AOI, as shown in the Hydrogeologic Evaluation (BLM 2020b). These water wells are currently designated for industry, testing, monitoring, irrigation, municipal, and domestic uses (NDWR 2020).~~

Jurisdictional Water

Surface water may be briefly present in ephemeral drainages originating in the Lake Range and flowing into the AOI. Surface water also has the potential to pond on small playa features in the AOI, on the floor of the San Emidio Desert. Further, according to the USFWS National Wetland Inventory, approximately 115 acres of freshwater emergent wetlands may be present on the floor of the San Emidio Desert, west of the AOI. These areas may be considered jurisdictional Wetlands and Other Waters of the US by the US Army Corps of Engineers (USACE), potentially placing them under USACE jurisdiction under Section 404 of the Clean Water Act~~; however,~~. Ormat is ~~coordination~~ coordinating with the USACE ~~would be necessary~~ to determine the jurisdictional status of this area and would obtain a Section 404 Permit if the project could impact Waters of the US.

3.2.2 Geology and Minerals

The geologic setting is described in detail in the Hydrogeologic Evaluation (BLM 2020b). A summary of the geologic setting in the AOI is included below.

The project is located within the Basin and Range physiographic province of northwestern Nevada. This province is characterized by north- or northwest-trending mountain ranges, which are bounded by faults against adjacent basins.

The San Emidio Desert is bounded by the Fox Range to the west and the northern Lake Range to the east, and occurs within a north-trending, right-step (extension) normal fault system. The San Emidio fault, Empire fault, and Lake Range fault are three major faults that occur in the vicinity of the AOI. These faults are north-northeast striking with subsurface conditions characteristic of hydrothermal alteration. The San Emidio fault and the Emidio fault intersect each other within the AOI, where fracturing and permeability are especially high, making ideal conditions for hydrothermal alteration and flow.

Surface geology in the AOI includes middle to late Miocene volcanic rocks and late Miocene to recent sediments, all overlying Mesozoic metasedimentary rocks. These Tertiary volcanic and sedimentary rocks are overlain with Quaternary alluvium and lacustrine deposits ranging from Pleistocene Lake Lahontan sediments to current deposits. Basement rock is a thick and folded Triassic-Jurassic Nightingale Sequence, consisting of clay-rich and low-grade Mesozoic metasedimentary rocks with felsic (rich in feldspar and silicon) intrusions.

Existing mineral activity and mining claims in the vicinity of the AOI include the Wind Mountain Mine, and 1,084 acres of patented and unpatented mining claims owned by Pyramid Associates, LP (see **Figure A-9**). Approximately 820 acres of surface disturbance associated with mining and ore processing at the Wind Mountain Mine are in the reclamation phase. Approximately 200 acres of the Pyramid Associates, LP unpatented mining claims overlap the SEGU, but they are outside the AOI.

~~Pyramid Associates, L.P. does not have an approved Plan of Operations. The Multiple Minerals and Development Act specifies that mineral development occurs on a first come first served basis and that a mining claim does not reserve exclusive surface use. Furthermore, Pyramid Associates, L.P. is not party to the SEGU and has not attempted to develop fluid mineral resources on their property. The BLM encourages unitization; however, because the Pyramid Associates, L.P. properties are private lands, the BLM cannot require joinder to the unit. Pursuant to the Rule of Capture under the Geothermal Steam Act, claimants not party to a unit can develop their resource, but must do so at the risk of competition with development in the unit.~~

3.2.3 Vegetation

General Vegetation Communities

As described in the biological baseline report (BLM 2020a), there are 10 Southwest Regional Gap Analysis Project (SWReGAP) land cover types in the project area. **Table 3-3** summarizes acres and provides a brief description of each type. A map of land cover types and representative photographs of the land cover types are in the biological baseline report (BLM 2020a).

Table 3-3
Vegetation

SWReGAP Cover Type	Description	Acres[1]
Invasive Annual Grassland	Areas that are dominated by introduced annual grass species, such as cheatgrass (*Bromus tectorum*) and others.	1,893.7
Intermountain Basins Mixed Salt Desert Scrub	Open-canopied shrublands of typically saline basins, alluvial slopes, and plains. Vegetation composed of one or more *Atriplex* species, such as shadscale or fourwing saltbush. Other shrubs present to co-dominate may include Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), and others.	1,393.7
Intermountain Basins Greasewood Flat	Occurs near drainages on stream terraces and flats and around sparsely vegetated playas. Soils are saline, with a shallow water table, and flood intermittently. Open to moderately dense shrublands dominated or co-dominated by black greasewood (*Sarcobatus vermiculatus*), fourwing saltbush (*Atriplex canescens*), or shadscale (*Atriplex confertifolia*).	986.7
Intermountain Basins Big Sagebrush Shrubland	Occurs in broad basins between mountain ranges, plains, and foothills. Soils are typically deep, well drained, and nonsaline. These shrublands are dominated by big sagebrush.	978.7
Invasive Annual and Biennial Forbland	Areas that are dominated by introduced annual and/or biennial forb species, such as saltlover (*Halogeton glomeratus*), kochia (*Kochia scoparia*), Russian thistle (*Salsola* spp.), and others.	481.8
Great Basin Xeric Mixed Sagebrush Shrubland	Occurs on dry sites with typically shallow, rocky, nonsaline soils. Shrublands are dominated by black sagebrush (*Artemisia nova*), low sagebrush (*Artemisia arbuscula*), and may be co-dominated by big sagebrush or yellow rabbitbrush.	97
Intermountain Basins Semidesert Grassland	Occurs in lowland and upland xeric swales, playas, alluvial flats, and plains. Substrates are often well-drained sandy or loamy soils. The dominant perennial bunch grasses in this system are all drought resistant; they include Indian ricegrass (*Achnatherum hymenoides*), three-awn (*Aristida* spp.), blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Hesperostipa comata*), and others.	74.2
Recently Mined or Quarried	Areas where mining or quarries are visible in the imagery and are 5 acres or greater in size.	49.9
Intermountain Basins Playa	Barren and sparsely vegetated playas with generally less than 10 percent plant cover. Salt crusts are common, with small saltgrass (*Distichlis spicata*) beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded.	46.7
Disturbed	Areas that are barren or have relatively low vegetation cover that are associated with some form of generic human alteration or management regime.	32.1
Total	**—**	**6,034.4**

Sources: Ormat GIS 2019; USGS 2005
[1] Acres in the AOI and in the 300-foot-wide gen-tie ROW

Noxious Weeds and Nonnative, Invasive Plant Species

The Nevada noxious weed (NDA 2020) salt cedar (*Tamarix ramosissima*) was mapped in the southern portion of the AOI (BLM 2020a). Several individuals are present near existing well pads and access roads. This is the only Nevada noxious weed known from the project area; however, Russian knapweed (*Acroptilon repens*) and perennial pepperweed (*Lepidium latifolium*) have been documented nearby, along State Route 447 (BLM 2010).

As described in the biological baseline report (BLM 2020a), approximately 1,894 acres of the SWReGAP land cover type Invasive Annual Grassland was mapped in the project area. Most of these are in the southern portion of the AOI and southern portion of the gen-tie alignment, where recent wildfires have converted other land cover types to one dominated by cheatgrass (*Bromus tectorum*) and other invasive annual species. Other nonnative, invasive plants observed in the project area are saltlover (*Halogeton glomeratus*), Russian thistle (*Salsola tragus*), and tall tumblemustard (*Sisymbrium altissimum*).

Special Status Plants

Based on ground-truthed vegetation (BLM 2020a, Section 2.6) and soil map units (BLM 2020a, Section 2.3) in the project area, there are approximately 2,265 acres of potentially suitable habitat for Tonopah milkvetch (*Astragalus pseudoiodanthus*), oryctes (*Oryctes nevadensis*), and Nevada dune beardtongue (*Penstemon arenarius*); however, these species were not observed during special status plant surveys conducted for the project (BLM 2020a).

3.2.4 Wildlife

Eagles and Other Raptors

As detailed in the biological baseline report (BLM 2020a), surveys carried out in 2019 observed occupied nests of golden eagle (*Aquila chrysaetos*) and prairie falcon (*Falco mexicanus*), and active western burrowing owl (*Athene cunicularia hypugaea*) nest complexes. Occupied common raven (*Corvus corax*) nests were also observed, and other raptor species incidentally observed were red-tailed hawk (*Buteo jamaicensis*) and northern harrier (*Circus cyaneus*).

Golden eagle and raptor aerial surveys documented 135 stick nests in the survey area, which included a 4-mile buffer around the AOI, a 2-mile buffer around the northern portion of the gen-tie alignment, and a 10-mile buffer around the southern portion of the gen-tie alignment. Of these, 69 nests were classified as likely belonging to golden eagles. In 2019, golden eagles occupied four of these nests, and there was an unsuccessful nesting attempt made at one nest (Nest 2).

Two small raptor stick nests were observed within 1 mile of the geothermal unit; neither was occupied in 2019. Eighteen stick nests were observed within 1 mile of the gen-tie alignment. One was classified as a large raptor nest and two were classified as belonging to a *Buteo* spp. or common raven. The other 15 were classified as golden eagle, or likely golden eagle, nests. None of these nests were occupied in 2019.

Burrowing owl surveys documented two active burrow complexes in 2019. Young fledged at both complexes. Burrowing owls responded to broadcast calls at two additional call points, but no burrows were found at these locations. Based on the habitat delineation methodology described in the biological baseline report (BLM 2020a), there are approximately 5,509 acres of suitable burrowing owl habitat in the project area.

As detailed in the biological baseline report (BLM 2020a), eagles and other raptors with suitable habitat in the project area, but that were not observed during surveys, are bald eagle (*Haliaeetus leucocephalus*), ferruginous hawk (*Buteo regalis*), northern goshawk (*Accipiter gentilis*), short-eared owl (*Asio flammeus*), Swainson's hawk (*Buteo swainsoni*), and peregrine falcon (*Falco peregrinus*).

Migratory Birds

Based on the habitat delineation methodology described in the biological baseline report (2020a), since migratory birds may use the entire project area, regardless of vegetation community, the entire 6,034-acre project area contains potential habitat for migratory birds.

Migratory bird point-count surveys in the geothermal unit documented six species: black-throated sparrow (*Amphispiza bilineata*), sage sparrow (*Artemisiospiza nevadensis*), horned lark (*Eremophila alpestris*), barn swallow (*Hirundo rustica*), Say's phoebe (*Sayornis saya*), and Brewer's sparrow (*Spizella breweri*). Bird density was low with 0.08 birds ± 0.05 birds per acre (or between 0.03 and 0.13 birds per acre [95 percent confidence interval]).

Other species observed incidentally were common nighthawk (*Chordeiles minor*), common raven (*Corvus corax*), loggerhead shrike (*Lanius ludovicianus*), chipping sparrow (*Spizella passerina*), western meadowlark (*Sturnella neglecta*), western kingbird (*Tyrannus verticalis*), and mourning dove (*Zenaida macroura*). Brewer's sparrow and loggerhead shrike are sensitive species (BLM Instruction Memorandum No. NV-IM-2018-003).

Though the number of migratory birds observed in the project area was relatively low, numerous other species have potential to occur there based on local habitat conditions, such as sagebrush steppe and salt desert scrub, playas, and cliffs and canyons. These species are listed in the Wildlife Clearance Form, which is included as Appendix C of the biological baseline report (BLM 2020a).

Mammals

Kangaroo Mouse Habitat Delineation

Acres of non-habitat and low-, moderate-, and high-potential habitat for dark kangaroo mouse (*Microdipodops megacephalus*) and pale kangaroo mouse (*Microdipodops pallidus*) were delineated as described in detail in the biological baseline report; they are summarized in **Table 3-4**. The habitat delineation was done in a larger area than the 6,034-acre project area; the habitat delineation area included the AOI, gen-tie alignment, and a 0.25-mile buffer around these areas, which is approximately 25,736 acres.

Table 3-4
Kangaroo Mouse Habitat

Common Name ***Scientific Name***	**Non-Habitat**	**Low-Potential Habitat**	**Medium-Potential Habitat**	**High-Potential Habitat**	**Total**
Dark kangaroo mouse *Microdipodops megacephalus*	730 acres	3,444 acres	962 acres	8,403 acres	**13,539 acres**
Pale (*M. pallidus*) and dark kangaroo mouse	1,298 acres	4,406 acres	435 acres	6,059 acres	**18,198 acres**

Source: BLM 2020a

Small Mammal Trapping

Two dark kangaroo mice (genetic identification is pending) were trapped during early summer surveys for kangaroo mice. One individual was trapped in the northern portion of the AOI, and one individual was trapped along the gen-tie alignment. Additional species trapped include Merriam's kangaroo rat (*Dipodomys merriami*), Ord's kangaroo rat (*Dipodomys ordii*), northern grasshopper mouse (*Onychomys leucogaster*), Great Basin pocket mouse (*Perognathus parvus*), and deer mouse (*Peromyscus maniculatus*).

Bats

Bat surveys (such as acoustic or roost emergence surveys) were not carried out given the typically low habitat suitability observed in the project area. Several bat species may forage in vegetation communities in the project area, but foraging and roosting opportunities are limited. This is because the project area lacks surface water features. Similarly, typical roosting habitat, including mature trees, caves, abandoned mine lands, bridges, and disused buildings are not present. Bat species with potential to forage in the project area are big brown bat (*Eptesicus fuscus*), fringed myotis (*Myotis thysanodes*), western small-footed myotis (*Myotis ciliolabrum*), and Yuma myotis (*Myotis yumanensis*) (BLM 2020a). The species listed in the paragraph below may also forage in the project area.

Limited-quality roosting opportunities, primarily in the form of small and discontinuous rock outcrops, are present in some locations along the proposed gen-tie alignment. Higher-quality suitable roosting opportunities, primarily in the form of larger and more extensive cliff and rock outcrop habitat and abandoned mine workings, are present in the ranges outside the project area. The presence of these features reduces the potential that bats would roost in less suitable habitat in the project area, including in rock outcrops along the proposed gen-tie. Nonetheless, bat species with potential to roost there are Brazilian (Mexican) free-tailed bat (*Tadarida brasiliensis*), California myotis (*Myotis californicus*), canyon bat (*Parastrellus Hesperus*), little brown bat (Myotis lucifugus), long-eared myotis (*Myotis evotis*), pallid bat (*Antrozous pallidus*), and spotted bat (*Euderma maculatum*) (BLM 2020a).

Large Mammals

Year-round and winter range habitat, as designated by the NDOW, for both mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) occurs in the project area (BLM 2020a). Further, correspondence with the NDOW in April 2019 indicated that a limited amount of bighorn sheep distribution may be present in the transmission line alignment. Of these species, only pronghorn antelope was observed or detected in the project area.

In January 2020, the NDOW and the PLPT released bighorn sheep in the Lake Range, including at a location approximately 4 miles south of the AOI, and approximately 5 miles south of where the proposed gen-tie alignment crosses the range. In February 2020, the NDOW notified the BLM[2] that several individuals had since moved through the southern portion of the AOI, near the existing geothermal plant facilities, and near the proposed gen-tie alignment. The NDOW did not make recommendations at that time. However, they indicated that future recommendations, such as timing restrictions during sensitive periods, may be made based on movement data, if warranted. The BLM now considers occupied bighorn habitat to be present in the project area.

Insects

There are approximately 740 acres of buckwheat (*Eriogonum* spp.) and oxytheca (*Oxytheca* spp.) populations in the project area (BLM 2020a, Section 3.7). These populations provide larval development habitat for Rice's blue (*Euphilotes pallescens ricei*) and Great Basin small blue (*Philotiella speciosa septentrionalis*) butterflies. Mexican whorled milkweed (*Asclepias fascicularis*) was observed in one location in the project area. This species is a larval host plant for monarch butterfly (*Danaus plexippus plexippus*).

[2] Personal communication between Mark Freese, Nevada Department of Wildlife, and Kathy Torrence, BLM, February 13, 2020, regarding bighorn sheep movements in the Lake Range since release.

Observations of host plants indicate there is suitable habitat for these sensitive insect species; however, direct observations of the insect species were not made.

Reptiles

Based on the habitat delineation methodology described in the biological baseline report, since reptiles may use the entire project area, regardless of vegetation community, the entire 6,034-acre project area contains suitable habitat (BLM 2020a, Section 3.9).

The sensitive species Great Basin collared lizard (*Crotaphytus bicinctores*), long-nosed leopard lizard (*Gambelia wislizenii*), and desert horned lizard (*Phrynosoma platyrhinos*), were incidentally observed in the project area during the course of the other surveys carried out there. Great Basin collared lizards were observed in rocky areas. None were observed in the geothermal unit area, but scattered observations were made along the length of the proposed gen-tie alignment. Long-nosed leopard lizards were observed in areas with sandy soils. Desert horned lizards were observed in the intermountain basins mixed salt desert scrub vegetation type, both in the geothermal unit area and along the proposed gen-tie alignment. The project area is within the mapped range of an additional sensitive reptile species, northern rubber boa (*Charina bottae*). While suitable sagebrush shrubland habitat is present, this species was not directly observed.

Greater Sage-Grouse

As described in the biological baseline report (BLM 2020a), habitat for greater sage-grouse (*Centrocercus urophasianus*) was delineated by both the 2015 Nevada and Northeastern California Approved RMP Amendment (BLM 2015b) and the 2019 Nevada and Northeastern California Greater Sage-Grouse RMP Amendment (BLM 2019a). The 2015 and 2019 BLM habitat data identify greater sage-grouse habitat types as priority habitat management areas (PHMAs), general habitat management areas (GHMAs), and other habitat management areas (OHMAs). This report uses both the 2015 and 2019 BLM geographic information system (GIS) habitat data to identify greater sage-grouse habitat in the project area.

According to the 2015 greater sage-grouse habitat data, there are approximately 513 acres of OHMAs in the project area on BLM-administered lands; another 172 acres are on private lands in the project area (BLM GIS 2015). There are OHMAs in three areas of the proposed transmission line in the Nightingale Mountains and Truckee Range. There are no GHMAs or PHMAs in the project area. The nearest GHMA is approximately 2.7 miles northeast of the proposed transmission line in the Selenite Range, and the nearest PHMA is over 16 miles west of the southern portion of the proposed transmission line in the Pah Rah Range (BLM GIS 2015).

There are no habitat management areas in the project area according to the 2019 greater sage-grouse habitat data. The nearest OHMA and GHMA are approximately 6 miles west of the southern portion of the proposed transmission line in the Pah Rah Range. The nearest PHMA is approximately 17 miles west of the southern portion of the proposed transmission line, also in the Pah Rah Range (BLM GIS 2019; Figure A-15 in BLM 2020a).

Available data from the NDOW (BLM 2020a) indicate there are no known radio-marked greater sage-grouse lek sites or tracking locations in the vicinity of the project area.

The BLM coordinated with the Nevada Sagebrush Ecosystem Technical Team to determine if further project area habitat quantification was warranted, or if Alternative A would indirectly affect greater sage-grouse habitat. The team determined[3] that no further habitat quantification was warranted and that Alternative A would not indirectly affect greater sage-grouse habitat.

Threatened and Endangered Species

As described in the biological baseline report (BLM 2020a), the BLM queried the USFWS IPaC system on April 11, 2019, and again on March 31, 2020. The USFWS IPaC identified one federally listed endangered wildlife species, cui-ui (*Chasmistes cujus*), and two federally listed threatened wildlife species, Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) and western yellow-billed cuckoo (*Coccyzus americanus*). Critical habitat for western yellow-billed cuckoo has been proposed, but none is in the region.

There are no occupied or recovery streams for Lahontan cutthroat trout in the project area. Occupied habitat for Lahontan cutthroat trout and cui-ui, and potentially occupied habitat for western yellow-billed cuckoo, in the lower Truckee River, in the vicinity of Wadsworth, Nevada, is approximately 4 miles from the southern portion of the gen-tie. Occupied habitat for Lahontan cutthroat trout and cui-ui in Pyramid Lake is approximately 12 miles south of the AOI.

3.2.5 Soil Resources

The AOI overlaps 7 soil map units, while the gen-tie ROW overlaps 35 units (BLM 2020a, Section 2.3).

The three most prevalent soil map units underlying proposed infrastructure in the AOI are 542—Mazuma-Ragtown association, 1060—Trocken-Mazuma association, and 1444—Umberland silty clay loam, ponded. The three most prevalent soil map units, based on acres in a 300-foot corridor around the gen-tie alignment are 1330—Sutcliff-Kleinbush-Washoe association, 1331—Sutcliff-Bundorf-Kleinbush association, and 1410—Slipback-Shawave-Nodur association. **Table 3-5** summarizes selected characteristics of these map units, including Natural Resources Conservation Service ratings for soil erosion susceptibility by wind and water.

Table 3-5
Soils

Soil Map Unit	Landscape Position	Surface Texture	Drainage	Wind Erosion Rating[1]	Water Erosion Rating[2]
542—Mazuma-Ragtown association	Lake plains	Silt loam	Well drained	5	0.55
1060—Trocken-Mazuma association	Alluvial fans	Very gravelly sandy loam	Well drained	6	0.10
1330—Sutcliff-Kleinbush-Washoe association	no data	no data	Well drained	8	0.15
1331—Sutcliff-Bundorf-Kleinbush association	Fan remnants	Very stony loam	Well drained	7	0.15

[3] Personal communication between Katie Andrle, Nevada Sagebrush Ecosystem Technical Team, and Peter Gower, EMPSi, February 28, 2020, regarding assessment of Proposed Action effects on greater sage-grouse habitat.

Soil Map Unit	Landscape Position	Surface Texture	Drainage	Wind Erosion Rating[1]	Water Erosion Rating[2]
1410—Slipback-Shawave-Nodur association	Fan remnants	Sandy loam	Well drained	3	0.32
1444—Umberland silty clay loam, ponded	Lake plains	Silty clay loam	Somewhat poorly drained	8	0.37

Sources: Web Soil Survey 2019; Ormat GIS 2019
[1] Wind erosion potential is classified on a scale between 1 and 8, with a rating of 1 for soils that are highly susceptible to wind erosion, and a rating of 8 for soils that are the least susceptible to wind erosion.
[2] K-Factor (Whole Soil) is a water erosion rating that indicates susceptibility of a soil to sheet and rill erosion by water. K values range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to erosion by water.

3.2.6 Cultural Resources

The BLM has determined a direct area of potential effect[4] (APE) for physical effects on cultural resources, and an indirect APE for visual and auditory effects. The direct APE is an approximately 6,061-acre area encompassing the AOI and gen-tie alignment, while the indirect APE is approximately 87,500 acres surrounding the direct APE. Approximately 1,709 acres of the direct APE have been previously surveyed up to current regulatory standards for cultural resources within the last 20 years. A Class III cultural resources inventory of the remaining portion of the direct APE was done in July 2019 (BLM 2019b). A summary of resources is included below.

Taking all known cultural resources into account, 269 archaeological resources and 3 architectural resources are documented across the direct and indirect APEs. From this total, 177 cultural resources are not eligible for listing on the NRHP under any criteria and do not require further consideration. An additional 7 linear cultural resources cross the direct and indirect APEs, but all documented segments with the APEs are not eligible/do not contribute to the larger unevaluated linear resource. One architectural resource is in the direct APE and two architectural resources are in the indirect APE; however, none are eligible for listing on the NRHP and do not require further consideration. The remaining 85 archaeological resources are discussed below.

Cultural resources within the direct APE include eight cultural resources that are NRHP-eligible under criterion D ~~for their information potential~~ and another two cultural resources that are unevaluated to the NRHP.

Cultural resources within the indirect APE include one traditional cultural property that is NRHP-eligible for its association with significant events (unevaluated under other criteria) and one unrecorded potentially historic mining cabin. Visual assessments were conducted to determine potential impacts on both of these resources; the assessments indicated minimal impact. Additional eligible and unevaluated cultural resources within the indirect APE include 42 NRHP-unevaluated prehistoric artifact scatters that are likely ~~in all likelihood would only be~~ eligible for listing under criterion D of ~~on~~ the NRHP for their information potential, 20 cultural resources that are NRHP-eligible under criterion D, ~~solely for their information potential~~ and one NRHP-unevaluated cultural resource adjacent to existing

[4] The area of potential effect is defined as the "geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 CFR 800.16(d)).

infrastructure; if this last resource has the potential to be indirectly affected, it would have already occurred.

Several cultural resources cover portions of both the direct and indirect APEs, including five cultural resources eligible for listing on the NRHP under criterion D ~~for their information potential~~ and two NRHP-unevaluated cultural resources. An additional two cultural resources—segments of the California Trail and the Central Pacific Railroad—are eligible for listing on the NRHP under criteria A and D ~~for their association with significant events and for their information potential~~, and both cross through the direct and indirect APEs. Visual assessments were conducted to determine potential impacts on both of these resources; the assessments indicated minimal impact. Finally, the Lake Range District—a collection of resources related to prehistoric quarrying and processing of opalitic chert[5]—is eligible under criterion D and ~~for its information potential and~~ is spread across both the direct and indirect APEs; through approximately 12 acres of disturbance are proposed within the roughly 2,000-acre district.

3.2.7 Wild Horses and Burros

The entire AOI and an approximately 4-mile portion of the gen-tie alignment are in the Fox and Lake Range Herd Area (HA)/Herd Management Area (HMA), while an approximately 16-mile portion of the gen-tie alignment crosses the Shawave HMA and Nightingale Mountains HA, and an approximately 28-mile portion of the gen-tie alignment crosses the Truckee Range HA (**Figure A-5**, Wild Horses and Burros). HA and HMA characteristics, such as horse and burro population estimates and the appropriate management level, are described in the Winnemucca District Proposed RMP/Final EIS (BLM 2015a, pages 3-80 to 3-83).

3.2.8 Range

The BLM manages rangelands on public lands under 43 CFR 4100 and BLM Handbooks 4100 to 4180. The project area is in portions of the Blue Wing/Seven Troughs, Desert Queen, and Rodeo Creek grazing allotments. The AOI is wholly within the Rodeo Creek allotment. Collectively, these areas comprise 1,508,214 acres and 29,011 active Animal Unit Months (AUMs). The Blue Wing/Seven Troughs allotment is the largest allotment in the BLM Winnemucca District and has the most active AUMs.

The livestock type in the Blue Wing/Seven Troughs allotment is sheep and cattle; the livestock type in the other allotments is cattle. Cattle grazing is allowed year-round in the Blue Wing/Seven Troughs and Rodeo Creek allotments, but seasonally restricted to November 30–April 15 in the Desert Queen allotment (BLM 2015).

Active grazing occurs in the project area, including in the AOI and along the proposed gen-tie. Range improvements consist of watering areas for livestock, such as those located near the AOI access road from State Route 447 (**Figure A-6**, Range Improvements). There is limited fencing; livestock grazing largely takes place on the open range.

3.2.9 Recreation

Recreational activities in the project area mostly occur along the proposed gen-tie alignment, and typically include motorized and nonmotorized activities, such as hunting, nature viewing, dispersed

[5] A yellowish-brown mineral used for stone tools.

camping, hiking, and OHV use. Many game species provide opportunities for both wildlife observation and hunting along and near the proposed gen-tie. There are also opportunities to view wild horses and burros. Recreational activities occur within the Nightingale Special Recreation Management Area (SRMA), which manages for experiences from activities where isolation is present and requires high interaction with the natural world (BLM 2015a).

Approximately 21 miles of the gen-tie are in the Nightingale SRMA and Nightingale Recreation Management Zone 5 (**Figure A-7**, Nightingale Special Recreation Management Area). The BLM manages this area for remote motorized and nonmotorized access for recreational opportunities and experiences in a backcountry and near-primitive setting (BLM 2015a).

There is little recreational activity in the AOI, most likely because of access restrictions and the presence of industrial facilities. Motorized off-highway vehicle use occurs on the access road for the existing 500 kV power line and on roads that intersect the access road. Motorized use in the AOI is for access to the existing geothermal power plant and wells. Paved and unpaved roads north and west of the AOI provide access to Empire Farms. There is limited recreational off-highway vehicle use in and surrounding the AOI.

There are no campgrounds, trails, trailheads, or other developed recreation sites in or within the immediate vicinity of the project area. The nearest developed recreation sites are at Pyramid Lake and along the Truckee River near Wadsworth, which are 12 and 4 miles away from the gen-tie alignment portion of the project area, respectively.

Driving for pleasure is also a notable recreational activity on State Route 447 along with being a primary access route into the Black Rock Desert-High Rock Canyon Emigrant Trails National Conservation Area (NCA). Additionally, the Burning Man Event, which occurs annually in late-August to September in the Black Rock Desert-High Rock Canyon Emigrant Trails NCA, brings large traffic volumes to State Route 447 and surrounding roadways.

3.2.10 Special Designations and Visual Resources

Special Designations

There are two wilderness study areas (WSAs) near the project area (**Figure A-8**, Wilderness Study Areas). The Mount Limbo WSA (NV020-201) is in the Selenite Range, east of State Route 447. The southern border of this WSA is within 1,000 feet of the gen-tie centerline in places. The Fox Range (NV020-014) WSA is west of the AOI in the Fox Range. The southeast corner of this WSA is approximately 1.5 miles from the AOI boundary.

Visual Resources

BLM-administered lands in the AOI and northern portion of the gen-tie alignment are visual resource management (VRM) Class III[6], and VRM Class IV[7] in the southern portion of the gen-tie alignment. The

[6] The objective of VRM Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

visual contrast rating system provides a systematic way to evaluate proposed projects and determine whether projects conform with the approved VRM objectives along with identifying mitigation measures to minimize impacts. A visual contrast inventory was done in the project area using key observation points (KOPs) in accordance with the BLM's VRM system (BLM Manual 8400, Manual H-8410-1, and Manual H-8431).[8] **Appendix E** provides completed visual contrast rating worksheets, a map depicting KOP locations, and photograph logs.

3.2.11 Socioeconomics and Environmental Justice

Environmental Justice

The environmental justice analysis area is defined as Washoe and Lyon Counties, and the PLPT Reservation.

Low-Income Populations

The CEQ guidance on environmental justice (CEQ 1997) defines low-income populations based on the US Census Bureau's annual statistical poverty thresholds. The 2016 poverty level is based on total income of $12,486 for an individual and $24,339 for a family of four (US Census Bureau 2019a). The CEQ guidance does not specify percentage guidelines for defining a population as low income; for this analysis, low income is defined as an area where the number of individuals living below the poverty line exceeds 50 percent of the total population, or if the percentage of the low-income population is meaningfully greater (10 percentage points) than the percentage below poverty in the comparison population.

Neither county has been identified for potential environmental justice consideration; however, the PLPT meets the criteria for families living in poverty, as shown in **Table 3-6**. This is due to higher levels of low-income families than in Nevada, which is used as the reference population.

Table 3-6
Low-Income Populations

Area	Percentage of Individuals in Poverty, 2017	Percentage of Families in Poverty, 2017	Median Household Income
Washoe County	13.3	8.5	$58,595
Lyon County	13.7	8.6	$50,920
PLPT Reservation	22.1	20.4	$31,800
State of Nevada	14.2	10.3	$55,434

Source: US Census Bureau 2019b

Minority Populations

CEQ guidance defines a minority population as one where an individual group or the aggregate population of all minority groups combined exceeds 50 percent of the total population, or if the

[7] The objective of VRM Class IV is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

[8] Internet website: https://www.blm.gov/programs/recreation/recreation-programs/visual-resource-management.

percentage of the population comprising all minority groups is meaningfully greater (10 percentage points) than the minority population percentage in the broader region.

Nevada has a higher aggregate minority population than all analysis area counties, at 49.5 percent, as shown in **Table 3-7**. As a result, no racial or ethnic minority populations have been identified for further environmental justice consideration.

Table 3-7
Minority Population Demographics

Population	Washoe County (Percent)	Lyon County (Percent)	State of Nevada (Percent)
Total population	445,551	52,303	2,887,725
Hispanic or Latino	106,543 (23.9)	8,486 (16.2)	814,305 (28.2)
White	354,735 (79.6)	44,910 (85.9)	1,936,543 (67.1)
Black or African American	10,103 (2.3)	545 (1)	253,013 (8.8)
American Indian or Alaska Native	7,219 (1.6)	1,248 (2.4)	32,426 (1.1)
Asian	23,906 (5.4)	571 (1.1)	232,502 (8.1)
Native Hawaiian and Other Pacific Islander	2,689 (0.6)	109 (0.2)	19,019 (0.7)
Other race	27,714 (6.2)	2,777 (5.3)	279,977 (9.7)
Two or more races	19,185 (4.3)	2,143 (4.1)	134,335 (4.7)
Aggregate minority population	161,563 (36.3)	12,513 (23.9)	1,430,453 (49.5)

Source: US Census Bureau 2019c

Native American Populations

The BLM identified the PLPT as having religious or cultural affiliation within the analysis area. Government-to-government consultation with the PLPT is ongoing, as described in **Section 4.1**, Tribes, Individuals, Organizations, and Agencies Consulted.

Socioeconomics

The socioeconomic analysis area is the project area, which includes portions of Washoe, Pershing, Churchill, and Lyon Counties. Data on employment and income were collected from Washoe and Lyon Counties to best represent the analysis area.

The population centers closest to the project area are Gerlach in Washoe County and Fernley in Lyon County. In 2017, Washoe County had a population of 445,551, while Lyon County had a population of 52,303 (US Census Bureau 2019c). Another nearby population is the PLPT Reservation, with a population of 1,473 (US Census Bureau 2019c).

In 2017, Washoe County had rental vacancy rates of 5.6 percent and median rental rates of $947, while Lyon County had rental vacancy rates of 4.8 percent and median rental rates of $919 (US Census Bureau 2019a).

In 2017, unemployment varied from 4.2 percent in Washoe County to 6.0 percent in Lyon County. For reference, Nevada had an annual unemployment rate of 5.1 percent in 2018 (BLS 2019).

3.2.12 Land Use and Infrastructure

Existing land use authorizations in and surrounding the AOI are the San Emidio geothermal power plant and associated wells and well pads, geothermal pipelines, access roads, electrical substation, and ancillary structures associated with geothermal operations. Empire Farms, a working alfalfa farm with several agricultural fields and residential structures, is approximately 2 miles west of the northern portion of the AOI. Rodeo Creek Road, a Washoe County-maintained public roadway, provides shared access from State Route 447 to Empire Farms, the Wind Mountain Mine, and the AOI. Most segments of Rodeo Creek Road are paved, while others are unpaved gravel.

The gen-tie portion of the project area is within a designated west-wide energy corridor. It crosses or is next to authorized ROWs, including for a 500 kV transmission line, smaller distribution power lines, and State Route 447.

3.2.13 Noise

During operation, geothermal power plants and well pumps generate noise that is audible above ambient sound at certain distances. Ambient sound is the result of combined noise sources in a given area, usually measured in A-weighted decibels (dBA), which most closely relates to the way humans perceive sound. The decibel scale is logarithmic, not linear. In other words, two sound levels 10 dB apart differ in acoustic energy by a factor of 10. When the standard logarithmic decibel is A-weighted, an increase of 10 dBA is generally perceived as a doubling in loudness. For example, a 70-dBA sound is half as loud as an 80-dBA sound, and twice as loud as a 60-dBA sound. Noise from stationary sources lessens at a rate of approximately 6 dB per doubling of distance, depending on such environmental conditions as topography, vegetation, and weather. **Table 3-8** indicates typical noise levels for common indoor and outdoor situations.

Table 3-8
Typical Noise Levels

Common Outdoor Activity	Noise Level (dBA)	Common Indoor Situation
Typical construction site at 50 feet	70–105	—
Jet fly-over at 1,000 feet	100	—
Gas lawn mower at 3 feet	90	—
Geothermal steam turbine and electric generator and cooling fans at 8 feet Operational 1,250-horsepower geothermal production well at 2 feet; Diesel truck at 50 feet traveling 50 miles per hour	80–85	Food blender at 3 feet; garbage disposal at 3 feet
Congested urban area, daytime	70	Vacuum cleaner at 10 feet
Commercial area with heavy traffic	60	Normal speech at 3 feet
Quiet urban daytime	50	Large business office; dishwasher in next room
Quiet urban nighttime	40	Theater, large conference room (background)
Quiet suburban nighttime	30	Library
Quiet rural nighttime	20	Bedroom at night
—	10	Broadcast/recording studio
Lowest threshold of human hearing	0	Lowest threshold of human hearing

Source: Caltrans 2013, US EPA 1971

The typical operational noise levels for binary geothermal power plants and production wells are between 70 and 85 dBA. At approximately 1,000 feet from these features, with no obstructions, typical noise levels are 50 dBA or less, and 40 dBA or less at 1 mile. Observed noise levels at 625 feet from Ormat's Tungsten Mountain binary geothermal power plant are 60 dBA (Ormat 2018). Topography, weather, vegetation, and other environmental conditions would increase the rate of reduction (Ormat 2018, 2019b). Noise from the existing San Emidio power plant, wells, and plant operations result in higher ambient noise levels in the AOI compared with surrounding areas where there is no industrial development. Similarly, corona discharge[9] from the existing 500 kV power line contributes to ambient noise levels within approximately 100 feet of the line.

3.3 Environmental Consequences

3.3.1 Analysis Method and Assumptions

This section describes the potential impacts on resources and resource uses by issue. It assesses impacts from the alternatives in terms of their duration (temporary or permanent) and context (local or regional). A temporary impact is one that occurs only during implementation of the alternative, while a permanent impact could occur for an extended period after implementation of the alternative. Where appropriate, the analysis provides recommended avoidance, minimization, or mitigation measures to avoid, reduce, or otherwise offset impacts on the specified resource. These measures are described below. Any specific assumptions are identified for each issue.

Implementing applicant-committed environmental protection measures (**Section 2.1.3**), additional stipulations required by the BLM (see **Table 3-9**), and best management practices in Appendix D of the Geothermal PEIS (BLM and Forest Service 2008) would avoid, reduce, or mitigate effects. Analysis of the environmental consequences of implementing applicant-committed environmental protection measures and BLM-recommended mitigation and monitoring measures follows the analysis of direct and indirect effects under each issue. The direct and indirect effects are those that may occur after implementing the applicant committed, BLM-recommended mitigation and monitoring measures, and best management practices from the Geothermal PEIS, as applicable.

[9] A buzzing or humming sound from power lines that is the result of electrical discharge into the air surrounding the line.

Table 3-9
BLM-Required Stipulations

Resource	Required Stipulation	Applicable Issue(s)
Cultural	• Proposed work areas would be located away from potentially sensitive sites and would be approved by the BLM Authorized Officer prior to work beginning in these areas. All cultural resources that are eligible or unevaluated for listing on the NRHP would be avoided. When ground-disturbing project activities would occur within 30 meters (98 feet) of an NRHP-eligible or unevaluated cultural resource, an archaeological monitor would be present to ensure that resources are not disturbed. Temporary or permanent fencing around NRHP-eligible or unevaluated cultural resources may be installed to prevent disturbance if determined necessary by the BLM. Employees, contractors, and suppliers would be instructed that all cultural resources are protected, and that if previously undiscovered resources are encountered, they will be left in place and reported to the BLM by the responsible Ormat representative.	**2 and 3**
Range	• To minimize the potential that livestock would ingest geothermal fluids, Ormat would coordinate with the BLM to obtain approval prior to discharging geothermal fluids to the ground surface during short- and long-term well testing activities.	**2**
Special Designations and Visual Resources	• The paint used on the power plant, pipelines, wellheads, pump motors, and motor control buildings would be consistent with BLM visual guidelines to blend with the area and minimize their visibility. The overhead conductors used on the gen-tie power poles would have a matte surface to reduce sunlight reflection and glare.	**4**
Vegetation	General	
	• If a special status plant species is identified during construction, work near the plant(s) would be halted, and a qualified biologist familiar with the biology and species likely to be encountered in the project area would be consulted to determine an appropriate buffer and other protective measures. The appropriate resource agencies would be notified of the discovery within 24 hours. If avoidance is infeasible, consultation with the jurisdictional resource agency would be conducted prior to continuing work in the immediate area of the species. Any federal- or state-listed species discovered on public land would also be reported to the BLM, USFWS, and NDOW.	**3**
	• The operator would identify important, sensitive, or unique habitat and biota in the project vicinity and site and should design the project to avoid (if possible), minimize, or mitigate potential impacts on these resources. The design and siting of the facilities would follow appropriate guidance and requirements from the BLM.	**4**

Resource	Required Stipulation	Applicable Issue(s)
Vegetation *(cont.)*	<u>Portion of Area of Interest not previously surveyed</u>	
	• The BLM analyzes specific environmental protection measures as part of the proposed project NEPA documentation process. To ensure that potential impacts on species of concern from the proposed project are avoided, minimized, or mitigated, as applicable, a potential environmental protection measure would be a requirement that pre-construction surveys be conducted in the additional area before the surface is disturbed. If pre-construction surveys indicate suitable habitat or presence of the same species of concern as documented elsewhere in the biological baseline report and EA, then the same recommended measures to avoid, minimize, or mitigate impacts would be applied.	**3**
	• If pre-construction surveys indicate suitable habitat or presence of a species of concern not already documented elsewhere in the biological baseline report and EA, then additional NEPA documentation would occur. Measures to avoid, minimize, or mitigate impacts would be developed during that additional NEPA process.	**3**
	• Unoccupied disturbed areas would be seeded by the applicant as directed by the BLM using a BLM-approved native seed mixture and application rate. Any variance in the mix would be coordinated first with the BLM.	**3 and 4**
	• Following construction activities, areas of disturbed land no longer required for operations would be reclaimed to promote the reestablishment of native plant and wildlife habitat.	**3 and 4**
	• Prior to any surface-disturbing activities, a special status plant survey is required for the entire disturbance area. Timing of the survey would be dependent on the habitat type and the detectability of the target species. If a special status plant is located, a protective buffer would be delineated in consultation with the BLM Authorized Officer.	**3**
Wildlife	<u>General</u>	
	• To minimize the potential that wildlife would ingest geothermal fluids, Ormat would coordinate with the BLM to obtain approval prior to discharging geothermal fluids to the ground surface during short- and long-term well testing activities. Discharges may be limited seasonally during sensitive time periods for wildlife species.	**3**
	• If a sensitive animal species is identified during construction, work near the sensitive species would be halted, and a qualified biologist familiar with the biology and species likely to be encountered in the project area would be consulted to determine an appropriate buffer and other protective measures. The appropriate resource agencies would be notified of the discovery within 24 hours. If avoidance is not feasible, consultation with the jurisdictional resource agency would be conducted prior to continuing work in the immediate area of the species. Any federal- or state-listed species discovered on public land would also be reported to the BLM, USFWS, and NDOW.	**3**
	• The Ormat would prepare a habitat restoration plan to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan would identify revegetation, soil stabilization, and erosion reduction measures that would be implemented to ensure that all temporary use areas are restored. The plan would require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.	**3**
	• Ormat would implement applicable measures described in the NDOW's *Design Features and Tools to Reduce Wildlife Mortalities Associated with Geothermal Sumps*. Applicable measures would be determined in coordination with the BLM and NDOW.	**4**

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	• Ormat would ensure that employees, contractors, and site visitors avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets would be controlled or excluded to avoid harassment and disturbance of wildlife.	**4**
	• Ponds, tanks, and impoundments (including but not limited to drill pits) containing liquids can present hazards to wildlife. Any liquids contaminated by substances that may be harmful due to toxicity, or fouling of the fur or feathers (detergents, oils), should be excluded from wildlife access by fencing, netting, or covering at all times when not in active use. Liquids at excessive temperatures should likewise be excluded. If exclusion is not feasible, such as a large pond, a hazing program based on radar or visual detection, in conjunction with formal monitoring, should be implemented. Clean water impoundments can also present a trapping hazard if they are steep-sided or lined with smooth material. All pits, ponds, and tanks should have escape ramps functional at any reasonably anticipated water level, down to almost empty. Escape ramps can take various forms depending on the configuration of the impoundment. Earthen pits may be constructed with one side sloped 3:1 or greater; lined ponds can use textured material; straight-sided tanks can be fitted with expanded metal escape ladders (Geothermal PEIS; BLM and Forest Service 2008).	**4**
	<u>General – Portion of Area of Interest not previously surveyed</u> • The BLM analyzes specific environmental protection measures as part of the proposed project NEPA documentation process. To ensure that potential impacts on species of concern from the proposed project are avoided, minimized, or mitigated, as applicable, a potential environmental protection measure would be a requirement that pre-construction surveys be conducted in the additional area before the surface is disturbed. If pre-construction surveys indicate suitable habitat or presence of the same species of concern as documented elsewhere in the biological baseline report and EA, then the same recommended measures to avoid, minimize, or mitigate impacts would be applied.	**3**
	• If pre-construction surveys indicate suitable habitat or presence of a species of concern not already documented elsewhere in the biological baseline report and EA, then additional NEPA documentation would occur. Measures to avoid, minimize, or mitigate impacts would be developed during that additional NEPA process.	**3**
	<u>Bighorn Sheep</u> • If recommended by the NDOW, construction activity in newly-occupied bighorn sheep habitat in the Lake Range and Nightingale Range may be limited during critical life history stages. Measures would be determined in coordination with the BLM and NDOW.	**3**
	<u>Greater Sage-Grouse</u> • Project would be in compliance with Nevada State Executive Order 2018-32, which may include coordination with the Sagebrush Ecosystem Technical Team on the application of a compensatory mitigation program, such as the Nevada Conservation Credit System for mitigating activities that result in habitat loss and degradation of greater sage-grouse habitat in Nevada, where the application of compensatory mitigation would occur on or the credit would be applied to disturbance on BLM-administered lands.	**1, 3, and 4**

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	• Greater sage-grouse required design features (RDFs; BLM 2015b, Appendix C) would be implemented along the 7 miles of proposed gen-tie that crosses areas mapped as OHMA on BLM-administered lands (BLM GIS 2015; see Issue 3 Mitigation). Within OHMAs, the following RDFs would be applied: ○ RDF Gen 1 – Locate new roads outside of greater sage-grouse habitat to the extent practical. ○ RDF Gen 2 – Avoid constructing roads within riparian areas and ephemeral drainages. Construct low water crossings at right angles to ephemeral drainages and stream crossings (note that such construction may require permitting under Sections 401 and 404 of the Clean Water Act). ○ RDF Gen 3 – Limit construction of new roads where roads are already in existence and could be used or upgraded to meet the needs of the project or operation. Design roads to an appropriate standard, no higher than necessary, to accommodate intended purpose and level of use. ○ RDF Gen 4 – Coordinate road construction and use with ROW holders to minimize disturbance to the extent possible. ○ RDF Gen 5 – During project construction and operation, establish and post speed limits in greater sage-grouse habitat to reduce vehicle/wildlife collisions or design roads to be driven at slower speeds. ○ RDF Gen 7 – Require dust abatement practices when authorizing use on roads. ○ RDF Gen 9 – Upon project completion, reclaim roads developed for project access on public lands unless, based on site-specific analysis, the route provides specific benefits for public access and does not contribute to resource conflicts. ○ RDF Gen 11 – Equip temporary and permanent aboveground facilities with structures or devices that discourage nesting and perching of raptors, corvids, and other predators. ○ RDF Gen 12 – Control the spread and effects of nonnative, invasive plant species (e.g., by washing vehicles and equipment, minimize unnecessary surface disturbance; Evangelista et al. 2011). All projects would be required to have a noxious weed management plan in place prior to construction and operations. ○ RDF Gen 13 – Implement project site-cleaning practices to preclude the accumulation of debris, solid waste, putrescible wastes, and other potential anthropogenic subsidies for predators of greater sage-grouse. ○ RDF Gen 15 – When interim reclamation is required, irrigate site to establish seedlings more quickly if the site requires it. ○ RDF Gen 16 – Utilize mulching techniques to expedite reclamation and to protect soils if the site requires it. ○ RDF Gen 17 – Restore disturbed areas at final reclamation to the pre-disturbance landforms and desired plant community. ○ RDF Gen 18 – When authorizing ground-disturbing activities, require the use of vegetation and soil reclamation standards suitable for the site type prior to construction. ○ RDF Gen 19 – Instruct all construction employees to avoid harassment and disturbance of wildlife, especially during the greater sage-grouse breeding (e.g., courtship and nesting) season. In addition, pets shall not be permitted on site during construction (BLM 2005). ○ RDF Gen 20 – To reduce predator perching in greater sage-grouse habitat, limit the construction of vertical facilities and fences to the minimum number and amount needed and install anti-perch devices where applicable.	**1, 3, and 4**

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	○ RDF Gen 22 – Load and unload all equipment on existing roads to minimize disturbance to vegetation and soil. ○ RDF LR-LUA 1 – Where new ROWs associated with valid existing rights are required, collocate new ROWs within existing ROWs or where it best minimizes impacts in greater sage-grouse habitat. Use existing roads or realignments of existing roads to access valid existing rights that are not yet developed. ○ RDF LR-LUA 3 – Where necessary, fit transmission towers with anti-perch devices (Lammers and Collopy 2007) in greater sage-grouse habitat. ○ RDF Lease FM 1 – Collocate power lines, flow lines, and small pipelines under or immediately adjacent to existing roads (Bui et al. 2010) in order to minimize or avoid disturbance. ○ RDF Lease FM 4 – Ensure habitat restoration meets greater sage-grouse habitat objectives for reclamation and restoration practices/sites (Pyke 2011). ○ RDF Lease FM 5 – Maximize the area of interim reclamation on long-term access roads and well pads, including reshaping, topsoil management, and revegetating cut-and-fill slopes. ○ RDF Lease FM 6 – Restore disturbed areas at final reclamation to the pre-disturbance landforms and ensure it meets the greater sage-grouse habitat objectives. ○ RDF Lease FM 11 – Cluster disturbances associated with operations and facilities as closely as possible, unless site-specific conditions indicate that disturbances to greater sage-grouse habitat would be reduced if operations and facilities locations would best fit a unique special arrangement. ○ RDF Lease-FM 12 – Apply a phased approach with concurrent reclamation. ○ RDF Lease-FM 15 – Consider using oak (or other material) mats for drilling activities to reduce vegetation disturbance and for roads between closely spaced wells to reduce soil compaction and maintain soil structure to increase likelihood of vegetation reestablishment following drilling.	
	<u>Dark Kangaroo Mouse and Pale Kangaroo Mouse</u> Monitoring and mitigation of impacts on dark kangaroo mouse and pale kangaroo mouse are described in the draft Kangaroo Mouse Monitoring ~~and Mitigation~~ Plan (**Appendix F**).The following options outline potential actions considered by the BLM and NDOW to minimize impacts on DKM/PKM habitat caused by the development of the proposed project: • Avoidance of dark and pale kangaroo mice and identified habitat • When possible, project features should be located outside of DKM/PKM habitat. However, based on the location of the geothermal resource and siting needs for the project, complete avoidance of suitable dark and pale kangaroo mouse habitat is not possible. Thus this mitigation cannot be fully employed. • Minimize impacts on dark and pale kangaroo mice and identified habitat ○ If the project/activity cannot be placed outside DKM/PKM habitat, locate the surface-disturbing activities in non-habitat areas first, then in the least suitable habitat for DKM/PKM. For example, staging areas should avoid the most suitable habitat and should be created in non-habitat first. ○ Collocate the project/activity next to or in the footprint of existing infrastructure to minimize the amount of habitat disturbance. ○ Whenever possible, minimize the amount of habitat disturbance in high and medium potential habitat. For example, power pole placement should be designed to span high and medium potential habitat whenever possible.	**3 and 4**

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	○ However, based on the location of the geothermal resource and siting needs for the project, it is unknown at this time if this mitigation is feasible and it is unknown if this mitigation would be effective to minimize impacts on DKM/PKM habitat. • Restore suitable replacement habitat within project area ○ Selection of the proposed project would result in the temporary removal of approximately 857 acres of mouse habitat and the permanent removal of 176 acres of mouse habitat. ○ Following construction activities, the 857 acres of temporarily disturbed mouse habitat no longer required for operations would be restored to promote the reestablishment of native plant and DKM/PKM habitat. As DKM/PKM are burrowing/fossorial species, they are dependent on specific soil conditions (Ghiselin 1970, Hafner and Upton 2011). It is unknown if the temporary disturbance from project actions would cause changes in the soil to not be inhabitable by DKM/PKM (e.g., soil compaction). In the event portions or all of the 857 acres of temporarily disturbed mouse habitat soil characteristics have been altered and are no longer inhabitable for DKM/PKM, the portions of uninhabitable habitat would be replaced by restoring mouse habitat within the project area at a 1 to 1 ratio. ○ The 176 acres of mouse habitat permanently removed by project activities would be replaced by restoring mouse habitat within the project area at a 2 to 1 ratio. Therefore, a total of 352 acres of habitat would need to be restored within the project area to replace the permanently lost mouse habitat. The 2 to 1 ratio is following the same approach identified in the Crescent Dunes Solar Energy Project, which required a 2 to 1 ratio for permanent PKM habitat loss. ○ Prior to implementation, suitable on-site areas would need to be identified, preferably in areas where medium quality habitat is adjacent to high quality habitat. Soil information for construction areas would also need to be monitored before and after construction activities to determine if the soil characteristics are uninhabitable. Habitat restoration would include revegetating habitat using a BLM WDO-approved seed mixture and focusing on key soil characteristics. In the event that heavy seeding equipment could crush DKM/PKM and their habitat, restoration activities would need to include hand seeding and/or hand planting seedlings. ○ It is recommended that rehabilitated areas be fenced to eliminate grazing by livestock, which would require coordination with the permittee and further NEPA analysis. The success and effectiveness of this option is unknown due to the uncertainty of future multiple-use actions within the project area. Dark and Pale Kangaroo Mouse Habitat Research • Currently, information regarding the DKM/PKM local and geographic distribution, habitat use, population demography (e.g., abundance estimates, mortality), population genetics (e.g., cryptic speciation and distinct lineages), and dietary needs is limited. Through pre-construction trapping efforts, a rough distribution of kangaroo mice occupancy is known throughout the proposed disturbance sites. • For this loss of known habitat, Ormat would ~~develop and~~ implement the ~~a~~ BLM-approved monitoring plan in **Appendix F** to enable informed management and land use decisions for the long-term management and conservation of the DKM/PKM.	

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	• ~~At a minimum,~~ Ormat's final monitoring plan ~~would~~ contains the following parameters: 1) compile and summarize existing PKM and DKM information to develop project goals and methodologies for habitat mapping, surveying, and sampling; and 2) use the above information to conduct surveys to determine habitat needs, distribution, and relative abundance of the PKM/DKM. Data would be collected and analyzed to develop spatially precise PKM/DKM distribution and abundance information, set guidelines for and establish long-term population monitoring, possibly clarify population genetics, and refine trapping protocols to enhance efficacy. This monitoring would run for 2 to 5 years. The synthesis of this data collection process would contribute to the BLM and NDOW's evaluation of DKM/PKM status, help understand the effectiveness of habitat restoration efforts, and address a projected risk of further protection for this vulnerable species (Light et al. 2013). • To comply with the BLM's Compensatory Mitigation IM-2019-018, the monitoring ~~under this mitigation~~ would need to be conducted within the power plant and transmission line project area.	
	<u>Migratory Birds</u> • In order to avoid potential impacts on breeding migratory birds, a nest survey would be conducted by a qualified biologist within potential breeding habitat prior to any surface disturbance proposed during the avian breeding season (March 1st through August 31st). Surveys would be conducted no more than 10 days and no less than 3 days prior to initiation of surface disturbance. Surveys would follow established BLM standards and protocols and would be approved by the BLM biologist prior to being implemented. If active nests are located, the BLM biologist would be notified immediately and appropriate protection measures, which may include avoidance or restriction of activities, would be established. If no active nests are present in the area survey, implementation of the surface disturbance would commence within 10 days of survey completion.	**3**
	<u>Raptors (including golden eagles)</u> • As described in **Appendix D**, the proposed gen-tie would provide raptor protection in compliance with the standards described in the Suggested Practices for Raptor Protection on Powerlines, The State of the Art in 2006 (APLIC 2006).	**4**
	• All power poles would be constructed to be eagle safe and/or utilize raptor anti-electrocution and devices or equipment.	**4**
	• Bald and/or golden eagles may now or hereafter be found to use the project area. The BLM would not issue a notice to proceed for any project that is likely to result in take of bald eagles and/or golden eagles until the applicant completes its obligation and demonstrates compliance with the Bald and Golden Eagle Protection Act, including coordination with the USFWS on agreed-upon measures to avoid take, or to obtain an eagle take permit should take be unavoidable. The BLM hereby notifies the applicant that compliance with the Eagle Act is a dynamic and adaptable process that may require the applicant to conduct further analysis and mitigation following assessment of operational impacts. Any additional analysis or mitigation required to comply with the Eagle Act would be developed with the USFWS and coordinated with the BLM (WO-IM-2010-056).	**3 and 4**

Resource	Required Stipulation	Applicable Issue(s)
Wildlife *(cont.)*	Western Burrowing Owl (BUOW)	
	• During western burrowing owl nesting season (March 1 through August 31), a clearance survey following the BLM Winnemucca District Office's clearance survey protocol would be conducted by a qualified biologist prior to surface disturbance in the areas identified as potential BUOW habitat within the project area and survey results and report submitted to the BLM. For active burrows, an avoidance buffer, no less than 75 meters (250 feet), would be established and the buffer area avoided to prevent destruction or disturbance to nests/burrows until they are no longer active. The site characteristics used to determine the size of the buffer are: a) topographic screening; b) distance from disturbance to nest/burrow; c) the size and quality of foraging habitat surrounding the nest/burrow; d) sensitivity of the species to nest disturbances; and e) the protection status of the species. Additional monitoring would be conducted to ensure the nesting BUOW have fledged the nest prior to disturbance. If no active nests are present within the area surveyed, implementation of the proposed disturbance would commence within 10 days of survey completion.	**1 and 3**
	• To avoid impacts on burrowing owls, there would be no construction near known burrow complexes. As above, construction near burrows would be done outside the breeding season, unless it must occur during this period; in this case, breeding season pre-construction surveys, following the BLM method, would be conducted, and active burrows would be avoided by using an appropriate buffer during the breeding season.	**1 and 3**
	• An adaptive approach to BUOW and habitat would be required for the portion of the AOI not previously surveyed for BUOW during baseline data collection. o Phase 1: Prior to any surface-disturbing activities, a BUOW baseline survey is required for the entire portion of the AOI not previously surveyed. The BUOW survey would follow the BLM Winnemucca District Office's BUOW baseline survey protocol, which requires BUOW surveys for three survey windows in the same breeding season. BUOW survey point locations would need to be coordinated through BLM prior to surveys being conducted by a qualified biologist. o Phase 2: Any BUOW and associated complexes identified during the Phase 1 surveys would be protected following the same measures previously identified for the entire project area. Monitoring would be required to determine if the BUOW return to the associated burrows after project construction and temporary disturbance. o Phase 3: Additional protection measures may be implemented in the event multiple BUOW burrows identified in the portion of the AOI not previously surveyed would be permanently removed due to project activities and/or monitoring results indicate that BUOW have not returned to previously occupied habitat. Additional protection measures may include coordinating with the BLM and NDOW to create Artificial Burrow Systems (ABS) to replace lost burrows. Techniques and methods for creating the ABS would be done in coordination with the BLM and the NDOW based on existing literature. Pre-clearance surveys would be completed prior to the installation of ABS. Monitoring for the effectiveness of the created ABS would include identification of BUOW within the project area during the time of year they are present (spring/summer) and capturing and tagging BUOW by installing telemetry devices to track their movements to determine if they are using the ABS for nesting. Monitoring would be coordinated with the BLM and NDOW prior to any field identification of BUOW. If Phase 3 is implemented, monitoring would be required for 5 years.	**1 and 3**

Resource	Required Stipulation	Applicable Issue(s)
Water	• **Appendix G** describes the BLM's goals and objectives for groundwater monitoring. ~~The shallow g~~Groundwater ~~aquifer~~ would be monitored to allow early detection of potential changes. Within 1 year of the signing of the Decision Record, Ormat would prepare a final hydrologic monitoring ~~program~~ plan outlining monitoring locations, parameters, frequency, and duration, for BLM Authorized Officer approval prior to drilling activities. The BLM would have final approval of the monitoring plan. ~~The draft monitoring plan is **Appendix G**~~ • If water quality or quantity effects in groundwater aquifers were detected, appropriate measures to mitigate effects, as determined by Ormat in coordination with the BLM Authorized Officer, would be implemented. • ~~Within one year of the signing of the Decision Record, the proponent will develop in coordination with the BLM, a final hydrologic monitoring plan. The draft monitoring plan is **Appendix G**. for the water sources listed in Table 5 of the Hydrogeology Baseline Report. The BLM will have final approval of the monitoring plan.~~ • Ormat must follow USACE requirements, including the acquisition of a Clean Water Act Section 404 permit, if deemed applicable by the USACE.	**2**
Wild Horses and Burros	• To minimize the potential that livestock and wild horses would ingest geothermal fluids, Ormat would coordinate with the BLM to obtain approval prior to discharging geothermal fluids to the ground surface during short- and long-term well testing activities. Discharges may be limited seasonally during sensitive time periods for wild horses and burros.	**2**

3.3.2 Issue 1: How would ambient noise levels change, and what would be the effect on sensitive resources?

Analysis Area and Assumptions

The primary noise generators would be construction, including drilling wells and building the plants and associated infrastructure, including the gen-tie. Noise generators associated with project operation would be the production well pumps and the cooling fans, generators, and steam turbines at the two power plants. The assumption is that, at a typical noise attenuation rate, the noise levels at 1,500 feet from the plants and wells would be at or below 50 dBA and that at 1 mile the noise level would be at or below 40 dBA. Accordingly, the analysis area for direct effects is the project area, including the AOI and gen-tie alignment, plus a 1-mile buffer around this area.

Direct effects would occur at the project area during construction and operation and maintenance. Indirect effects could occur farther away from the project area; effect intensity would depend on the distance from the project area and on receptor sensitivity.

Effects from Alternative A: Proposed Action

Wildlife

Construction-related noise may temporarily displace wildlife from suitable habitat in and around the construction area. This may reduce breeding or nesting success, especially if species are displaced during sensitive life-cycle periods. Noise may also affect foraging opportunities. For example, raptors may avoid foraging in or near the project area during construction. Generally, these effects would last only as long as construction.

Construction would not occur within 1 mile of golden eagle nests during the golden eagle breeding season (generally late January through August), per USFWS-recommended conservation measures (see **Appendix D**). Thus, construction noise would be unlikely to disrupt golden eagle nesting, reduce nest productivity, or cause nest abandonment.

Construction would not occur near active burrowing owl burrows or migratory bird nests during the burrowing owl and migratory bird breeding season (March 15 through August 30). Thus, construction would be unlikely to cause nest failure or abandonment.

Residual operational noise generated by geothermal power plants despite noise-reducing operational design may affect wildlife differently than construction-related noises. This is because power plant-generated noises are consistent and at lower decibel, as opposed to the inconsistent, sudden, higher decibel noises from typical construction activities. This type of noise may inhibit a species' ability to hear sounds and communicate with others (Barber et al. 2009). This would cause long-term habitat loss in an area greater than the actual plant footprints.

The existing San Emidio power plant, approximately 0.5 mile north of the proposed plants, already generates operational noise in the area (see **Section 3.2.13**). Operational noise under Alternative A would be the same type and level as the noise from the existing operational power plant. Noise from Alternative A, especially north of the proposed power plants, would be largely imperceptible from noise associated with the existing plant. There would be higher ambient noise levels south of the proposed plants where ambient noise levels are currently lower because of the further distance from the San Emidio facility. Additionally, Alternative A would comply with the BLM regulation that mandates noise at 0.5 mile—or at the lease boundary if closer—from a major geothermal operation should not exceed 65 dBA (43 CFR 3200.4[b]). Accordingly, Alternative A would not result in any additional effects on wildlife from operational noise beyond those already occurring or as allowed by law.

Both construction and residual operational noise could displace big game species from habitat in or near the project area. Construction-related displacement would be a temporary effect, while displacement due to residual operational noise would be a long-term effect. However, it is expected that even if animals avoid the plant location, increasingly lower operational noise further from the plant and wells that approach ambient conditions for a rural setting would not affect movement in and use of the surrounding contiguous habitat.

Bats may be affected by operational noise, because they echolocate and receive sound waves in a wide range of frequencies. Residual operational noise may disrupt bat foraging behavior by acoustic masking, attentional distraction, and avoidance response (Barber et al. 2009). This effect would be long term, but it is not expected to affect bats at high quality foraging or roosting habitat, because there is no such habitat at or near the proposed power plant locations.

<u>Proposed Mitigation</u>

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on wildlife from noise. Specifically, noise-reducing measures, including muffles on drilling rig engines, and operational practices and design would minimize noise level generation and distinctive noise impacts.

Effects from construction noise on breeding golden eagles would be avoided by implementing measures described in the project's USFWS-approved eagle conservation plan~~. The plan would be approved by the USFWS before construction begins on the proposed gen-tie. The draft plan is included~~ (see **Appendix D** ~~of this EA~~).

Implementing BLM-required stipulations would avoid construction noise impacts on breeding migratory birds and burrowing owls because construction would be done outside the breeding season. If construction must occur during this period, pre-construction surveys, following the BLM method, would be conducted (see **Table 3-9**). Active nests near the construction area would be avoided by using an appropriate buffer, as determined in coordination with the BLM. For migratory birds, buffers would remain in effect until young have fledged or the nest has failed, subject to BLM approval. Combined with noise-reducing plant design and operation, timing construction outside the breeding season (see **Table 3-9**) would avoid noise impacts on wildlife during the most sensitive life cycle stage.

If recommended by the NDOW, limiting construction activity in newly-occupied bighorn sheep habitat in the Lake Range and Nightingale Range during critical life history stages, as determined in coordination with the BLM and NDOW, would avoid noise-related impacts from construction activities (**Table 3-9**).

Wild Horses and Burros

Noise from gen-tie construction, particularly stringing lines using helicopters, could temporarily harass, disturb, or displace animals in HAs and HMAs. While construction of the gen-tie is anticipated to take up to approximately 9 months, stringing would be a relatively small portion of the overall time needed to construct the gen-tie. Should this effect occur, it would be reduced in intensity because it would happen outside of critical breeding and birthing periods. In the Nightingale Mountains HA, the proposed gen-tie is approximately 1 mile east of Sage Hen Springs, which is an important water source for animals. Given this, effects may be most likely to occur at this location.

Animals in the Fox and Lake Range HA/HMA may also avoid the area around the proposed geothermal plants due to operational noise. As described under *Wildlife*, animals may already avoid this general location due to operational noise from the nearby existing geothermal plant.

<u>Proposed Mitigation</u>

Implementing construction best management practices and mitigation measures contained in Appendix D of the Geothermal PEIS (BLM and Forest Service 2008) would reduce the potential for impacts on wild horses and burros under Alternative A. Specifically, ensuring that construction and operation activities do not harass animals (page D-16), especially during critical reproductive seasons such as breeding and birthing, would minimize potential impacts on wild horses and burros.

Recreation

Construction noise may temporarily impact the recreation setting, in turn affecting experiences of isolation and remoteness, and reducing the potential for positive recreation outcomes. The greatest potential for this effect would be in the Nightingale SRMA. These impacts would be temporary, lasting the duration of construction in the SRMA, which is expected to be on the order of several days to a few weeks.

There would be no impacts on recreation in or near the AOI from construction or operational noise. This is because the existing San Emidio power plant, approximately 0.5 mile north of the proposed plants, already generates operational noise in the area (see **Section 3.2.13**). Anticipated noise from Alternative A, especially north of the proposed power plants, would be largely imperceptible from noise associated with the existing plant. There would be higher ambient noise levels south of the proposed plants where ambient noise levels are currently lower because of the further distance from the San Emidio facility. However, the lack of existing recreation opportunities in this area would reduce the potential for adverse effects. Alternative A would comply with the BLM regulation that mandates that noise at 0.5 mile—or at the lease boundary if closer—from a major geothermal operation should not exceed 65 dBA (43 CFR 3200.4[b]).

Proposed Mitigation

There would be no specific mitigation measures for recreation. However, implementing measures to avoid, reduce, or mitigate noise-related impacts on other resources would directly and indirectly reduce the potential for noise from Alternative A to affect the recreation setting or experiences.

Range

Noise from gen-tie stringing may temporarily disturb animals in grazing allotments along the proposed alignment. Effects would be temporary and similar to those described for *Wild Horses and Burros*.

Proposed Mitigation

There would be no specific mitigation measures for range. However, implementing measures to avoid, reduce, or mitigate noise-related impacts on other resources would directly and indirectly reduce the potential for noise from Alternative A to disrupt or displace grazing livestock.

Effects from Alternative B: No Action Alternative

There would be no construction-related noise because there would be no construction; thus, the effects on wildlife, range, wild horses and burros, and recreation as described for Alternative A would not occur. Animals may continue to avoid the existing geothermal plant area due to operational noise, as described above. Noise from maintenance on existing infrastructure, previously authorized exploration drilling (BLM 2010), and existing plant operation could affect wildlife, range, wild horses and burros, and recreationists in or near the project area. The effects would generally be as described for Alternative A, above.

3.3.3 Issue 2: How would geothermal fluid utilization affect geology, water resources, and use of water rights?

Analysis Area and Assumptions

The analysis area for most resources analyzed under this issue is the San Emidio Desert cataloging unit (BLM 2020b). The analysis areas for socioeconomics and environmental justice are defined in **Section 3.2.11**.

Effects from Alternative A: Proposed Action

Water Resources

<u>Surface Water</u>

Effects on surface water quality in the San Emidio Desert basin are unlikely because there are no perennial streams or other surface waters in the project area. Further, soil erosion protection measures would be implemented, as described under *Issue 3*, below; examples are using BMPs for cut and fill activities and access roads and implementing a stormwater pollution prevention plan. ~~As such, there would be no effects on surface water quality.~~

Evidence (Glancy and Rush 1968) suggests that groundwater underflow (or subsurface flow) only occurs through alluvium from the San Emidio Desert to the Smoke Creek Desert or from the San Emidio Desert to the Black Rock Desert. There is no conclusive evidence supporting the interconnectivity of groundwater resources in the San Emidio Desert with Pyramid Lake (Van Denburgh et al. 1973; BLM 2020b). As such, ~~there would be~~ no effects on the surface water quality at Pyramid Lake from Alternative A are anticipated. The results of groundwater monitoring conducted in accordance with the BLM's draft groundwater monitoring goals and objectives (**Appendix G**) and required stipulations (**Table 3-9**) would inform future management relative to the Proposed Action.

<u>Groundwater</u>

Impacts on groundwater quality from geothermal reservoir waters mixing with the shallow groundwater aquifer would not occur, outside of the amount of mixing that occurs naturally, as described in **Section 3.2.1**.

The air-cooled, binary geothermal plants are not anticipated to consume geothermal water resources, and geothermal fluids used in production would be reinjected into the geothermal reservoir. This would minimize the potential that geothermal reservoir pressures could fall as a result of geothermal utilization. This would in turn minimize the potential that utilization would alter water quantity by reducing water levels of groundwater aquifers that may have a hydrologic connection to the geothermal reservoir, such as in the outflow zone north and northwest of the geothermal unit (BLM 2020b).

If geothermal fluids are used during construction, they would not be reinjected into the reservoir. As described in **Section 2.1.1.7**, Water Use, construction would use up to approximately 50,000 gallons of water per day for two months and 5,000 gallons per day for six months thereafter for dust control, and some or all of this requirement may be geothermal fluid. Though the precise volume of the geothermal reservoir is not known, the amount required for construction likely represents a small fraction of its overall volume. Thus surface water alterations are not anticipated to occur as a result of geothermal fluid use for construction purposes.

During short- and long-term well testing (see **Section 2.1.1.3**, Well Field), geothermal fluids would be discharged to the reserve pits, containers, or to the ground surface. This could affect the volume of groundwater aquifers that may have a hydrologic connection to the geothermal reservoir. The precise volume of the geothermal reservoir is not known; however, the volume of fluid withdrawn during the relatively short-duration well tests would be up to approximately 1.5 million gallons per short-term test and up to 15 million gallons per long-term test. This is expected to be minor, compared with the volume of fluid available in the geothermal resource. Removing geothermal fluid during testing would not be expected to affect groundwater resources.

~~As described in **Section 3.2.1** and the Hydrogeologic Evaluation (BLM 2020b), geothermal fluids naturally mix with the shallow groundwater aquifer along the San Emidio fault in the vicinity of the project area. Thus, additional mixing of geothermal fluids and the shallow groundwater aquifer is not expected to significantly alter shallow groundwater quality. Additional mixing of geothermal fluids in the reserve pits and the shallow groundwater aquifer is not expected to occur, because bentonite drilling muds discharged into the reserve pits would tend to act as a liner, in the same way they prevent the loss of drilling fluids in the well bore into the surrounding rock.~~

Geothermal water injection is not anticipated to have impacts on surface or shallow groundwater quality because of the NDEP's Bureau of Water Pollution Control underground injection control permit, which is required for the project's injection program. The permit would require that the injection program be designed and monitored to prevent degradation of underground drinking water sources from geothermal fluid injection. The results of groundwater monitoring conducted in accordance with the BLM's draft groundwater monitoring goals and objectives (**Appendix G**) and required stipulations (**Table 3-9**) would further inform future management to avoid impacts from the Proposed Action.

Environmental protection measures to protect surface and groundwater would be implemented. As such, surface or groundwater contamination from spills of production products, such as diesel fuel or lubricants would be unlikely to occur.

~~Because the state engineer designated the San Emidio Desert groundwater basin (Basin 22) as over-appropriated, groundwater consumption may affect groundwater quantity; this could affect~~ Changes in water levels at groundwater wells in the basin~~; however, this is~~ are not anticipated ~~to occur,~~ because pumping, reinjection, and other operational management of the geothermal resource within the geothermal aquifer do not appear to affect water levels in the freshwater aquifer (BLM 2020b). Water required for construction would be obtained from geothermal fluid, from an established private source trucked to each construction or drill site, or from shallow water wells drilled from one or more of the proposed drill sites. If shallow water wells were used, the wells would be permitted under a geothermal waiver by the NDWR and approved by the BLM. Anticipated water consumption for construction would be 11.7 acre-feet over 6 months of construction, while water consumption during operation would be 0.37 acre-feet per year~~. The overall aquifer perennial yield is 4,600 acre-feet per year~~.

As described in the Hydrogeologic Evaluation (2020b), the presence or extent of connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unknown. Proposed geothermal utilization, including reinjecting cooled geothermal fluids, is not anticipated to affect adjacent geothermal resources or the possibility of developing these resources in the future. Similarly, there is no known direct connection between the geothermal resource in the San Emidio Desert and groundwater resources in adjacent hydrographic basins, such as the Pyramid Lake Valley groundwater basin (Basin 81); thus, Alternative A is not anticipated to have effects on groundwater or geothermal resources in adjacent hydrographic basins.

Developing and implementing a groundwater monitoring and reporting program, in accordance with the BLM's draft groundwater monitoring goals and objectives (see **Appendix G**) and required stipulations (**Table 3-9**), would reduce the potential that vested and other water rights, including those available for geothermal development, in the vicinity could be indirectly affected. ~~The monitoring and reporting program would also minimize the potential of permittees being unable to fulfill the intended beneficial use of their water rights, such as for watering stock or irrigating crops.~~ This is because appropriate corrective measures, as determined by Ormat in coordination with the BLM Authorized Officer and other affected stakeholders, would be applied if determined to be necessary as a result of monitoring results. Corrective measures could include modifying or temporarily suspending project operations until discharge rates return to appropriate levels.

~~As described in the Hydrogeologic Evaluation (2020b), connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unlikely. Proposed geothermal utilization, including reinjecting cooled geothermal fluids, is not anticipated to affect adjacent geothermal resources or the possibility of developing these resources in the future. Similarly, there is no direct connection between the geothermal resource in the San Emidio Desert and groundwater and surface water resources in adjacent hydrographic basins such as the Pyramid Lake Valley groundwater basin (Basin 81); thus, Alternative A is not anticipated to have effects on groundwater or surface water quality or quantity in adjacent hydrographic basins or on Pyramid Lake.~~

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on water resources from geothermal fluid utilization. Specifically, geothermal fluids would not be discharged to the ground under normal operating conditions, and maintenance measures would minimize the potential for accidental discharges. Should accidental discharges occur, measures in a spill prevention, control, and countermeasure plan (**Appendix B**) would be implemented. Ormat would also follow stormwater BMPs, and minimize cut and fill activities, to minimize the potential for erosion from stormwater runoff.

Implementing BLM-required stipulations (**Table 3-9**) would further minimize the potential for effects on groundwater resources. The shallow groundwater aquifer would be monitored to allow early detection of potential changes. **Appendix G** outlines the BLM's draft goals and objectives for ~~Ormat's proposed would prepare a~~ hydrologic ~~program outlining~~ monitoring ~~locations, parameters, frequency, and duration~~. Ormat's final hydrologic monitoring plan is subject to BLM Authorized Officer approval prior to drilling activities. If water quality or quantity effects in groundwater aquifers were detected, appropriate measures to mitigate effects, as determined by Ormat in coordination with the BLM Authorized Officer, would be implemented.

Geology and Minerals

Under certain circumstances, increased pore pressures resulting from fluid injection for waste disposal, secondary recovery, geothermal energy, or solution mining can trigger earthquakes (Nicholson and Wesson 1990); thus, injecting cooled geothermal fluids could induce earthquakes. This potential varies depending on several factors, such as the injection site's proximity to a fault or fracture and the hydrologic properties of the receiving reservoir. For example, for a given volume of fluid, higher values of transmissivity and storability allow for lower injection pressures so as to attain a desired injection rate and, consequently, a lower potential for triggering earthquakes (Nicholson and Wesson 1990).

As discussed in the Department of Energy's Protocol for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems (EGS; Majer et al. 2012) and the Best Practices for Addressing Induced Seismicity Associated with Enhanced Geothermal Systems (Majer et al. 2016), earthquakes induced in EGS fields generally range from magnitude 2 (insignificant) to about 3.5 (locally perceptible to humans). Because Alternative A does not include EGS, the potential for induced seismicity may be reduced, but it is not negligible. This is because fluid injection is a component of both EGS and conventional geothermal energy development.

Direct impacts on surface geology would be limited to the pads, sumps, and containment basins, due to the construction of these features and well drilling. These impacts would last until the beginning of any required reclamation.

Alternative A could affect the ability of mining claimants overlapping the SEGU to develop their resource. However, in accordance with the Multiple Minerals and Development Act, undeveloped claims outside a plan of operations do not reserve a specific right to surface use. Locatable minerals could still be developed under the Multiple Minerals and Development Act, but could be limited by approved development in the AOI. Similarly, pursuant to the Geothermal Steam Act, non-unitized geothermal development is not party to the agreements or royalties of a geothermal unit. Any geothermal development outside the unit would be subject to the potential adverse effects of competing for the same geothermal reservoir.

Proposed Mitigation

There would be no specific mitigation measures for geology and minerals.

Wildlife

As described in the analysis for *Water Resources*, above, monitoring the shallow groundwater aquifer would allow early detection of potential changes; if effects were detected, appropriate measures, as determined by Ormat in coordination with the BLM Authorized Officer, would be implemented. Thus, Alternative A is not anticipated to affect water availability for wildlife at area springs or wells in the long term.

Limiting discharges of geothermal fluids to the ground surface during sensitive time periods for wildlife species would minimize the potential that wildlife would ingest geothermal fluids. For example, big game species may be more likely to be present at the San Emidio Desert Valley floor in winter, meaning they would be more likely to use geothermal fluids as a water source if present during this time.

There is no conclusive evidence to suggest that groundwater systems in the San Emidio Desert are ~~not inter~~connected to those in the Pyramid Lake Valley groundwater basin (Basin 81). This apparent lack of interconnection (BLM 2020b) indicates that proposed geothermal utilization would not affect groundwater quantity or quality in the Pyramid Lake basin or associated habitat conditions for Lahontan cutthroat trout or cui-ui in Pyramid Lake. There would be no effect on these species or their habitat.

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on wildlife from exposure to geothermal fluid utilization. Specifically, geothermal fluids would not be discharged to the ground under normal operating conditions, and maintenance measures would minimize the potential for accidental discharges. Should accidental discharges occur, measures in a spill prevention, control, and countermeasure plan (**Appendix B**) would be implemented. Ormat would also follow stormwater BMPs, and minimize cut and fill activities, to minimize the potential for habitat loss and degradation from erosion.

Implementing BLM-required stipulations (**Table 3-9**) would further minimize the potential for effects on wildlife resources. The shallow groundwater aquifer would be monitored to allow early detection of potential changes (see **Appendix G**); this would minimize~~, minimizing~~ the potential that there would be changes in water quality or quantity at wells or springs used by wildlife. If water quality or quantity effects were detected, appropriate measures to mitigate effects, as determined by Ormat in coordination with the BLM Authorized Officer, would be implemented.

To minimize the potential that wildlife would ingest geothermal fluids, Ormat would coordinate with the BLM to obtain approval prior to discharging geothermal fluids to the ground surface during short- and long-term well testing activities. Discharges may be limited during sensitive time periods for wildlife species.

Cultural Resources

There is the potential for Alternative A to alter or diminish the quality and quantity of groundwater resources, which would indirectly affect cultural resources associated with springs and wells on the PLPT Reservation. Monitoring the shallow groundwater aquifer (see **Appendix G**) would allow early detection of potential changes; if effects were detected, appropriate measures, as determined by Ormat in coordination with the BLM Authorized Officer and the PLPT, would be implemented. Thus, Alternative A is not anticipated to affect cultural resources associated with area springs or wells in the long term.

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on water resources from geothermal fluid utilization. Implementing BLM-required stipulations (**Table 3-9**) would further minimize the potential for effects on cultural resources associated with springs and wells on the PLPT Reservation. Specifically, Ormat would prepare a final hydrologic monitoring plan in accordance with the BLM's draft groundwater monitoring goals and objectives (see ~~draft plan in~~ **Appendix G**); this plan would describe ~~describing~~ how the shallow groundwater aquifer would be monitored to allow early detection of potential changes. The final plan would outline the monitoring locations, parameters, frequency, and duration, for BLM Authorized Officer approval prior to drilling activities. If changes are detected, appropriate measures to mitigate the effects on groundwater and the associated cultural resources, as determined by Ormat in coordination with the BLM Authorized Officer and the PLPT, would be implemented.

Wild Horses and Burros

Effects on wild horses and burros from changes in water availability at springs or other water sources in the San Emidio Desert would be the same as described in the analysis for *Wildlife*, above. There would be no changes in water availability at Sage Hen Springs in the Nightingale Mountains HA/HMA.

Proposed Mitigation

There would be no specific mitigation measures for wild horses and burros. However, implementing measures to avoid, reduce, or mitigate geothermal fluid utilization-related impacts on other resources would directly and indirectly reduce the potential for geothermal fluid utilization from Alternative A to affect water availability for wild horses and burros at wells or springs.

Range

The effects on livestock water availability would be the same as those described in the analysis for *Wildlife*, above; the effects on water rights holders would be the same as those described in the analysis for *Water Resources*, above.

Proposed Mitigation

There would be no specific mitigation measures for range. However, implementing measures to avoid, reduce, or mitigate geothermal fluid utilization-related impacts on other resources would directly and indirectly reduce the potential for geothermal fluid utilization from Alternative A to affect water availability for livestock at wells or springs.

Socioeconomics and Environmental Justice

The currently producing geothermal reservoir at the SEGU and the geothermal reservoirs south of the unit on the PLPT Reservation do not interconnect (BLM 2020b). This indicates that proposed geothermal utilization would not affect the PLPT's ability to develop the geothermal resource on the reservation in the future.

As described in the analyses for *Water Resources*, above, the effects on permittees' ability to use their water rights as intended, such as for irrigation, are not anticipated. Further, monitoring, as described above, would identify any effects, and appropriate corrective measures, as determined by the BLM Authorized Officer, would be applied.

Construction would provide a short-term increase in employment for approximately 9 months. Temporary employment would be unlikely to have a significant impact on local economic conditions. Construction would likely result in short-term induced economic effects, which are changes to the local economy from purchasing materials to supply the project. Workers may increase demand for temporary housing in community centers in the region, but this effect would last only for the duration of the approximately 9-month construction period.

Proposed Mitigation

There would be no specific mitigation measures for socioeconomics or environmental justice. However, implementing measures to avoid, reduce, or mitigate geothermal fluid utilization-related impacts on other resources would directly and indirectly reduce the potential for geothermal fluid utilization from Alternative A to affect the ability of the PLPT to develop the geothermal resource on the reservation in the future, or on permittees' ability to use their water rights as intended.

Effects from Alternative B: No Action Alternative

There would be no increase in the potential for effects on surface water, groundwater, geothermal fluids, or use of water rights, compared with current conditions. There would be no changes in water availability for wildlife, livestock, or wild horses and burros at springs or wells in the analysis area. There would be no changes in habitat conditions for Lahontan cutthroat trout or cui-ui in Pyramid Lake.

There would be no increase in the potential for induced seismicity because increased injection, relative to current conditions, would not occur. The potential would continue for induced seismicity from geothermal fluid injection associated with the existing geothermal production in the project area.

There would be no changes in the ability of the PLPT to develop the geothermal resource on their reservation. There would be no change in the quantity or quality of available groundwater at groundwater wells in the San Emidio Desert; thus, there would be no environmental justice concerns.

There would be no changes to the socioeconomic conditions in the region, including from short-term economic contributions from construction employment or temporary demand for housing.

3.3.4 Issue 3: How would sensitive resources be affected by surface disturbance during construction, operations, and maintenance?

Analysis Area and Assumptions

The analysis area for direct effects is the project area; the analysis area for indirect effects is the project area, plus a 650-foot buffer around this area. The buffer is defined as the distance that fugitive dust or surface water runoff and erosion could travel from surface disturbance. This distance is based on typical Nevada BLM geothermal lease stipulations for surface disturbance buffers.

Effects from Alternative A: Proposed Action

Water Resources

Because stormwater BMPs would be implemented consistent with NDEP Bureau of Water Pollution Control requirements, increased water-driven soil erosion and sedimentation into ephemeral drainages from surface disturbance during construction or operations is not anticipated to occur.

<u>Proposed Mitigation</u>

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on water resources from surface disturbance. Specifically, stormwater BMPs would be followed, such as minimizing cut and fill activities and dissipating stormwater runoff to reduce erosion.

Vegetation

Construction in the AOI, including the proposed power plants, well pads, new and improved roads, pipelines, and aggregate pit, would temporarily remove approximately 189.9 acres of vegetation, as summarized in **Table 2-1**. Of this, approximately 60.4 acres would be reclaimed following the methodology in **Section 2.1.4**; the rest, approximately 129.5 acres, would not be reclaimed. Acres of proposed temporary and permanent vegetation removal in the AOI are summarized in **Table 3-10**.

Table 3-10
Vegetation Removal

SWReGAP Cover Type	Total Acres	Temporary Removal (AOI)	Permanent Removal (AOI)	Temporary Removal (Gen-Tie)	Permanent Removal (Gen-Tie)
Invasive Annual Grassland	1,893.7	1.4 (<1%)	0.9 (<1%)	201.2 (11%)	21.1 (1%)
Intermountain Basins Mixed Salt Desert Scrub	1,393.7	54.0 (4%)	34.1 (2%)	161.1 (12%)	11.7 (1%)
Intermountain Basins Greasewood Flat	986.7	98.4 (10%)	68.5 (7%)	8.7 (1%)	0.1 (<1%)
Intermountain Basins Big Sagebrush Shrubland	978.7	17.7 (2%)	10.9 (1%)	216.8 (22%)	6.9 (1%)

SWReGAP Cover Type	Total Acres	Temporary Removal (AOI)	Permanent Removal (AOI)	Temporary Removal (Gen-Tie)	Permanent Removal (Gen-Tie)
Invasive Annual and Biennial Forbland	481.8	0.0 (0%)	0.0 (0%)	11.8 (2%)	0.1 (<1%)
Great Basin Xeric Mixed Sagebrush Shrubland	97.0	0.0 (0%)	0.0 (0%)	30.2 (31%)	4.7 (5%)
Intermountain Basins Semidesert Grassland	74.2	7.8 (10%)	5.7 (8%)	8.7 (12%)	0.1 (<1%)
Recently Mined or Quarried	49.9	0.0 (0%)	0.0 (0%)	0.0 (0%)	0 (0%)
Intermountain Basins Playa	46.7	2.4 (5%)	1.6 (3%)	0.0 (0%)	0 (0%)
Disturbed	32.1	8.2 (26%)	7.8 (24%)	1.8 (6%)	0 (0%)
Total	**6,034.5**	**189.9 (3%)**	**129.5 (2%)**	**640.3 (11%)**	**44.6 (1%)**

Source: Ormat GIS 2019

Construction of the proposed gen-tie would temporarily remove approximately 640 acres of vegetation. Vegetation removal would be for temporary work areas at each structure site and at several stringing sites and angle points. After construction, these areas would be reclaimed, with the exception of an approximately 20-foot by 30-foot maintenance pad at each structure site. Additional permanent vegetation removal would be for new access spur roads. Permanent vegetation removal, therefore, would total approximately 45 acres. This information is summarized in **Table 3-10**.

Periodic vegetation removal within approximately 4 feet of gen-tie poles would occur as conditions warrant, as part of wildfire risk management. This would be done as needed within the permanent maintenance pad area, described above. Shrubby vegetation would be removed by trimming or other manual methods, while annual vegetation would receive herbicide application consistent with the BLM's 2007 Vegetation Treatments Final PEIS. Treatments would take place concurrent with regular ROW maintenance, or more frequently as warranted by vegetation conditions and potential wildfire risk.

There would be no additional vegetation removal associated with temporary material storage yards for gen-tie construction materials. This is because these areas would be on existing well pads or the power plant site at the gen-tie northern end.

Direct effects on special status plants would not occur. This is because surveys did not document special status plants in the project area, and because pre-construction surveys would be conducted, and any observed populations would be avoided during construction.

Indirect effects on special status plants would include habitat loss for Tonopah milkvetch, oryctes, and Nevada dune beardtongue. Temporary disturbance from construction in the AOI would occur on approximately 77 acres of suitable habitat for these species, rendering habitat unsuitable. Though most areas of temporary disturbance in special status plant habitat in the AOI would be reclaimed following construction, habitat suitability would likely take decades or more to return, if at all, effectively making this effect permanent.

Similarly, indirect effects on special status plant habitat would occur from proposed gen-tie construction. Temporary disturbance in special status plant habitat in the gen-tie ROW would occur on approximately 107 acres. As above, while all but approximately 3 acres would be reclaimed, since habitat suitability may not be restored in reclaimed areas, this effect would be considered permanent.

Implementing noxious weed measures would minimize, but not prevent, the potential that ground disturbance would result in noxious weed and nonnative, invasive plant establishment and spread.

Implementing fugitive dust control measures would minimize, but not prevent, the potential that vegetation would be indirectly affected by fugitive dust generated during ground disturbance. Fugitive dust can settle on nearby vegetation, reducing its productivity.

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**), including minimizing cross-country travel, using existing roads whenever possible, maintaining access roads consistent with road development BMPs, and minimizing cut and fill activities, would reduce the potential for Alternative A to remove vegetation during construction and operation. Reclaiming temporarily disturbed areas, using BLM-approved revegetation methods, and stockpiling topsoil would retain intact soil conditions that supports revegetation success following temporary disturbance.

Developing and implementing an invasive plant management plan and requiring all contractors to power wash their vehicles and equipment, including the body and undercarriage, before bringing them onto BLM-administered lands would prevent the spread of invasive, nonnative species. Ensuring all gravel and fill material is certified as weed free would further prevent the spread of invasive, nonnative species.

Implementing BLM-required stipulations (**Table 3-9**) would minimize the potential for effects on special status plant species. Ormat would conduct pre-construction surveys in proposed disturbance areas to supplement those conducted for the biological baseline report (see Section 3.1.2 of BLM 2020a). If pre-construction surveys indicate the presence of the same species of concern as documented in the biological baseline report, then the same measures to avoid, minimize, or mitigate impacts would be applied. If pre-construction surveys indicate the presence of a species of concern not already documented in the report, then additional NEPA documentation would occur. Measures to avoid, minimize, or mitigate impacts would be developed during that NEPA process.

As described in **Table 3-9**, if a special status plant species is identified during construction, work near the species would be halted, and a qualified biologist would be consulted to determine an appropriate buffer and other protective measures. The appropriate resource agencies would be notified of the discovery within 24 hours. If avoidance is infeasible, consultation with the jurisdictional resource agency would be conducted prior to continuing work in the immediate area of the species.

Wildlife

Alternative A would temporarily and permanently remove habitats for special status species other than dark and pale kangaroo mice, as summarized in **Table 3-11**. Temporary and permanent habitat removal for kangaroo mice is summarized in **Table 3-12**.

The duration of the temporary effects described above would vary, depending on the habitat type affected. For example, burrowing owls and some generalist migratory birds, such as common ravens, horned larks, and meadowlarks, can inhabit relatively disturbed habitats lacking intact, native vegetation; thus, these species may be able to reoccupy temporarily disturbed and restored areas relatively quickly.

Table 3-11
Wildlife Habitat Removal

Habitat Type	Total Acres[1]	Temporary Removal (AOI)	Permanent Removal (AOI)	Temporary Removal (Gen-Tie)	Permanent Removal (Gen-Tie)
Burrowing owl	5,509	189.9 (3%)	129.5 (2%)	505 (9%)	26 (<1%)
Migratory birds	6,034	189.9 (3%)	129.5 (2%)	640 (11%)	45 (1%)
Insects	740	20.7 (3%)	11.5 (2%)	101 (14%)	3 (<1%)
Reptiles	6,034	189.9 (3%)	129.5 (2%)	640 (11%)	45 (1%)
Greater sage-grouse OHMAs (2019 RMP Amendment)	0	0.0 (0%)	0.0 (0%)	0.0 (0%)	0.0 (0%)
Greater sage-grouse OHMAs (2015 RMP Amendment)	685	0.0 (0%)	0.0 (0%)	113 (16%)	2 (<1%)

Source: Ormat GIS 2019; BLM 2020a

Table 3-12
Kangaroo Mouse Habitat Removal

Habitat Type	Total Acres[1]	Temporary Removal (AOI)	Permanent Removal (AOI)	Temporary Removal (Gen-Tie)	Permanent Removal (Gen-Tie)
Dark kangaroo mouse high potential	8,403	176.8 (2%)	118.6 (1%)	154 (2%)	12 (<1%)
Dark kangaroo mouse medium potential	962	0.0 (0%)	0.0 (0%)	35 (4%)	5 (<1%)
Dark kangaroo mouse low potential	3,444	13.1 (<1%)	11.0 (<1%)	25 (1%)	0 (0%)
Dark kangaroo mouse non-habitat	730	0.0 (0%)	0.0 (0%)	15 (2%)	0 (0%)
Pale and dark kangaroo mouse high potential	6,059	0.0 (0%)	0.0 (0%)	217 (4%)	6 (<1%)
Pale and dark kangaroo mouse medium potential	435	0.0 (0%)	0.0 (0%)	13 (3%)	1 (<1%)
Pale and dark kangaroo mouse low potential	4,406	0.0 (0%)	0.0 (0%)	170 (4%)	20 (<1%)
Pale and dark kangaroo mouse non-habitat	1,298	0.0 (0%)	0.0 (0%)	41 (3%)	2 (<1%)

Source: Ormat GIS 2019; BLM 2020a
[1] As described in **Section 3.2.4**, the kangaroo mouse habitat delineation was done in a larger area than the 6,034-acre project area; the habitat delineation area included the AOI, gen-tie alignment, and a 0.25-mile buffer around these areas, which is approximately 25,736 acres.

In contrast, some migratory bird species that may be less tolerant of fragmented or disturbed habitats, such as Brewer's sparrow, black-throated sparrow, and sage sparrow, may not reoccupy temporarily disturbed habitats for longer periods. Similarly, kangaroo mice typically require relatively undisturbed habitats with intact native vegetation. Temporarily disturbed suitable habitat, even if restored, can take a relatively long time to regain suitability. Even if habitat suitability is restored, this does not always allow for species recolonization after habitat has been impacted.

There is an active burrowing owl burrow approximately 400 feet from a proposed temporary pole site work site along the southern portion of the gen-tie alignment, and another active burrow within approximately 800 feet of new road construction proposed in the AOI. Both of these burrows are within 150 to 200 feet of existing access roads, transmission lines, or well pads.

As discussed in *Vegetation*, above, adhering to noxious weed and fugitive dust measures would minimize, but not prevent, indirect effects on wildlife habitat from weed establishment and spread and fugitive dust deposition.

Proposed Mitigation

Implementing BLM-required stipulations (**Table 3-9**) would minimize the potential for effects on wildlife. Ormat would conduct pre-construction surveys in proposed disturbance areas to supplement those conducted for the biological baseline report (see Section 3.1.2 of BLM 2020a). If pre-construction surveys indicate the presence of the same species of concern as documented in the biological baseline report, then the same measures to avoid, minimize, or mitigate impacts would be applied. If pre-construction surveys indicate the presence of a species of concern not already documented in the report, then additional NEPA documentation would occur. Measures to avoid, minimize, or mitigate impacts would be developed during that NEPA process.

An adaptive approach incorporating burrowing owl surveys, monitoring, and protective measures as necessary, would be done in areas not already surveyed for this species during preparation of the baseline biological report (**Table 3-9**; BLM 2020a).

Temporarily disturbed areas would be reclaimed as soon as is feasible according to a required habitat restoration plan (**Table 3-9**). The plan would identify revegetation, soil stabilization, and erosion reduction measures that would be implemented to ensure that all temporary use areas are restored. The plan would require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.

Ormat would avoid, minimize, and restore impacts in kangaroo mouse habitats according to the BLM-required stipulations in **Table 3-9**. Developing and implementing a BLM-approved monitoring plan to enable informed management and land use decisions would contribute to improvements in long-term management and conservation of kangaroo mice in the region.

As described in **Table 3-9**, if a special status wildlife species is identified during construction, work near the species would be halted, and a qualified biologist would be consulted to determine an appropriate buffer and other protective measures. The appropriate resource agencies would be notified of the discovery within 24 hours. If avoidance is infeasible, consultation with the jurisdictional resource agency would be conducted prior to continuing work in the immediate area of the species.

Recreation

As discussed in *Vegetation*, above, adhering to fugitive dust measures would minimize, but not prevent, the potential for short-term modifications to the backcountry setting in portions of the project area from fugitive dust generation. The greatest potential for this effect would be in the Nightingale SRMA, during grading for gen-tie laydown areas and pole placement sites. This is because fugitive dust would be visible from the SRMA and other areas of dispersed recreation. These impacts would be temporary, lasting the duration of construction in this area, which would be in the order of several days to a few weeks. There would be no impacts on recreation near the AOI because of a lack of existing recreation opportunities and a negligible change in the setting, compared with current conditions.

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for effects on recreation from dust generation. Specifically, fugitive dust control measures would include compacting construction-disturbed areas, placing gravel on access roads, and watering construction areas.

Soil Resources

The approximate acres of temporary and permanent soil disturbance correspond with the amount of temporary and permanent vegetation removal. This information is discussed under *Vegetation*, above (see **Table 3-10**).

Where surface disturbance is proposed, implementing environmental protection measures as described for the resources above would minimize, but not prevent, the potential for soil erosion by wind or water. Residual effects may include increasing erosion rates from site grading or by reducing soil productivity and the potential for successful restoration. This would come about by exposing soil surfaces, which would increase the potential for wind- and water-driven erosion. There could also be effects from compacting the soil to a level that prevents or slows successful restoration and eventual reestablishment of vegetation.

The region has the potential for high winds and infrequent strong rains, which could increase erosion rates and soil loss. The use of vehicles and equipment on disturbed areas could further increase the potential for wind- and water-driven erosion and contribute to soil compaction, thus reducing restoration potential.

Soil ratings of the most prevalent soil map units in the project area suggest that the susceptibility of these soils to wind erosion is generally low; an exception is the 1410-Slipback-Shawave-Nodur association, which is relatively susceptible. This unit occurs along the gen-tie alignment. Values for susceptibility to sheet and rill erosion by water varies, depending on the unit, but it ranges from relatively high to low susceptibility.

Although measures would reduce the potential for wind- and water-driven erosion and soil compaction and would help maintain soil restoration potential, localized topsoil loss due to wind- and water-driven erosion and soil compaction is still expected to occur.

Proposed Mitigation

Following applicant-committed environmental protection measures (see **Section 2.1.3**), including BLM stormwater BMPs, would minimize the potential for Alternative A to erode soils. Specifically, cut and fill activities would be minimized when selecting the power plant sites and pipeline routes and off-site stormwater would be intercepted in ditches and channeled to energy dissipaters around the power plants. Restricting cross-country travel, using existing roads whenever possible, maintaining access roads consistent with road development BMPs, and implementing a stormwater pollution prevention plan, as required by the NDEP Bureau of Water Pollution Control (see **Table 3-9**), would further reduce the potential for soil erosion. Reclaiming temporarily disturbed areas, using BLM-approved revegetation methods, and stockpiling topsoil to enhance revegetation access would retain intact soil conditions that support revegetation success.

Cultural Resources

Because all NRHP-eligible and unevaluated sites in the APE would be avoided during construction and maintenance, and an archaeological monitor would be present during ground-disturbing activity within 30 meters (98 feet) of NRHP-eligible and unevaluated sites to ensure sites are not disturbed, direct effects from ground disturbance or periodic vegetation removal on eligible or unevaluated sites are not expected to occur.

Indirect effects on the California Trail are expected, because the proposed gen-tie crosses it near the Eagle Substation. Temporary impacts would occur from visual intrusion of construction activity and restricted access during the gen-tie construction, but they would be minimal and limited to the period of construction, which is expected to last from several weeks to a month. The integrity of setting, feeling, and association of the California Trail would not be significantly impacted in the long term.

No significant indirect effects on other cultural resources are expected to occur.

<u>Proposed Mitigation</u>

Following applicant-committed environmental protection measures (see **Section 2.1.3**) would minimize the potential for direct adverse effects on NRHP-eligible and unevaluated resources because these resources would be avoided. As outlined in the BLM-required stipulations (**Table 3-9**), when ground-disturbing project activities are proposed within 30 meters (98 feet) of an NRHP-eligible or unevaluated cultural resource, an archaeological monitor would be present to ensure that sites are avoided and not disturbed during construction and maintenance. Temporary or permanent fencing around NRHP-eligible or unevaluated cultural resources may be installed to prevent disturbance, and personnel would be instructed that all cultural resources are protected.

Special Designations and Visual Resources

<u>Special Designations</u>

Construction activity may generate dust that would be temporarily visible from the Fox Range and Mount Limbo WSAs. Visible dust would diminish the naturalness character of the WSA. These impacts would last only for the duration of construction.

<u>Visual Resources</u>

Surface-disturbing activities would also result in temporary and permanent changes to the existing landscape as visible from KOPs (see **Appendix E**). Linear and vertical forms and lines within the land and vegetation would be added to the landscape from vegetation clearing. Changes in land and vegetation would occur from new line edges and interrupted continuity along with changes in form shapes. The activity from construction would increase the amount of motion present, drawing attention to viewers at KOPs. However, visual changes would have a weak contrast to the landscape character. The activity would be seen but would not dominate the ~~attention~~ view of the casual viewer.

Proposed Mitigation – Special Designations and Visual Resources

Controlling fugitive dust through construction BMPs and adhering to speed limits on construction access roads would minimize the amount of dust generated by construction traffic, vegetation removal, or surface disturbance during construction, including in the geothermal unit AOI and the gen-tie. Additionally, complying with air quality requirements prescribed by the Nevada Department of Environmental Protection, Bureau of Air Pollution Control, which would require Alternative A to avoid compacting construction-disturbed areas, placing gravel on access roads, and watering construction areas, would avoid fugitive dust generation. These measures would minimize the potential for fugitive dust to diminish naturalness character and change the viewshed as visible from identified KOPs (**Appendix E**). Reclaiming temporarily disturbed areas following construction would reduce Alternative A's visual contrast and avoid long-term direct and indirect impacts on visual resources from unnatural forms and lines.

Effects from Alternative B: No Action Alternative

Surface disturbance from construction would not occur. As a result, the potential for water-driven erosion and sedimentation would not increase. Similarly, there would be no effects from construction on wildlife habitats, NRHP-eligible or unevaluated properties, or vegetation, including special status plant species.

Operation and maintenance associated with current geothermal production infrastructure, as well as previously authorized vegetation removal for exploration well pads (BLM 2010), may remove limited amounts of vegetation, cause localized soil losses, contribute to weed establishment and spread, and degrade wildlife habitats in the project area. If undiscovered cultural resources were revealed during previously authorized disturbance (BLM 2010), direct or indirect effects may result, though measures are in place to reduce these effects.

There would be no dust generated by the proposed construction because Alternative A would not be constructed. Dust generated by passenger vehicle traffic on existing dirt roads in the project area would continue to be visible from WSAs and to be visible to other receptors in the area.

3.3.5 Issue 4: How would the physical presence and design of the proposed infrastructure influence resources and resource use conditions?

Analysis Area and Assumptions

The analysis area for both direct and indirect effects is the project area. The analysis area for indirect effects on cultural resources is defined as the indirect APE for cultural resources; the indirect effects analysis area for special designations and visual resources is the viewsheds from which proposed infrastructure would be visible.

Effects from Alternative A: Proposed Action

Wildlife

The presence of the gen-tie may increase avian or bat injury or mortality due to collisions. Bats that cannot actively echolocate may fail to detect transmission lines or poles when in flight. Similarly, avian species may fail to see or distinguish the lines. If they spot the transmission lines during flight, heavy-bodied, less agile birds or birds in large flocks may lack the ability to quickly negotiate the lines, making these birds more susceptible to a potential collision.

Incorporating APLIC guidelines (APLIC 2006, 2012) into gen-tie design would minimize, but not prevent, the potential for injury or mortality from avian electrocution. This can occur when a bird simultaneously contacts energized or grounded structures, conductors, hardware, or equipment (APLIC 2006).

Raptors and corvids, such as crows, ravens, jays, and magpies, may benefit from the presence of transmission lines, because they provide more roosting or nesting opportunities (Steenhof et al. 1993); however, nests built near energized conductors and hardware may pose an electrocution risk. The gen-tie also may increase predation on wildlife species. This is because the gen-tie structures would provide improved perching locations for raptors and corvids.

Incorporating greater sage-grouse RDFs in OHMA on BLM-administered lands would minimize the potential for indirect effects on greater sage-grouse from increased predation threat and reduced habitat quality. ~~These~~ Additional effects may be unlikely to occur in the project area. This is because ~~the greater~~ sage-grouse habitat near the proposed gen-tie is already affected by ~~closely parallels~~ the existing LADWP 500 kV transmission line~~, meaning that individuals are less likely to be present in habitat areas~~.

Proponents of projects that would involve human disturbances in or within 3.7 miles of PHMA, GHMA, or OHMA are required to consult with the Nevada Sagebrush Ecosystem Technical Team to determine if mitigation is necessary. The BLM has coordinated with this team, which has not recommended any additional habitat quantification or mitigation measures beyond those already proposed in this EA.

Lights on drill rig derricks would pulse at the minimum intensity and minimum number of flashes per minute allowable by Federal Aviation Administration or other applicable regulations. Minimizing lighting would reduce, but not avoid, the potential for avian injury or mortality during drilling operations, as a result of birds striking drill rigs. Bird strikes may be particularly pronounced for night-migrating species, which may become disoriented by nighttime lights on tall structures, particularly during inclement weather (Rich and Longcore 2006).

Using wildlife-friendly fencing, netting, or other coverings to exclude wildlife from ponds, tanks, and impoundments, including drill reserve pits, containing hot or contaminated liquids and other constituent chemicals would minimize the potential for hazards to migratory birds, bats, and other wildlife from exposure to detrimental substances.

Vehicles can collide with wildlife, causing injury or mortality. There may be an additional risk for scavenger species, such as turkey vultures (*Cathartes aura*), ravens, and raptors, foraging along roads. Also, risks may increase for perching bird species, such as horned larks, whose concentrations have been observed to increase along newly constructed roads in sagebrush habitats (Inglefinger and Anderson 2004). Risks from road use would be greater during project construction than operation due to the higher volume of construction traffic.

Proposed Mitigation

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) and BLM-required stipulations (**Table 3-9**) would reduce the potential for effects on wildlife from the physical presence of proposed infrastructure. Specifically, power plant sites, permanent well pads, and pits would be fenced to prevent wildlife entry, and wellhead cellars would be covered to prevent wildlife entrapment. The proposed gen-tie would comply with raptor protection standards described in the Suggested Practices for Raptor Protection on Power Lines, The State of the Art in 2006 (APLIC 2006;

see **Appendix D**). All power poles would be constructed to be eagle safe and/or utilize raptor anti-electrocution and devices or equipment.

Implementing BLM-required stipulations (**Table 3-9**) would minimize the potential for effects on greater sage-grouse from the proposed gen-tie in OHMA. Greater sage-grouse RDFs (BLM 2015b, Appendix C) would be implemented along the 7 miles of proposed gen-tie that crosses areas mapped as OHMA on BLM-administered lands (BLM GIS 2015).

To minimize the potential for wildlife impacts from exposure to detrimental substances associated with geothermal reserve pits, Ormat would implement applicable measures described in the NDOW's *Design Features and Tools to Reduce Wildlife Mortalities Associated with Geothermal Sumps*. Applicable measures would be determined in coordination with the BLM and NDOW.

Cultural Resources

Because the proposed gen-tie would cross the California Trail near the Eagle Substation, there is potential for indirect effects. Temporary impacts would occur from visual intrusion of construction activity and restricted access during the gen-tie construction, but they would be minimal and limited to the period of construction. Permanent impacts to the integrity of setting, feeling, and association of the California Trail would occur where the gen-tie crosses the trail; however the impacts would not be significant.

Potential indirect effects on eligible or unevaluated sites in the AOI may include visual effects caused by construction and presence and use of equipment and the operation of new geothermal plant facilities. The existing San Emidio power plant, approximately 0.5 mile north of the proposed plants, already generates operational noise in the area, and anticipated noise from Alternative A, especially north of the proposed power plants, would be largely imperceptible from noise associated with the existing plant. There would be higher ambient noise levels south of the proposed plants where ambient noise levels are currently lower because of the further distance from the San Emidio facility. However, Alternative A would comply with the BLM regulation that mandates that noise at 0.5 miles—or at the lease boundary if closer—from a major geothermal operation should not exceed 65 dBA (43 CFR 3200.4[b]).

No significant indirect effects on other cultural resources are expected to occur.

<u>Proposed Mitigation</u>

There would be no specific mitigation measures for cultural resources because there would be no significant visual or auditory impacts. However, implementing measures to avoid, reduce, or mitigate visual and auditory impacts on other resources would directly and indirectly reduce the potential for Alternative A to affect the integrity of setting, feeling, and association of cultural resources.

Wild Horses and Burros

Permanent disturbance associated with geothermal development in the AOI would remove rangeland and forage areas for wild horses and burros in the approximately 177,700-acre Fox and Lake Range HA/HMA. This would come about by constructing power plants, fences, well pads, roads, and pipelines. Physical presence of proposed infrastructure may restrict animal movement. This effect would occur in approximately 190 acres, or approximately 0.1 percent, of the HA/HMA. This effect would be further minimized because development under Alternative A would occur next to existing geothermal utilization infrastructure.

Proposed Mitigation

There would be no specific mitigation measures for wild horses and burros that apply to Issue 4.

Land Use and Infrastructure

Placement of the power plants, pipelines, roads, substation, and gen-tie would increase the amount of infrastructure on BLM-administered lands. The proposed gen-tie would be in a designated west-wide energy corridor. There would continue to be opportunities for collocation of future electrical transmission infrastructure in the corridor. The substation could accommodate future connections.

Alternative A would result in a maximum of 50 workers during construction and would have an on-site staff of up to 2 employees during operation. Vehicle trips would include pick-up trucks, drilling rigs, haul trucks with construction vehicles, and semi-trucks hauling well equipment, power plant equipment and materials, and piping. These vehicles would access the AOI using Rodeo Creek Road. There would be short-term congestion and potential road surface deterioration on Rodeo Creek Road from construction vehicle traffic. There would be no impacts on Rodeo Creek Road during plant operation because less than 5 average daily vehicle trips would be expected for the 1–2 employees.

Proposed Mitigation

There would be no specific mitigation measures for land use and infrastructure. Potential impacts on the Rodeo Creek Road surface would be addressed through normal maintenance performed by Washoe County.

Recreation

Potential impacts on recreation from the physical presence of infrastructure would come from displacing visitors and modifying the backcountry setting. The greatest potential for Alternative A to affect the recreation setting would be in the Nightingale SRMA. Placement of the gen-tie would increase the amount of infrastructure visible from the SRMA and other areas where dispersed recreation occurs; however, because the new line would be in a corridor that already contains a large transmission line, the changes in the backcountry recreation setting or visitor displacement would be negligible. Proposed new and improved access roads would expand motorized and nonmotorized access to recreation opportunities. There would be no impacts on recreation near the AOI because of a lack of recreation opportunities and negligible change in the setting, compared with current conditions.

Proposed Mitigation

There would be no specific mitigation measures for recreation. However, implementing measures to avoid, reduce, or mitigate visual-related impacts on other resources would directly and indirectly reduce the potential for Alternative A to change the backcountry recreation setting.

Special Designations and Visual Resources

Special Designations

Alternative A would conform with BLM Manual 6330, Management of BLM Wilderness Study Areas, which requires an approximately 660-foot setback, or facility modification, for fluid mineral developments that could affect WSA characteristics. The southeast corner of the Fox Range WSA is approximately 2 miles from the southern portion of the AOI, though proposed infrastructure such as well pads and power plants would be approximately 3 miles from the WSA. The proposed air-cooled, binary power plants would not have steam plumes in cold weather, reducing their visibility on the landscape and the potential that they would affect wilderness characteristics in the Fox Range WSA.

The AOI is over 4 miles from the Mount Limbo WSA, but infrastructure in the AOI would not be visible from the WSA because the Lake Range would obscure it.

The non-impairment standard in BLM Manual 6330 stipulates that no new ROWs will be approved for uses that would impair the suitability of such areas for future preservation as wilderness. Alternative A would conform with BLM Manual 6330. The southern portion of the Mount Limbo WSA is less than 1,000 feet from the proposed gen-tie alignment in places. However, the proposed gen-tie ROW parallels the larger LADWP 500 kV transmission line through this area. The proposed ROW is at least 500 feet farther from the WSA boundary than is the 500 kV transmission line. Given the proposed ROW's location relative to existing infrastructure and design features to minimize visual impacts (see **Section 2.1.3**), the non-impairment standard would not be violated by the proposed ROW placement.

Proposed Mitigation – Special Designations

There would be no specific mitigation measures for special designations. However, implementing applicant-committed environmental protection measures (**Section 2.1.3**) to avoid, reduce, or mitigate visual-related impacts on other resources would directly and indirectly minimize the potential for Alternative A to diminish the naturalness character of these areas.

Visual Resources

The visual contrast rating analysis for the KOPs (**Appendix E**) found that the project components would be visible and would create a contrast with the surrounding landscape. The predominant vegetation is under 3 feet high and would not provide screening of the project. The horizon line would be discontinuous from most KOPs, thereby reducing contrasting impacts on the landscape lines and form. This is because power lines and facilities generally would not protrude above the skyline; however, from some KOPs, project components would protrude above the skyline where it is relatively low in elevation. The project would introduce additional visible elements into the landscape; however, there are already non-natural lines and forms, namely geothermal plant facilities, utility poles and transmission lines, roadways, fence lines, and other human-made structures.

Short-term effects on visual resources would occur during project construction and drilling, when heavy equipment, drill rigs, and other equipment would be present. During drilling operations, the rig would be visible at distances of greater than 1 mile from the respective drill sites. Lights used during night drilling would increase rig visibility, but the lights would be limited to those required to safely conduct the operations. The lights would be shielded or directed to focus light on the immediate work area.

Long-term effects would be minimized by incorporating visual design considerations to minimize visual contrast and to meet the VRM objectives of the area. Project facilities would be painted consistent with BLM visual guidelines, which would further blend the structures into the surrounding landscape.

Long-term effects would also occur from the gen-tie structures and conductor. However, because the proposed line would parallel the larger LADWP 500 kV transmission line for most of its length, ~~the quality of the views as seen from~~ visual changes seen from project KOPs (**Appendix E**) would repeat basic elements in the preexisting landscape character ~~be largely unaffected~~.

Infrastructure would be noticeable from project KOPs but would not dominate the view of the casual observer. The impact on the characteristic visual landscape would be greatest where existing infrastructure or other forms of visual contrast are not present. Overall, the degree of contrast and modification imposed on the landscape by the project would be moderate or less, which is within the parameters of the VRM Class III objective to partially retain the existing character of the landscape. Accordingly, Alternative A would be in conformance with VRM guidelines and policy (BLM Manual 8400, Manual H-8410-1, and Manual H-8431).

<u>Proposed Mitigation – Visual Resources</u>

Implementing applicant-committed environmental protection measures (see **Section 2.1.3**) would reduce the potential for visual resources effects from the physical presence of proposed infrastructure. Specifically, the paint used on the power plant, pipelines, wellheads, pump motors, and motor control buildings would be consistent with BLM visual guidelines to blend with the area and minimize their visibility. The overhead conductors used on the gen-tie power poles would have a matte surface to reduce sunlight reflection and glare.

Effects from Alternative B: No Action Alternative

There would be no effects from the presence of the proposed gen-tie, including on the California NHT, because the gen-tie would not be constructed. Effects, as described above, may continue to occur in portions of the project area; this is because there is already infrastructure along the proposed gen-tie alignment.

Rangeland and forage resources in the Fox and Lake Range HA/HMA would not be removed, because Alternative A would not be constructed. Animals may experience movement restrictions in the existing geothermal field area due to the power plant, fences, well pads, roads, and pipelines that are already there.

Wilderness characteristics in the Fox Range and Mount Limbo WSAs would be unchanged, because Alternative A infrastructure would not be built. Existing infrastructure, including the San Emidio power plant and auxiliary buildings, would continue to be visible from the Fox Range WSA, and the LADWP 500 kV transmission line would continue to be visible from the Mount Limbo WSA.

Similarly, there would be no changes to existing form, color, line, or texture, in accordance with BLM VRM guidelines, because Alternative A infrastructure would not be built.

3.3.6 Cumulative Effects

Past, Present, and Reasonably Foreseeable Future Activities

The CEQ defines cumulative effects as "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal and non-federal) or person undertakes such other actions" (40 CFR 1508.7; CEQ 1997).

To determine which other actions should be included in a cumulative impacts analysis, the region of influence for each resource must first be defined. These regions should not be limited to only the geographic areas of resources addressed by the project; they should also account for the distances that cumulative impacts may travel and the regional characteristics of the affected resources. ~~Unless otherwise noted, the cumulative effects analysis area for geothermal production is the San Emidio Desert. This is a closed hydrologic basin that is not visible from any state road. The cumulative effects analysis area for the gen-tie is the viewsheds in which the gen-tie would be visible~~. The cumulative effects analysis area is the San Emidio Desert and the areas within 3 miles of the gen-tie from which the gen-tie would be visible (see **Figure A-10**). The timescale for analysis is the lifetime of the geothermal leases (10 years) and ROW grant. Generally, a BLM ROW is granted for a term appropriate for the life of the project, which is anticipated to be 50 to 60 years depending upon maintenance operations and climatic conditions. The geothermal leases and ROW grant may be extended or renewed beyond these timelines.

The BLM has identified past, present, and reasonably foreseeable future actions (**Table 3-13**) that overlap both spatially and temporally with Alternative A on BLM-administered lands in the analysis area and thus are relevant for analyses.

Table 3-13
Past, Present, and Reasonably Foreseeable Future Actions

Past, Present, or Reasonably Foreseeable	Action	Brief Description
Past	Locatable mineral exploration and development	Surface disturbance from the Wind Mountain Mine is in the reclamation phase under care and maintenance by Rio Furtuna Exploration. Approximately 820 acres in the cumulative effects analysis area were disturbed by mining and ore processing. The BLM is evaluating mine reclamation annually for revegetation performance. The BLM has determined the bond status is adequate and the notice is active until April 2021.
Present	Lands and realty	A LADWP 500 kV transmission line runs north to south, along the base of the Lake Range. The line passes through the Eagle Substation near Fernley, Nevada. The Eagle Substation is operated by NV Energy.
Present	Fluid mineral exploration and development	Ormat operates the 10 MW San Emidio geothermal plant. Surface disturbance associated with the plant is approximately 64 acres (Ormat 2019). There are also 7 production or injection wells, well pads, and access roads associated with the San Emidio plant and decommissioned AMOR II plant.
Present	Fluid mineral exploration and development	Drilling and testing six geothermal resource exploration wells on BLM-administered land in the SEGU per the 2010 EA (BLM 2010).
Present	Agricultural development	Farming and ranching interests are anticipated to continue at current levels into the foreseeable future. Approximately 1,660 acres are under cultivation on private land in the cumulative effects analysis area (BLM 2010).
Present	Rangeland	The project area crosses portions of the Blue Wing/Seven Troughs, Desert Queen, and Rodeo Creek grazing allotments. There is grazing in the project area, including in the AOI and along the proposed gen-tie. Range improvements consist of watering areas for livestock and some fencing.

Past, Present, or Reasonably Foreseeable	Action	Brief Description
Present	Transportation	State Route 447 crosses the proposed gen-tie cumulative effects analysis area east of the Lake Range. There are several unpaved access roads in the project area, including an existing maintenance road that serves the LADWP transmission line. Rodeo Creek Road provides paved and unpaved public access to the AOI and Empire Farms. Washoe County is responsible for maintaining Rodeo Creek Road.
Reasonably foreseeable	Water rights transfer	Water rights acquisition and proposed transfer for planned municipal uses in Storey County. Any transfer of water out of the San Emidio Desert basin would be subject to the approval of the Nevada State Engineer.
Reasonably foreseeable	Fluid mineral exploration and development	Gerlach Geothermal ~~Development~~ Exploration Project, which proposes new exploration ~~a new geothermal power plant~~ wells near Gerlach. Depending on the results of exploration, geothermal development, including a power plant and ~~an approximately 20-mile-long 120 kV~~ transmission line, ~~terminating at the San Emidio substation~~ could be proposed in the future.
Reasonably foreseeable	Fluid mineral exploration and development	Juniper Geothermal Development Project, which proposes new geothermal wells, power plant, and a powerline near Winnemucca Lake.
Reasonably foreseeable	Fluid mineral exploration and development	Development of the geothermal resource at the Astor Pass area on the PLPT Reservation.

Sources: As noted in the table

Cumulative Effects Analysis

Past, present, and reasonably foreseeable future actions that have affected, and would continue to affect, ambient noise levels in the cumulative effects analysis area are as follows: the existing 10 MW San Emidio Geothermal Plant, authorized geothermal exploration activities in the SEGU, operation of the LADWP 500 kV transmission line, and traffic on State Route 447 and Rodeo Creek Road.

Those actions that have affected and would continue to affect water resources are the existing and planned geothermal resource utilization and agricultural irrigation water use. The recent acquisition of water rights in the San Emidio Desert for planned municipal uses in Storey County could result in water being transferred out of the basin. Any transfer of water out of the basin would be subject to the approval of the Nevada State Engineer.

Construction, operation, and maintenance of most of the past, present, and reasonably foreseeable future actions would continue to remove vegetation and disturb soils in the cumulative effects analysis area.

Finally, actions that have contributed to infrastructure presence in the analysis area are primarily existing geothermal utilization in the SEGU, the LADWP 500 kV transmission line, and State Route 447.

When combined with these past, present, and reasonably foreseeable future actions, Alternative A would contribute incrementally to noise levels, the potential for effects on water resources, surface disturbance and associated vegetation removal, and infrastructure in the analysis area, as described below. Implementing applicant-committed environmental protection measures and additional BLM-required stipulations would minimize Alternative A's contribution to the cumulative effects.

Temporary noise would come from constructing and maintaining proposed infrastructure, including from drilling proposed injection and production wells; long-term noise would come from plant operation. Noise generated during construction would affect wildlife, wild horses and burros, and livestock, such as from disturbance and displacement from habitat during construction. Construction noise from the gen-tie would also temporarily impact the recreation setting in the Nightingale SRMA. Long-term noise-related effects are also possible on animals and recreation near the proposed power plants, but since the existing San Emidio power plant already generates operational noise in the area, anticipated noise would be largely imperceptible from noise associated with the existing plant. Further, recreation opportunities are limited in and near the AOI.

Geothermal utilization would have the potential to contribute incrementally to effects on resources in the analysis area. Long-term contributions would occur if geothermal fluid utilization changed groundwater aquifer quality or quantity. This could affect water quality or availability in the San Emidio Desert and adjacent groundwater basins for wildlife, livestock, wild horses and burros, and water rights holders. While the best available science indicates a lack of connectivity between the geothermal resource in the San Emidio Desert and undeveloped geothermal and groundwater resources in adjacent hydrologic basins, ~~D~~ developing and implementing a final groundwater monitoring and reporting plan, in accordance with the BLM's draft groundwater monitoring goals and objectives (see ~~draft plan in~~ **Appendix G**) and BLM required stipulations (**Table 3-9**), ~~program~~ would ~~reduce the potential for these effects; if effects were observed,~~ identify changes in nearby resources and inform appropriate corrective measures ~~would be applied~~.

~~Because there is a lack of connectivity between the geothermal resource in the San Emidio Desert and undeveloped geothermal resources in adjacent hydrologic basins, Alternative A is not anticipated to prevent development of these resources in the future.~~ Similarly, the best available science indicates there is no direct connection between the geothermal resource in the San Emidio Desert and ~~groundwater and~~ surface water resources in the Pyramid Lake Valley basin~~; thus,~~. Developing and implementing a water monitoring and reporting program, in accordance with the BLM's draft groundwater monitoring goals and objectives (see **Appendix G**) and BLM required stipulations (**Table 3-9**), would ~~confirm~~ provide additional data relative to the presence or absence of any ~~there would be no contributions to~~ cumulative effects on water quality or quantity in Pyramid Lake, including habitat for listed fish species. Mitigation measures informed by the monitoring results would avoid or mitigate cumulative effects.

Alternative A would cause surface disturbance, remove vegetation, and increase the potential for water- and wind-driven soil erosion. Surface disturbance in suitable habitat for special status species would result in contributions to cumulative effects on these species and their habitat. The impacts would be incremental, when combined with vegetation removal and soil disturbance from past, present, and future actions in the analysis area. Temporary contributions would occur from constructing the proposed facilities, including temporary work areas along the gen-tie. Long-term contributions would occur in the footprints of permanent facilities and in maintenance areas that would not be reclaimed after construction. The primary potential impacts associated with this are temporary and permanent vegetation and wildlife habitat removal, soil disturbance increasing the potential for invasive plant establishment and spread and water- and wind-driven soil erosion, and temporary visual impacts.

Contributions to cumulative effects on special status species would be greater for those species that are less tolerant of fragmented or disturbed habitats. While some general wildlife can inhabit relatively disturbed habitats and reoccupy temporarily disturbed and restored areas relatively quickly, some special status species, including kangaroo mice, may not have this ability. Temporarily disturbed suitable habitat, even if restored, can take a relatively long time to regain suitability, and this does not guarantee species reoccupation.

Finally, combined with past, present, and reasonably foreseeable future actions, Alternative A would increase the presence of infrastructure in the analysis area, including power lines, power plants, wells, and ancillary power generation infrastructure. The primary potential impacts associated with this are increased potential for wildlife injury or mortality due to strike, entrapment, or electrocution, though the potential for this would be reduced by incorporating design best practices for wildlife protection. Because there is existing electrical transmission infrastructure crossing the California NHT, the proposed gen-tie would not reduce the integrity of setting, feeling, and association of this resource. There would also be the potential for changes in the context and setting for special designation areas, visual resources, and recreation, though the potential would be reduced by incorporating visual design standards.

Based on the anticipated potential impacts from Alternative A, when combined with impacts from past, present, and reasonably foreseeable future actions in the cumulative effects analysis area, no cumulatively significant impacts are anticipated.

There would be no cumulative effects from Alternative B because the project would not be constructed. Cumulative effects, as described above, may continue to occur in portions of the project area; this is because there is already geothermal production and power line infrastructure in the project area.

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Chapter 4. Consultation and Coordination

4.1 Tribes, Individuals, Organizations, and Agencies Consulted

During the NEPA process for this EA, the BLM formally and informally consulted and coordinated with other federal agencies, state and local governments, Native American tribes, and the interested public. The agency did this to ensure its compliance, in both the spirit and intent, with 40 CFR 1501.7, 1502.19, and 1503. In addition to formal scoping, the BLM implemented collaborative outreach and a public involvement process that included inviting agencies to be cooperative partners for the EA planning process. A cooperating agency is any federal, state, or local government agency or Native American tribe that enters into formal agreement with the lead federal agency to help develop an environmental analysis.

4.1.1 Government-to-Government Consultation

The federal government works on a government-to-government basis with Native American tribes as they are recognized to be separate governments. This relationship was formally recognized on November 6, 2000, with Executive Order 13175 (Federal Register, Volume 65, page 67249). As a matter of practice, the BLM coordinates with all tribal governments, associated native communities, native organizations, and tribal individuals whose interests might be directly and substantially affected by activities on public lands. In addition, Section 106 of the NHPA requires federal agencies to consult with Native American tribes for undertakings on tribal lands and for historic properties of significance to the tribes that may be affected by an undertaking (36 CFR 800.2(c)(2)). BLM Manual 1780, Tribal Relations, and BLM Handbook H-1780-1, Improving and Sustaining BLM-Tribal Relations, provide guidance for Native American consultations.

Executive Order 13175 stipulates that, during the NEPA process, federal agencies consult tribes identified as being directly and substantially affected. The BLM notified several tribes of the Proposed Action in writing in May 2019. Letters were sent to the PLPT, Summit Lake Paiute Tribe, Reno-Sparks Indian Colony, and Susanville Rancheria. The BLM also held consultation and informational meetings to discuss the Proposed Action with the PLPT on January 7 and March 3, 2020. The PLPT expressed concerns regarding potential impacts on groundwater, surface water, and geothermal resources on their reservation.

On June 26, 2020, the BLM held a consultation meeting with the PLPT to discuss the PLPT's comments provided on the draft EA. In October 2020, the BLM and PLPT entered into a data-sharing agreement. This agreement identified the terms by which the PLPT would provide the BLM with relevant hydrogeologic data to inform the EA analysis. Through the data-sharing agreement, the PLPT shared several reports with the BLM regarding geothermal resource potential on the PLPT Reservation. The data were reviewed for consistency with the conclusions in the Hydrogeologic Evaluation (BLM 2020b). The BLM participated in consultation meetings with the PLPT on December 18, 2020, and January 20, March 2, and March 17, 2021, to discuss the PLPT's concerns regarding the second public draft EA, specifically regarding potential impacts on groundwater, surface water, and geothermal resources on the PLPT Reservation.

4.1.2 Nevada State Historic Preservation Officer

In accordance with the requirements of Section 106 of the NHPA, the BLM ~~is~~ consulted ~~consulting~~ with the Nevada State Historic Preservation Office.

4.1.3 US Department of the Interior, Fish and Wildlife Service

Consultation with the USFWS is required under Section 7(c) of the ESA before the BLM begins any project that may affect federally listed or endangered species or their habitat. Current surveys have indicated that ESA-listed species are not found in the project area. This indicates that a draft biological assessment would not be needed to evaluate the potential impact of the project on federally listed threatened and endangered species. The BLM coordinated with the USFWS during each agency's review of Ormat's Eagle Act Compliance Document (**Appendix D**).

4.1.4 US Department of the Interior, National Park Service

The National Park Service is the administering agency for National Historic Trails. The BLM ~~is coordinating~~ coordinated with the National Park Service because the gen-tie alignment crosses the California Trail near its southern terminus near Fernley, Nevada.

4.1.5 Cooperating Agencies

Cooperating agencies are any federal, state, or local government agency or Native American tribe that enters into a formal agreement with the lead federal agency to help develop an environmental analysis. Cooperating agencies and tribes work with the BLM, sharing knowledge and resources, to achieve desired outcomes for public lands and communities within statutory and regulatory frameworks. Agencies and tribal entities that were invited and those that accepted and signed a memorandum of understanding agreeing to participate as cooperating agencies for this NEPA process are presented in **Table 4-1**, below.

Table 4-1
Cooperating Agency Participation

Agencies and Tribes Invited to Be Cooperators	Invited	Accepted
Nevada Department of Wildlife	Yes	Yes
Nevada Sagebrush Ecosystem Technical Team	Yes	No
Pyramid Lake Paiute Tribe	Yes	~~Yes~~ No
Truckee Meadows Regional Planning Agency	Yes	No
US Fish and Wildlife Service	Yes	Yes
Washoe County	Yes	No

4.2 List of Preparers

This environmental assessment was prepared by an interdisciplinary team of staff from the BLM and Environmental Management and Planning Solutions, Inc. (EMPSi), with their supporting subcontractors. The following is a list of people who prepared or contributed to the development of this EA.

4.2.1 US Department of the Interior, Bureau of Land Management

Team	Name	Role/Responsibility
Management	Mark Hall	Field Office Manager, Native American Religious Concerns, NEPA Lead and Authorized Officer
	Tai Subia	Project Manager, Geology
	Kathleen Rehberg	Assistant Field Office Manager, Minerals
	Andy Boerigter	Assistant Field Office Manager
	Robin Michel	Planning and Environmental Coordinator
Interdisciplinary	Kathryn Ataman (retired)	Cultural Resources, National Conservation Area, National Historic Trails
	Angela Arbonies	Range, Wild Horses and Burros
	Jean Black	Hydrology
	Kathleen Torrence (Cadigan)	Wildlife, Threatened and Endangered Species, Special Status Species, Migratory Birds
	Daniel Erbes	Hydrologist (Nevada State Office)
	Michael Kizorek	Recreation
	Andrew Laca	Soils
	Gabrielle Lukins	Visual Resources
	Michael McCampbell	Invasive, Nonnative Species
	Christine McCollum	Cultural Resources
	Julie McKinnon	Lands and Realty, Infrastructure
	Julie A. Suhr Pierce	Social values, environmental justice, economics
	Garret Swisher	Wild Horses and Burros
	Tanner Whetstone	Native American Religious Concerns, Cultural Resources, National Historic Trails

4.2.2 Consultant: Environmental Management and Planning Solutions, Inc.

Team	Name	Role/Responsibility
Management	Peter Gower	Project Manager
	Morgan Trieger	Assistant Project Manager, Lead Biologist
ID Team and Support Staff	Alex Dierker	GIS Technician
	Jenna Jonker	GIS Lead
	Rob Lavie	GIS Technician
	Kirsti Settas	Geology and Hydrology
	Jennifer Thies	Quality Assurance/Quality Control
	Andy Spellmeyer	Section 508 Compliance
	Cindy Schad	Word Processing
	Kim Murdock	Technical Editor
	Randolph Varney	Technical Editor

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Appendix A

Figures

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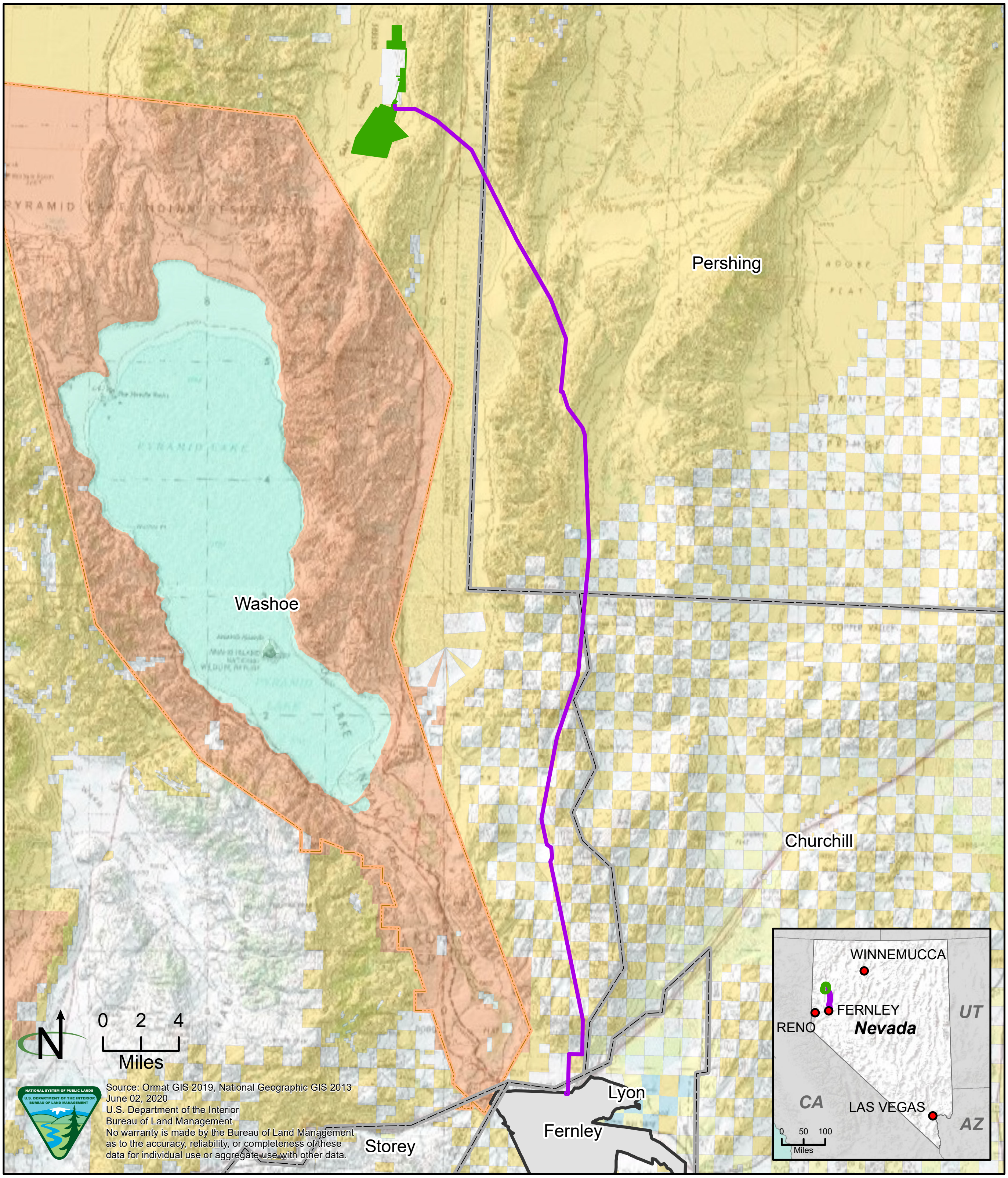

Figure A-1. Project Area

Proposed gen-tie	Surface Management Agency	Private
Area of Interest	Bureau of Indian Affairs	Fish and Wildlife Service
County boundary	Bureau of Land Management	Nevada State
Pyramid Lake Paiute Tribe Reservation Boundary	Bureau of Reclamation	Water

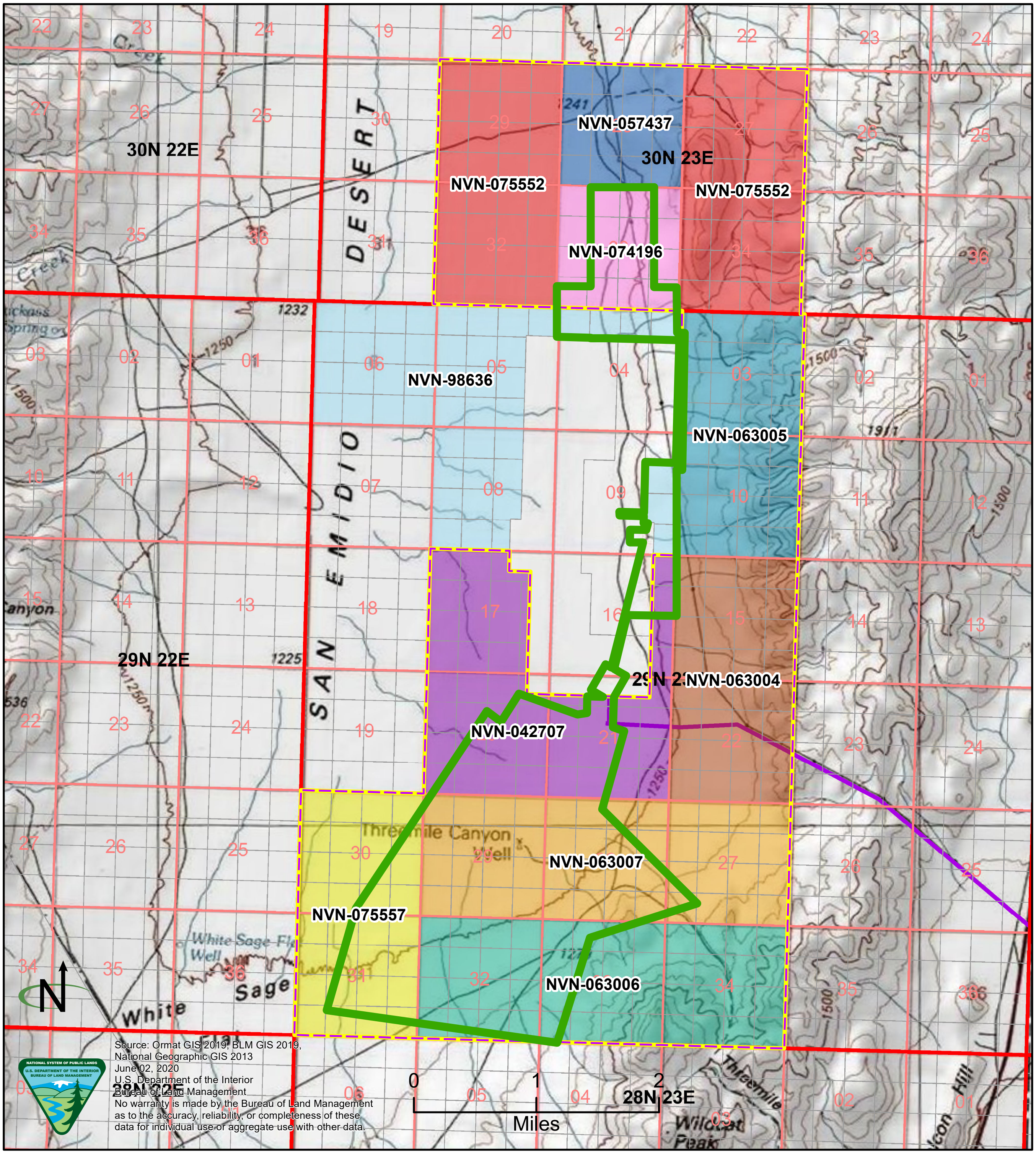

Figure A-2: Geothermal Lease Areas

Area of Interest

Proposed gen-tie

San Emidio Geothermal Unit

Geothermal Lease Boundaries

NVN-042707

NVN-057437

NVN-063004

NVN-063005

NVN-063006

NVN-063007

NVN-074196

NVN-98636

NVN-075552

NVN-075557

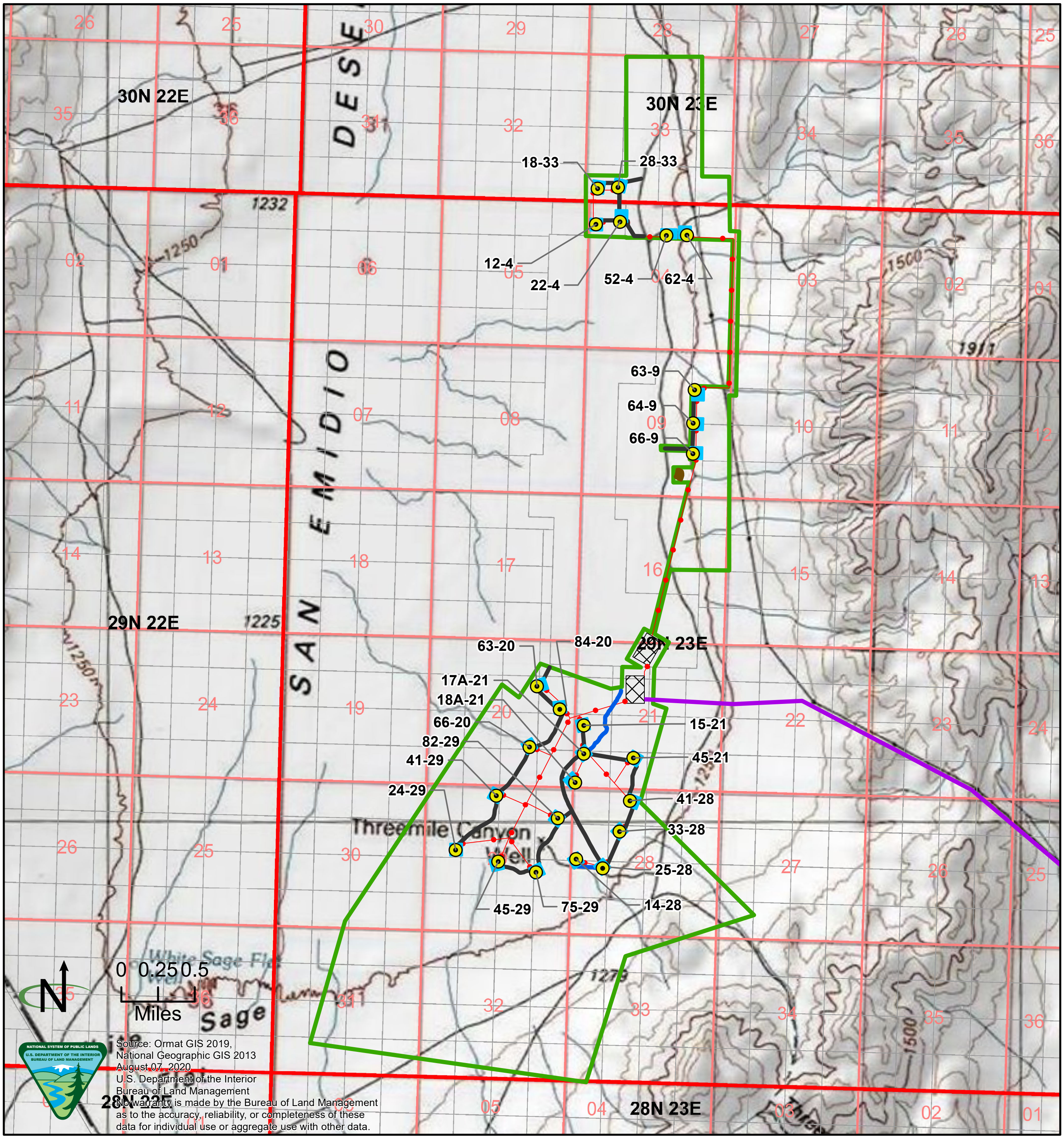

Figure A-3. Project Overview—San Emidio Geothermal Lease Unit

- Area of Interest
- Proposed gen-tie
- Power plant
- Well
- Well pad
- Aggregate pit
- Pipeline
- Road- improve
- Road- new

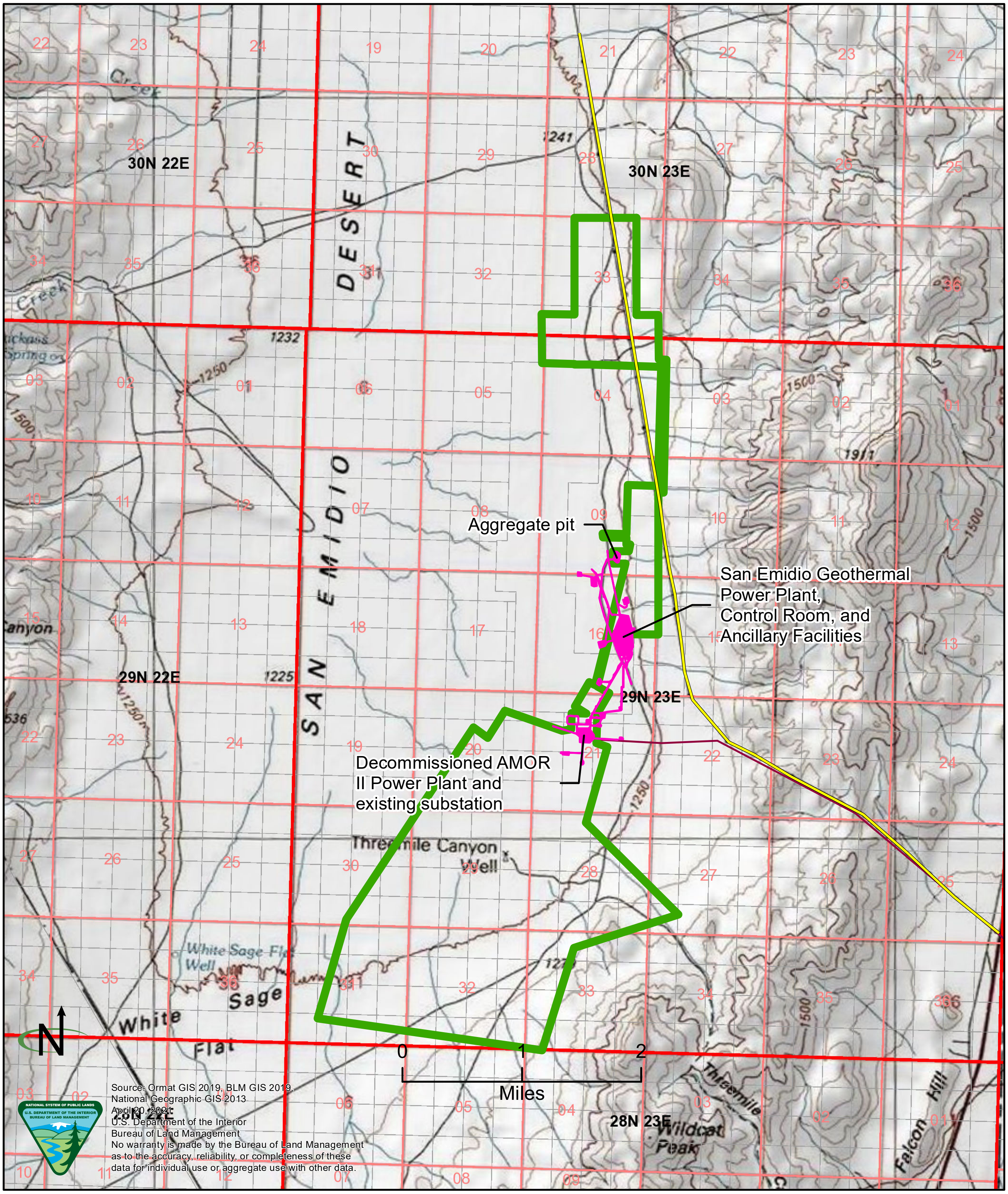

Figure A-4.
Existing Geothermal Utilization and Electrical Transmission Facilities

Area of Interest
Existing disturbance
LADWP 500 kV transmission line
Power line

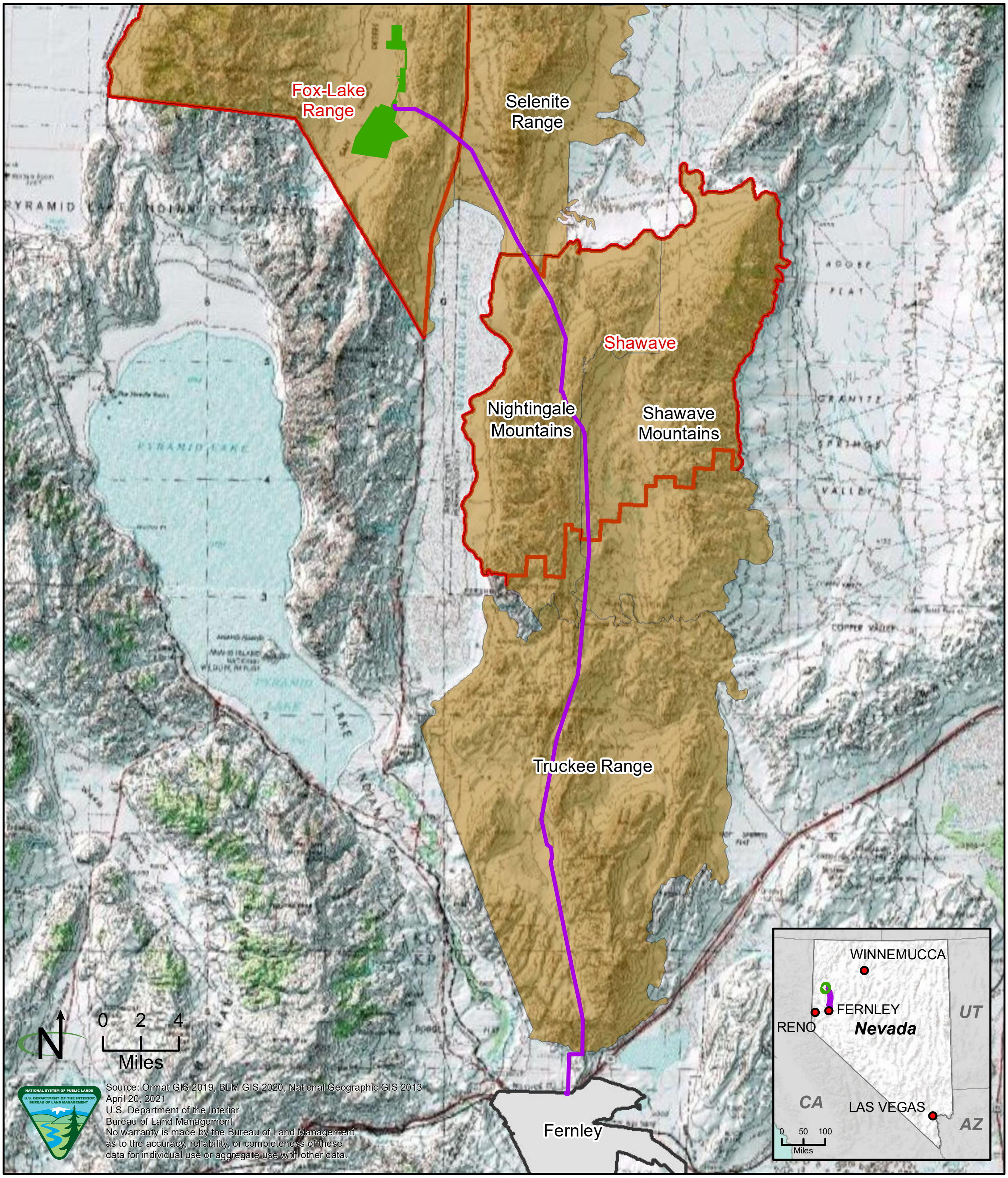

Figure A-5. Wild Horses and Burros Herd Areas and Herd Management Areas

Proposed gen-tie
Area of Interest
Wild horse and burro herd area
Wild horse and burro herd management area

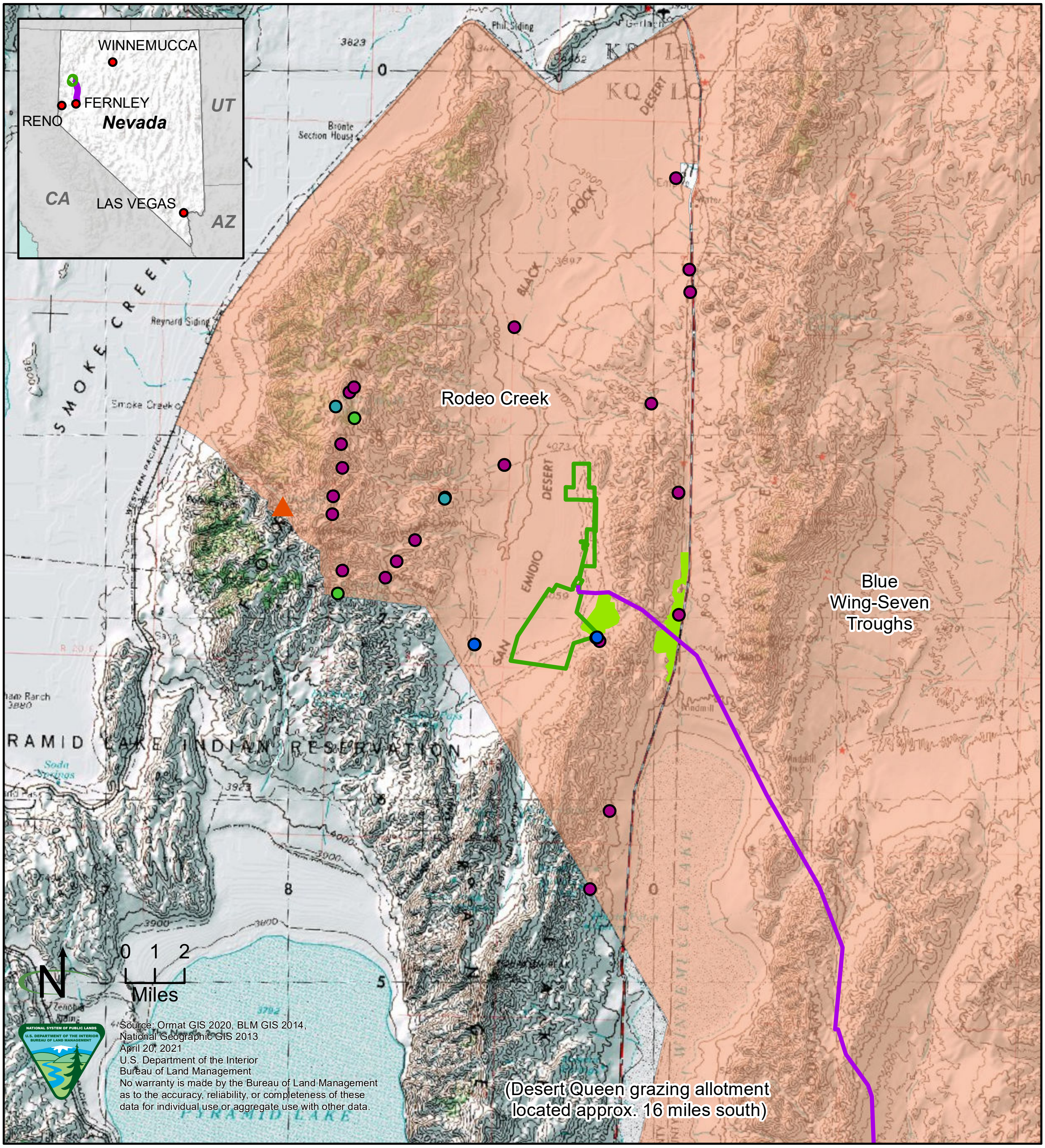

Figure A-6. Range Improvements

Area of Interest
Proposed gen-tie line
Grazing allotment
Seeded area
Cabin
Spring
Spring/trough
Trough
Well

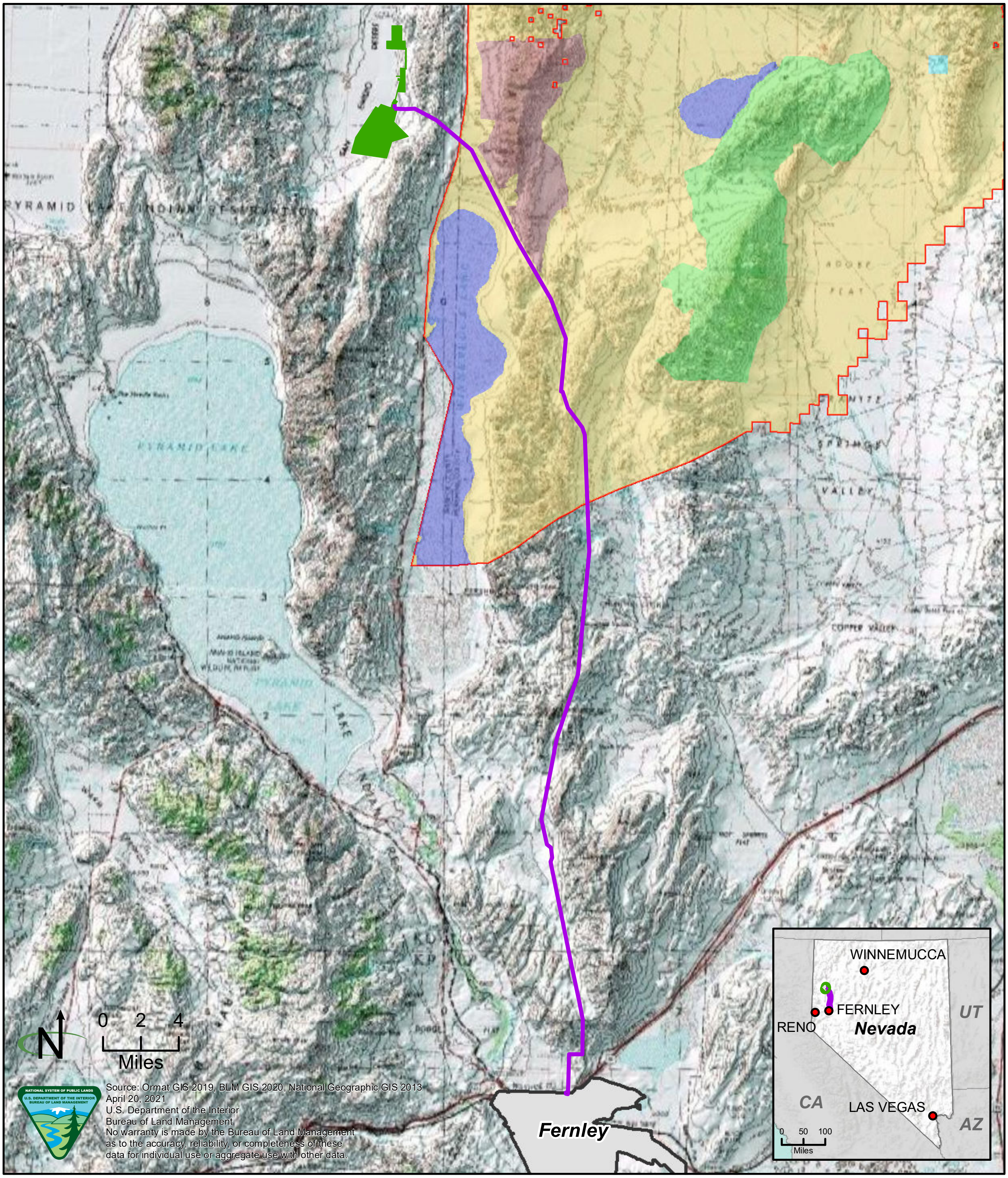

Figure A-7. Nightingale Special Recreation Management Area

- Proposed gen-tie
- Area of Interest
- Nightingale SRMA
- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Zone 5

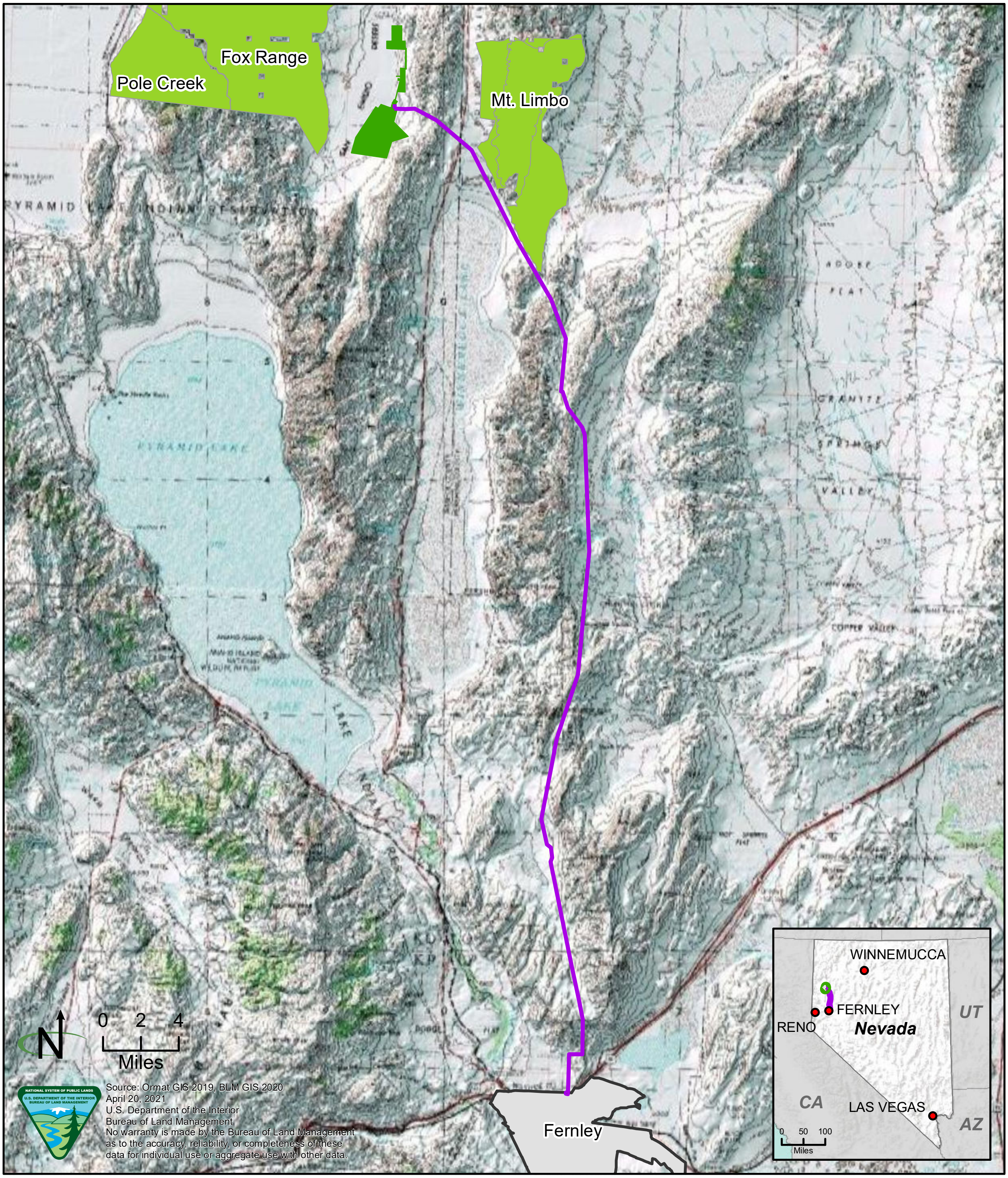

Figure A-8. Wilderness Study Areas

Proposed gen-tie
Wilderness study area
Area of Interest

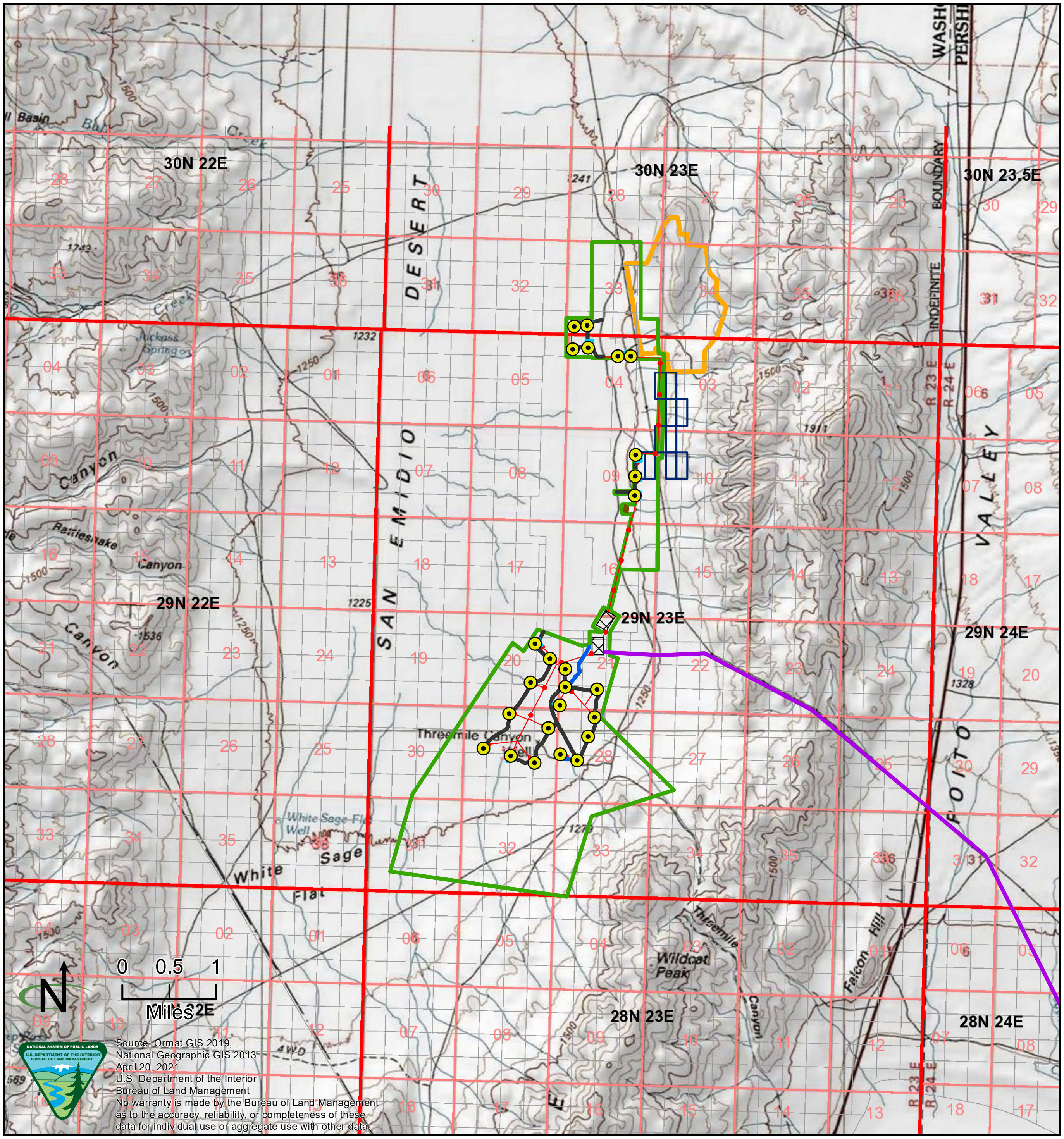

Figure A-9. Minerals

Area of Interest
Proposed gen-tie line
Power plant
Well
Well pad
Aggregate pit
Pipeline
Road- improve
Road- new
Pyramid Associates mining claims
Wind Mountain plan boundary

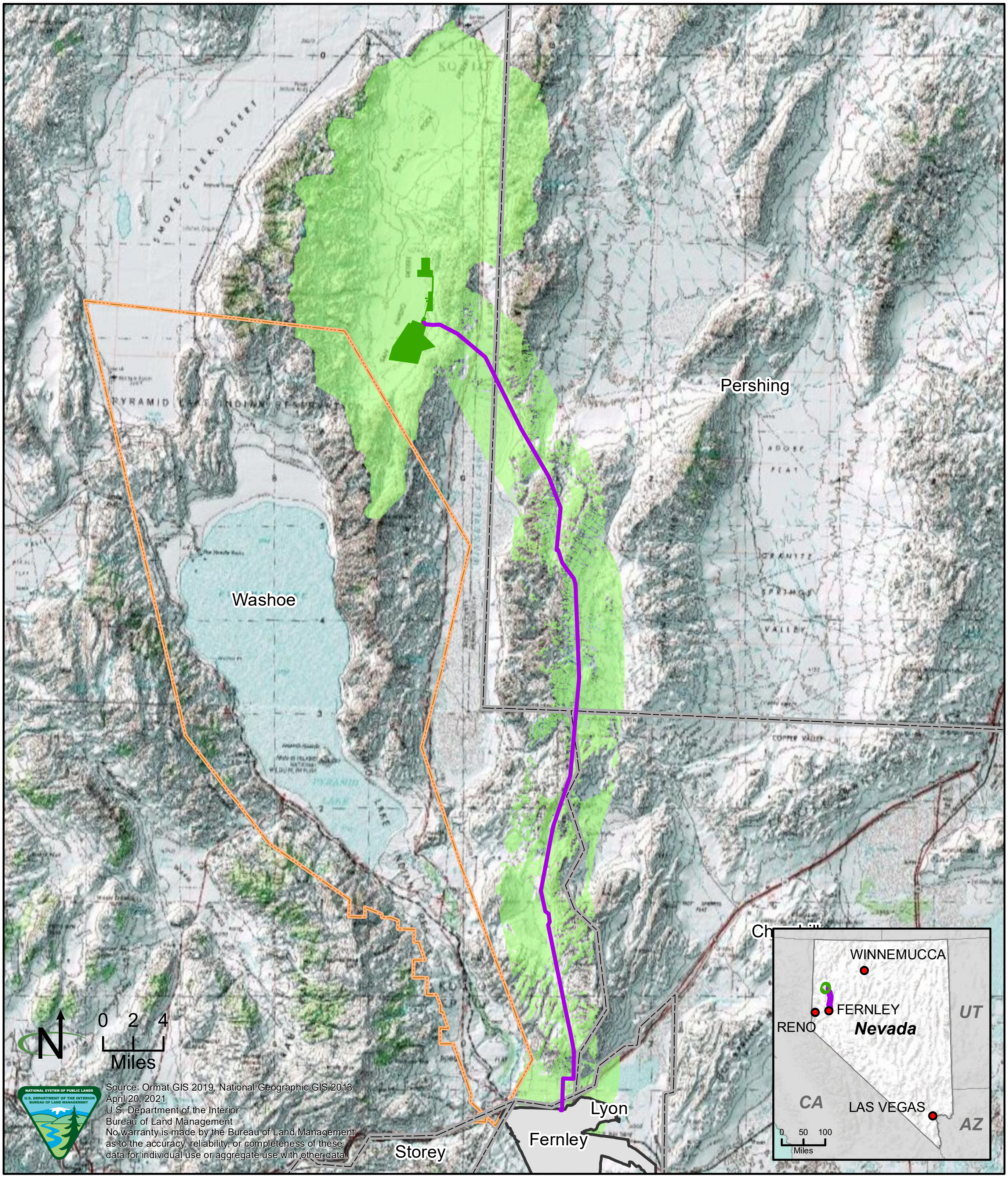

Figure A-10. Cumulative Effects Study Area

- Proposed gen-tie line
- Area of Interest
- County boundary
- Pyramid Lake Paiute Tribe Reservation Boundary
- Cumulative Effects Study Area

Appendix B

Environmental Contingency Plans

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Appendix B. Environmental Contingency Plans[10]

Fire Contingency Plan

1. Rig personnel utilizing on-site firefighting equipment should be able to control any small fires that occur around the well pad during drilling and/or testing operations.

2. The BLM Winnemucca District Office ([775] 623-1500) would be notified of any wildland fire, even if the available personnel can handle the situation or the fire poses no threat to the surrounding area. Additionally, the Sierra Front Interagency Dispatch Center would be notified at (775) 883-5995.

3. A roster of emergency phone numbers would be available on-site so that the appropriate firefighting agency can be contacted in case of a fire.

4. All vehicles shall carry at a minimum a shovel and 5 gallons of water (preferably in a backpack pump), in addition to a conventional fire extinguisher.

5. Adequate firefighting equipment (a shovel, a Pulaski, standard fire extinguisher(s), and an ample water supply) shall be kept readily available at each active drill site.

6. Vehicle catalytic converters (on vehicles that would enter and leave the drill site on a regular basis) shall be inspected often and cleaned of all flammable debris.

7. All cutting/welding torch use, electric-arc welding, and grinding operations shall be conducted in an area free, or mostly free, of vegetation. An ample water supply and shovel shall be on hand to extinguish any fires created from sparks. At least one person in addition to the cutter/welder/grinder shall be at the work site to promptly detect fires created by sparks.

8. Personnel would be responsible for being aware of and complying with the requirements of any fire restrictions or closures issued by the BLM Winnemucca District Office, as publicized in the local media or posted at various sites throughout the field office district.

Spill or Discharge Contingency Plan

1. Potential sources of accidental spills or discharges

a. Geothermal Fluid

[10] Ormat (Ormat Nevada, Inc.). 2020. Utilization Plan—North Valley Geothermal Development Project, Washoe, Pershing, Churchill, and Lyon Counties, Nevada. Reno, Nevada.

Accidental discharges or spills could result from any of the following:

(1) Loss of well control (blowout)

(2) Pipeline leak or rupture

(3) Leakage from test tank

b. Drilling Muds

Muds are a mixture of water, nontoxic chemicals, and solid particles used in the drilling operations to lubricate and cool the bit in the hole, carry cuttings out of the hole, maintain the hole condition, and control formation pressure. Drilling muds are prepared and stored in metal tanks at the drilling site. Waste drilling mud and cuttings are discharged into the reserve pit, which is open and is adequately sized to hold the volume necessary for the operation. Accidental discharges of drilling mud could occur by:

(1) overflow of the reserve pit;

(2) reserve pit wall seepage or wall failure;

(3) discharge from equipment failure on location; or

(4) shallow lost circulation channeling to the surface.

c. Lubricating or Fuel Oils and Petroleum Products

To minimize the potential for spills, all petroleum products on-site are labeled, stored, and handled in conformance with applicable federal and state requirements. All materials, except diesel fuel, are stored in the original shipping containers. Diesel fuel is stored in on-board tanks on the drill rig and replenished from a bulk tank truck using an electric transfer pump and hard lines. Large 500-gallon storage tanks at the power plant would include a secondary containment system that would accommodate a design criterion of 110 percent volume of the largest tank requiring containment, per 40 CFR 112. Further, supervisors trained in spill prevention, containment, and cleanup are on-site 24 hours a day.

Potential locations for accidental spills are:

(1) drilling equipment and machinery at and around the drilling location;

(2) other miscellaneous equipment and machinery at the well site and roads;

(3) storage areas; and

(4) equipment servicing areas.

d. Construction/Maintenance Debris

Trash shall be contained on-site and hauled to an approved landfill. Burial of trash on-site shall not be permitted.

2. Plan for Cleanup and Abatement

In the event of discharge of formation fluids, drilling muds, or petroleum products, the person responsible for the operation would make an immediate investigation, then contact the drilling supervisor and advise him of the spill. The drilling supervisor would, in turn, call out equipment, regulate field operations, or do other work as applicable for control and cleanup of the spill, as follows:

a. Action—Small, Containable Spill

If the spill is small (i.e., less than 25 gallons) and easily containable without endangering the watershed, the drilling supervisor would direct and supervise complete cleanup, and return to normal operations.

b. Action—Large or Uncontainable Spill

If the spill is larger than 25 gallons, is not easily contained, or endangers or has entered the watershed, the drilling supervisor would proceed to take necessary action to curtail, contain, and clean up the spill, as above, and notify personnel as listed below.

c. Notification

(1) The drilling supervisor would, as quickly as practicable:

- Call out contractor(s), as required
- Notify the Ormat project manager
- Notify the local and state law enforcement agencies if the public safety is threatened

(2) The Ormat project manager would notify the following as soon as practical and work closely with them in all phases of the curtailment, containment, and cleanup operations:

Nevada Division of Minerals (NDOM)
State of Nevada
400 W. King
Carson City, NV 89703
(775) 684-7040

Nevada Division of Environmental Protection (NDEP)
Division of Emergency Management
(775) 688-2830 or (888) 331-6337
901 S. Stewart Street
Carson City, NV 89706

BLM Winnemucca District Office
(within 24 hours of the knowledge of a reportable release)
5100 E. Winnemucca Blvd.
Winnemucca, NV 89445
(775) 623-1500

National Response Center
(800) 424-8802

The drilling supervisor would also advise the local population and affected property owners if the spill affects residents or property.

d. Specific Procedures

(1) For geothermal fluid spills:

- Contain spillage with dikes if possible and haul to the disposal site by vacuum or water trucks, or dispose of it in a manner acceptable to the NDOM and BLM.

(2) For drilling mud:

- Repair reserve pit or contain with dikes. Haul liquid to another reserve pit, available tanks, or approved disposal site.

(3) For petroleum products:

- Contain the spill with available personnel. Use absorbents and dispose of the same in an approved disposal area.
- Spills of petroleum products in excess of 25 gallons must be reported to the NDEP as soon as possible, but no later than the end of the first working day of the release at:
  - In state: (888) 331-6337
  - Out of state: (775) 687-9485

For (1) through (3) above, Ormat would have the source of the spill repaired at the earliest practical time, and continue working crews and equipment on cleanup until all concerned agencies are satisfied.

e. Confirm telephone notification to agencies and regulatory bodies. The Ormat project manager shall confirm telephone notification in writing within 2 weeks of telephone notification. Written confirmation would contain:

(1) The reason for the discharge or spillage

(2) The duration and volume of discharge or spillage

(3) The steps taken to correct the problem

(4) The steps taken to prevent recurrence of the problem

Appendix C

References

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Appendix C. References

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Appendix D

Eagle Act Compliance Document

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EAGLE ACT COMPLIANCE DOCUMENT

NORTH VALLEY GEOTHERMAL DEVELOPMENT PROJECT AT THE SAN EMIDIO GEOTHERMAL FIELD

Prepared by:

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Submitted to:
Bureau of Land Management
Winnemucca District

And

United States Fish and Wildlife Service
Pacific Southwest Region

October 2020

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APPENDICES

1.0 INTRODUCTION

The purpose of this Bald and Golden Eagle Protection Act (Eagle Act) compliance document is to describe measures that ORNI 36, a subsidiary of Ormat Nevada, Inc. (Ormat), would incorporate to avoid take of golden eagles (*Aquila chrysaetos*) during construction of the geothermal development project summarized below. This document also describes voluntary measures Ormat has committed to that would support golden eagle conservation in the region.

If determined to be necessary, Ormat also may use this document to support an eagle take permit application under the Eagle Act (50 Code of Federal Regulations [CFR] 22.26) for disturbance-related take of golden eagles during the breeding season. Nest removal is not proposed. The regulation that allows the US Fish and Wildlife Service (USFWS) to issue permits for “Eagle take that is associated with, but not the purpose of, an activity” is 50 CFR 22.26

1.1 PROJECT SETTING AND BACKGROUND

Ormat is proposing to construct and operate the North Valley Geothermal Development Project at the San Emidio Geothermal Field (project). The project is within an area of interest (AOI) in Washoe County and includes an associated overhead generation-tie (gen-tie) line that would cross portions of Churchill, Pershing, and Lyon Counties and connect with an existing substation near Fernley, Nevada. Collectively, the AOI and gen-tie right-of-way (ROW) make up the project area (**Appendix A, Figure A-1**, Project Area).

The project proposes geothermal development in the San Emidio Geothermal Unit (NVN-85820X), which encompasses approximately 20,400 acres of Bureau of Land Management (BLM)-administered public lands and private lands in the San Emidio Desert in Washoe County, Nevada (**Figure A-2**, Geothermal Leases).

The project proposes to construct two closed-loop binary geothermal power plants, geothermal fluid production and injection wells, well pads, access roads, geothermal fluid pipelines, and ancillary support facilities (**Figure A-3**, Project Overview—San Emidio Geothermal Lease Unit). A 58-mile-long, 120 kilovolt (kV) overhead gen-tie line with associated facilities is also proposed. The proposed 120 kV gen-tie line would mostly parallel an existing Los Angeles Department of Water and Power 500 kV transmission line.

As detailed in the project’s Biological Baseline Report (BLM 2020), raptor aerial surveys carried out in support of the project have documented 135 raptor nests in the survey area, which included a 4-mile buffer around the AOI, a 2-mile buffer around the northern portion of the gen-tie alignment, and a 10-mile buffer around the southern portion of the gen-tie alignment. Of these, 69 nests were classified as likely belonging to golden eagles. In 2019, golden eagles occupied four of these nests, and there was an unsuccessful nesting attempt made at one of the four nests.

2.0 PROPOSED OPERATIONS

2.1 PROPOSED ACTION

The proposed project includes construction and operation of two 20-megawatt, closed-loop binary geothermal power plants; geothermal fluid production wells, injection wells, and well pads; access roads; geothermal fluid pipelines; ancillary support facilities; and an electrical substation located in the AOI in the San Emidio Desert. It also includes construction and operation of an overhead gen-tie power line with associated facilities between the proposed electrical substation and the Eagle Substation near Fernley, Nevada. Unless otherwise noted, all information describing the elements of the proposed project, other than the proposed gen-tie line and ROW, is from the project's Utilization Plan (ORNI 36 LLC 2019). The details of the proposed gen-tie line and ROW are in Ormat's Plan of Development (Ormat 2019).

2.1.1 Area of Interest

The AOI consists of approximately 3,938 acres of BLM-administered public lands and private lands in Washoe County, Nevada (see **Figure A-3**, Project Overview—San Emidio Geothermal Lease Unit).

All proposed surface disturbance associated with project geothermal utilization components would be in the AOI. The AOI does not include proposed surface disturbance associated with the gen-tie line (see **Section 2.1.10**, Gen-Tie Line). The proposed surface disturbance would be associated with two new geothermal power plants, well pads, geothermal fluid pipelines, new and upgraded access roads, an aggregate pit, electrical substation, and ancillary features, such as office buildings and storage facilities.

2.1.2 Site Preparation

Site preparation would commence with grubbing and clearing of the construction area. Following grubbing and clearing, topsoil would be removed and stockpiled for later use in revegetation and reclamation.

As much as possible, native materials (derived from grading to balance cut and fill) would be used for site and road building materials. Approximately 100,000 cubic yards of surfacing material may be needed for power plant and pipeline construction. Ormat would obtain the aggregate material from an existing pit in the San Emidio Geothermal Unit. The existing pit would be expanded by up to approximately 5 acres.

2.1.3 Geothermal Power Plants

The two proposed geothermal power plants would be located in Sections 16 and 21, Township 29 North, Range 23 East (**Figure A-3**), respectively. Each would be an approximately 20-megawatt net-rated (24-megawatt gross) geothermal power generation facility. The combined footprint of the proposed power plants would be approximately 30 acres. A chain-link fence would be installed around the main facility areas to prevent unwarranted access to the facility by the public, and to exclude wildlife from the facility and electrical generation area. Additional details can be found in the project's Utilization Plan (USG Nevada LLC 2019).

2.1.4 Well Field

The number of geothermal production and injection wells required for the project is principally dependent on the productivity (or injectivity) of the wells and the temperature and pressure of the produced geothermal fluid. Production wells flow geothermal fluid to the surface. Injection wells are used to inject geothermal fluid from the power plant into the geothermal reservoir. Injection ensures the longevity and renewability of the geothermal resource.

Ormat is proposing up to 25 production and injection wells, all located within the San Emidio Geothermal Unit on BLM-administered public lands. **Figure A-3** shows the approximate locations of these proposed production and injection wells.

Temporary surface disturbance for the proposed well pads would be approximately 4.2 acres per pad. After interim reclamation, there would be approximately 2.5 acres of permanent disturbance at each well pad (see **Section 2.1.12**, Reclamation, for more details on interim reclamation).

Drill pad preparation activities would include clearing, earthwork, drainage, and other improvements necessary for efficient and safe operation and for fire prevention. Clearing would include brush removal, which would either be taken to an appropriate dump site or piled and left on-site. Topsoil would be stripped (typically to the rooting depth) and salvaged during the construction of all pads, as feasible. Salvaged topsoil (and cleared organic material, if saved) would be stockpiled on the pads for use during subsequent reclamation of the disturbed areas.

Stormwater runoff from undisturbed areas around the constructed drill pads would be directed into ditches surrounding the drill pad and back onto undisturbed ground. This is consistent with best management practices (BMPs) for stormwater. The site would be graded to prevent the movement of stormwater from the pad.

Reserve pits on each pad would be constructed in accordance with BMPs identified in the Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (commonly referred to as the Gold Book [BLM and Forest Service 2007]). The reserve pits would be fenced to prevent access by persons, wildlife, or livestock. The fence would remain in place until pit reclamation begins.

Once a well is drilled and the well head is completed, an industrial grate would be placed over the hole to prevent humans and wildlife from falling into the cellar. After interim reclamation is completed, the well pads would be fenced on all four sides to limit access.

2.1.5 Geothermal Fluid Pipelines

The geothermal fluid production pipelines would bring the geothermal fluid from the production wells to the power plant; injection pipelines would deliver the cooled geothermal fluid from the power plant to the injection wells. Ormat proposes approximately 7.6 miles of production and injection pipeline routes.

During pipeline construction, an approximately 40-foot-wide corridor would be temporarily disturbed. After Ormat performs interim reclamation, an approximately 20-foot-wide corridor would be maintained.

The production and injection pipeline routes generally would follow the shortest distance from each well pad to the next well pad or the power plant. This would be done to minimize the amount of pipe required, reduce heat losses and the power required to move the fluids, and minimize the amount of ground disturbance. In addition, the proposed pipeline routes generally would follow existing or proposed roads to facilitate ongoing monitoring and future maintenance.

When completed, the top of the new geothermal pipelines would average 3 feet above the ground surface; however, a number of pipeline lengths could be up to 6 feet above the ground surface, to accommodate terrain undulations and to facilitate movement of wildlife and livestock through the well field.

2.1.6 North Valley Substation

Ormat proposes to locate the North Valley Substation at the northernmost end of the 120 kV gen-tie line adjacent to the new power plant. The substation would be built within the power plant footprint. The gen-tie line would originate here. The proposed substation would have a fenced area of approximately 250 feet by 175 feet.

Work at the substation site would begin by clearing existing vegetation and grading a level pad for installation of the substation. Once the pad is prepared, the site would be secured with chain-link fencing. Holes for the structure footings and underground utilities would then be excavated. The footings and underground utilities would be installed, including electrical conduits and additions to the ground grid, and the excavations would be backfilled. Aboveground structures and equipment would then be installed.

Once the equipment is installed, gravel would be spread over the site. Ormat would obtain gravel from within the boundaries of an existing lease, from an existing aggregate pit, or from a private source located near the project area.

2.1.7 Access Roads

2.1.7.1 New Access Roads

New access roads would be constructed using a dozer or road grader, or both. Ormat proposes a total of approximately 4.2 miles of new access roads. The estimated surface disturbance required for new access road construction is a 25-foot-wide area.

Access roads that cross existing drainages may require culvert installation. Culvert installation would follow BLM design criteria and standards in the Gold Book (BLM and Forest Service 2007).

2.1.7.2 Existing Road Improvements

Approximately 0.5 miles of existing roads may be improved to facilitate project access. Improvements could include widening, grading, or blading. Approximately 5 feet of disturbance along the existing road shoulder would be required.

2.1.8 Water Use

Approximately 50,000 gallons per day would be consumed during the first 2 months of construction; 5,000 gallons per day would be consumed thereafter for approximately 6 months. This water would be supplied from geothermal fluid, the Sweetwater Well via a private ranch source, or one or more shallow water wells drilled from one or more of the proposed drill sites. Water quality would be tested prior to use.

Facility operation would consume up to approximately 325 gallons per day. This water would be obtained from the off-site sources identified above; it would be trucked to the power plants and stored on-site. Ormat would purchase drinking water from a commercial bottled water source.

2.1.9 Personnel

Project construction would likely require a maximum of 50 workers. After grading and excavation, this would drop to an average of three to four workers. Once operating, the project would have a staff of approximately 15 to 20 employees. The power plant would be staffed, and approximately one to two employees may be on-site at a given time.

2.1.10 Gen-Tie Line

The electrical substations described above would be connected to the NV Energy power grid via a proposed 58-mile-long, overhead 120 kV gen-tie line, from the proposed North Valley Substation to the existing Eagle Substation near Fernley, Nevada. The gen-tie line would cross approximately 40 miles of BLM-administered lands and 18 miles of private lands. The route would parallel an existing alignment of the Los Angeles Department of Water and Power's 500 kV direct current DC transmission line. The gen-tie line would consist of a single 120 kV circuit on direct-buried, wood, H-frame structures. Before installation, all structures would be preassembled, and insulators would be attached to the pole. A truck-mounted crane would lift and set the structure after it is assembled (Ormat 2019).

In order to accommodate gen-tie construction equipment and activities, temporary work areas (approximately 300 feet by 300 feet) would be necessary at each gen-tie structure site. Several stringing sites and angle points, which would each have an area of approximately 300 feet by 300 feet, would also be necessary to install the conductor for the 120 kV gen-tie line. Stringing sites would be located approximately every 10,000 to 15,000 feet along the gen-tie line.

Temporary material storage yards would be required for gen-tie construction materials. These staging areas would be located at existing well pads or the power plant site at the gen-tie line's northern end.

To establish work areas where poles and conductors would be installed, vegetation clearing and grading within the ROW could be necessary. In all locations, Ormat would use overland travel, to the extent possible; vegetation removal would be minimized, to the extent possible. In order to stage equipment and conduct work, the structure access, work areas, and stringing sites would require a relatively flat surface; therefore, the areas could be graded, and gravel or soil could be imported to achieve the necessary elevation. Proposed work areas would be located away from potentially sensitive sites, and the BLM Authorized Officer would approve them prior to work beginning in these areas.

After construction, the temporary work areas would be reclaimed and restored. This exception is a 20-foot by 30-foot pad, which would be used for future maintenance on gen-tie infrastructure. The temporary work areas would be revegetated, as described in **Section 2.1.12**, Reclamation.

2.1.11 Applicant-Committed Environmental Protection Measures

All construction, operation, and maintenance activities in the AOI and for the proposed gen-tie line would be conducted in compliance with all relevant federal, state, and local regulations and permits. All activities would also be conducted in accordance with the requirements and conditions specified in the National Environmental Policy Act (NEPA) decision record and BLM ROW grant for the gen-tie line. In addition to these requirements, Ormat has committed to implementing environmental protection measures to further avoid or minimize potential adverse environmental impacts. These are measures to prevent or control fires, prevent soil erosion and noxious weed establishment, protect surface and groundwater quality, protect wildlife, protect cultural properties and visual resources, minimize air and noise pollution, and minimize hazards to public health.

2.1.12 Reclamation

Areas to be reclaimed would be recontoured to a final or intermediate contour that would blend with the surrounding topography to the extent possible. Areas to be reclaimed would be ripped, tilled, or disked on contour, as necessary, and stockpiled topsoil would be applied. A BLM-approved seed mixture would be applied. At the end of project operations, wells would be plugged and abandoned as required by Nevada Division of Mineral regulations.

Reclamation of roads would include recontouring the roads back to the original contour and seeding with a BLM-approved seed mix. Other techniques to improve reclamation success, such as ripping, scarifying, replacing topsoil, and pitting and mulching, may be conducted if determined to be necessary. Pipeline reclamation would include removing all pipeline and supports, and breaking up and burying support foundations in place. Surface reclamation, as described above, would occur.

Ormat would completely remove all other aboveground facilities from the site, and concrete foundations would be broken and buried in place. Surface reclamation, as described above, would occur.

Ormat would attempt to close or restrict vehicle access to areas that have been seeded until reclamation success criteria have been achieved. Stormwater diversion measures would remain in place until successful revegetation is attained.

3.0 REGULATORY FRAMEWORK

The USFWS is charged with implementing statutes that protect eagles, including the Eagle Act and the Migratory Bird Treaty Act (MBTA). These are summarized below.

3.1 EAGLE ACT

The Eagle Act of 1940, as amended, prohibits the “take” or possession of bald and golden eagles with limited exceptions. Take, as defined in the Eagle Act, includes “to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Disturb means "to agitate or bother a bald or golden eagle to a degree that causes or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding or sheltering behavior."

The Eagle Act authorizes the USFWS to issue eagle take permits when the take is compatible with the preservation of each eagle species, defined as "consistent with the goals of maintaining stable or increasing breeding populations in all eagle management units (EMUs) and the persistence of local populations throughout the geographic range of each species" (USFWS 2016). The permits are designed to ensure cumulative take does not exceed levels that would result in regional or local eagle population declines from historical levels.

In January 2017, the USFWS revised the regulations for eagle nonpurposeful/incidental take permits and other components of the Eagle Act. Revisions include changes to permit issuance criteria and duration, definitions, compensatory mitigation standards, permit application requirements, and fees. The USFWS intended for the revisions to add clarity to the eagle permit regulations, improve their implementation, and increase compliance, while maintaining strong protection for eagles.

Under the Eagle Act, the USFWS may issue a permit that "authorizes incidental take of bald and golden eagles where the take is compatible with the preservation of the bald eagle and golden eagle; necessary to protect an interest in a particular locality; associated with but not the purpose of the activity and cannot practicably be avoided."

3.2 MIGRATORY BIRD TREATY ACT

The MBTA (16 United States Code 703-712) is administered by the USFWS and is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements a series of international treaties that provide for migratory bird protection. The act authorizes the Secretary of the Interior to regulate the taking of migratory birds. The act provides that it shall be unlawful, except as permitted by regulations, "to pursue, take, or kill any migratory bird, or any part, nest or egg of any such bird" (16 United States Code 703); however, the act does not regulate habitat. The list of species protected by the act was revised in March 2010. It includes almost all bird species that are native to the United States.

3.3 EXECUTIVE ORDER 13186—RESPONSIBILITIES OF FEDERAL AGENCIES TO PROTECT MIGRATORY BIRDS

Signed on January 11, 2001, this executive order directs each federal agency taking actions that are likely to have a measurable effect on migratory bird populations to develop and implement a memorandum of understanding (MOU) with the USFWS that promotes the conservation of migratory bird populations. The USFWS's MOU with the BLM states, in part, that both parties shall, as practicable, protect, restore, and conserve habitat of migratory birds; follow the USFWS Bald Eagle Management Guidelines; follow other migratory bird conservation measures as appropriate and consistent with agency missions; work collaboratively to identify and address issues that affect species of concern; and promote and contribute migratory bird population and habitat data to interagency partnership databases (BLM 2010). The MOU also commits the BLM to, among other measures, participate in planning efforts of bird conservation regions and, at the project level, evaluate the effects of the BLM's actions on migratory birds during the NEPA process (BLM 2010).

4.0 BASELINE SURVEY METHODS AND RESULTS

The project area was covered by two separate raptor aerial occupancy surveys; one survey covered the San Emidio Geothermal Unit portion of the project area and northern portion of the gen-tie alignment; the second survey covered the southern portion of the gen-tie alignment. The methodology and results for these separate surveys are described separately below.

4.1 SURVEY METHODOLOGY

4.1.1 Geothermal Unit and Northern Gen-Tie

Ormat conducted golden eagle and other raptor aerial occupancy surveys of the San Emidio Geothermal Unit and northern portion of the proposed gen-tie alignment in April, May, and August 2019[1] (WRC 2019; see **Appendix B**). The eagle survey area was developed in consultation with the BLM Winnemucca District and USFWS. It included a 2-mile buffer around the San Emidio Geothermal Unit portion of the project area. The survey covered a 4-mile buffer around the San Emidio Geothermal Unit portion of the project area was surveyed; results from this larger buffer are included in this report. In addition, the survey area included a 2-mile buffer around the northern portion of the gen-tie alignment. The survey methodology is described below.

Two aerial occupancy surveys of the San Emidio Geothermal Unit and northern portion of the proposed gen-tie alignment were conducted in 2019. The first was conducted on April 8, during incubation; the second was conducted on May 31, during fledging.

Flight lines were concentrated in areas with suitable golden eagle nesting habitat, which are typically rims of bedrock-formed cliffs and outcrops in the project area. All potential raptor nests observed in suitable habitat were recorded, including all common raven (*Corvus corax*) nests. All nests were closely inspected for evidence of occupation in 2019, including repair and decoration, or extensive droppings.

Several nest attributes were assessed and recorded, including nest size, nest condition, nest and substrate height, and nest protection. Any evidence of recent nest use and information on birds observed were also recorded.

[1] August is outside the survey protocol date range; however, as described in further detail, a relatively small area, consisting of lower-quality habitat, was missed during the April and May surveys. The August survey, therefore, was limited to this area.

On the second aerial survey, all golden eagle and large raptor nests, whether classified as occupied or not on the first aerial survey, were visited. The age of golden eagle young, if observed, was estimated.

A third aerial survey was conducted on August 22, 2019, to search for nests in a small portion of the survey area that was missed during the April 8 and May 31 survey dates. Two areas along the outer edge of the 4-mile buffer around the geothermal unit, each between 3.5 and 4 miles from the geothermal unit, were surveyed on this date. Most terrain in these areas was the flat basin of the San Emidio Desert. The size of the area surveyed during this flight was approximately 12,300 acres, or about 10 percent of the total geothermal unit and northern gen-tie survey area of approximately 121,400 acres. The area surveyed on the August 22 flight is outside the 2-mile survey area around the geothermal unit AOI.

Biologists recorded the location of all golden eagles observed. Where possible, the stage of plumage was also noted (immature, subadult, or adult).

4.1.2 Southern Gen-Tie

Ormat conducted separate golden eagle and raptor aerial occupancy surveys along the southern portion of the gen-tie alignment. The survey area and methodology were developed in consultation with the BLM Winnemucca District and USFWS for a separate project (Ormat's proposed Juniper project). The survey area was determined to include a 10-mile buffer around the proposed Juniper project, which includes the southern portion of the gen-tie alignment for the North Valley Geothermal Development Project. Surveys followed the methods described in Pagel et al. (2010).

McGinley & Associates, Inc. conducted these surveys in support of the proposed Juniper project, which shares the same southern portion of the gen-tie alignment (through Washoe County) with the proposed North Valley Geothermal Development Project; thus, at the BLM's direction, this baseline biological report incorporates results from the proposed Juniper project raptor occupancy surveys.

Two rounds of aerial occupancy surveys of the southern portion of the gen-tie alignment were conducted. The first was done over 2 days, on January 29 and February 6, 2019; the second round was flown on March 11, 2019. Datasheets from these surveys are included as **Appendix B**.

4.2 SURVEY RESULTS

4.2.1 Geothermal Unit and Northern Gen-Tie

4.2.1.1 Nests Observed

A total of 56 stick nests were observed in the survey area, as summarized in **Table 4-1** and shown on **Figures A-5.1** to **A-5.8**. Thirty-eight nests were classified as likely belonging to golden eagles. The Nevada Department of Wildlife (NDOW) raptor database had four nests within the survey area (three golden eagle nests and one falcon nest). Of nests in the NDOW database, two golden eagle nests were located during this survey; one golden eagle nest and the falcon nest were not located.

Nest 44 was observed in the area of limited habitat surveyed in August 2019. It was classified as a small raptor nest because its size was between 1 and 2 feet in diameter. No other nests were observed in this area. Nest 44 was, therefore, the only nest observed on the August flight.

Three nests were classified as occupied. Golden eagles occupied one nest classified as a golden eagle nest. Prairie falcons (*Falco mexicanus*) occupied one nest classified as a large raptor nest. Common ravens occupied one nest classified as a common raven nest. Nesting attempts were confirmed at all the occupied nests. A complete summary of data collected in the 2019 nesting surveys is provided in the WRC survey report (2019).

Table 4-1
Raptor Nest Summary—Geothermal Unit and Nothern Gen-Tie

Nest Size and Diameter (Feet)	Potential Nest Type	Total Nests	Occupied Nests (Raptor)	Confirmed Nesting Attempts (Raptor)
Very large (>3) or large (2–3)	Golden eagle	38	1 (golden eagles)	1 (golden eagles)
Very large (>3) or large (2–3)	Ferruginous hawk	1	0	0
Medium (1–2) to large (2–3)	Large raptor	7	1 (prairie falcons)	1 (prairie falcons)
Small (0–1) to medium (1–2)	Small raptor	5	0	0
Small (0–1)	Common raven	5	1 (common ravens)	1 (common ravens)
Total	-	**56**	**3**	**3**

Source: WRC 2019
> = greater than

4.2.1.2 Golden Eagle Nest Occupancy

Occupancy is definitively verified by the observation of a pair of adult birds at or near a nest, an observation of an adult at a nest in an incubation or brooding posture, or an observation of eggs or young. Ormat also considered the presence of fresh, green plant materials (nest decorations) as definitive evidence of occupancy. Other observations, such as an adult bird with a subadult bird or a single bird in the vicinity of a nest, suggest nest occupancy; however, they are generally not thought to be definitive (Driscoll 2010).

As described above, Nest 44 was observed only in August, past the survey protocol date range; therefore, occupancy at this nest in 2019 could not be definitely determined. It was classified as a potential small raptor nest because its size was between 1 and 2 feet in diameter.

One nest (Nest 2) was classified as occupied by golden eagles. An adult was observed incubating on Nest 2 during the first aerial survey, and a broken egg was observed in the nest on the second survey. Nest 2 is over 1 mile from the gen-tie alignment.

Potential eagle Nests 40 and 36-A were classified as destroyed or deteriorated; the bulk of the nest had fallen. As they were likely constructed by eagles, these nests were retained in the database. The remainder of the nests classified as golden eagle nests were considered intact.

4.2.1.3 Golden Eagle Nesting Attempts

A nesting attempt by golden eagles was detected at Nest 2, where an adult was observed incubating on the first flight; however, only a single broken egg was observed on the second flight, so the assumption was that the nesting attempt had failed.

4.2.1.4 Raptor Nests within 1 Mile of Project Components

Five golden eagle nests were observed within 1 mile of the geothermal AOI. These are summarized in **Table 4-2** and shown on **Figure A-6.1**.

Table 4-2
Golden Eagle Nests within 1 Mile of Project—Geothermal Unit

Nest Identification	Nest Type	Project Component within 1 Mile	Approximate Distance to Project Component (miles)	2019 Nest Status	Notes
26	Golden eagle	AOI	0.6	Unoccupied/alternate	
27A	Golden eagle	AOI	0.6	Unoccupied/alternate	
27B	Golden eagle	AOI	0.6	Unoccupied/alternate	
32	Golden eagle	AOI	0.3	Unoccupied/alternate	
33	Golden eagle	AOI	0.3	Unoccupied/alternate	

Source: WRC 2019; Ormat GIS 2019

Fourteen golden eagle nests were observed within 1 mile of the northern portion of the proposed gen-tie. These are summarized in **Table 4-3** and shown on **Figures A-6.1** and **A-6.2**. Two of the nests, 8 and 9, are located approximately 0.7 miles from the proposed gen-tie. Despite the proximity of nests 8 and 9 to the proposed gen-tie, due to topography, there is not a direct line of sight from the nests to the gen-tie.

Table 4-3
Golden Eagle Nests within 1 Mile of Project—Nothern Gen-Tie

Nest Identification	Nest Type	Project Component within 1 Mile	Approximate Distance to Project Component (miles)	2019 Nest Status	Notes
8	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	Does not have a direct line of sight to the gen-tie
9	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	Does not have a direct line of sight to the gen-tie
10	Golden eagle	Gen-tie	0.1	Unoccupied/alternate	
16	Golden eagle	Gen-tie	0.6	Unoccupied/alternate	

Nest Identification	Nest Type	Project Component within 1 Mile	Approximate Distance to Project Component (miles)	2019 Nest Status	Notes
17A	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	
17B	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	
17C	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	
17D	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	
17E	Golden eagle	Gen-tie	0.7	Unoccupied/alternate	
18	Golden eagle	Gen-tie	0.2	Unoccupied/alternate	
23	Golden eagle	AOI	0.9	Unoccupied/alternate	
24	Golden eagle	Gen-tie	1.0	Unoccupied/alternate	
29	Golden eagle	AOI	0.7	Unoccupied/alternate	
38	Golden eagle	Gen-tie	0.6	Unoccupied/alternate	

Source: WRC 2019; Ormat GIS 2019

4.2.2 Southern Gen-Tie

4.2.2.1 Nests Observed

A total of 79 stick nests were observed in the survey area, as summarized in **Table 4-4**, below. Thirty-one nests were classified as likely belonging to golden eagles.

Table 4-4
Raptor Nest Summary—Southern Gen-Tie

Nest Type[1]	Total Nests
Golden eagle	31
Ferruginous hawk/golden eagle	2
Buteo spp./golden eagle	16
Buteo spp.	15
Buteo spp./common raven	9
Prairie falcon	2
Common raven	4
Total	**79**

Source: Ormat GIS 2019
Note:
[1] A slash ("/") indicates the nest could be used by either type of raptor.

4.2.2.2 Golden Eagle Nest Occupancy and Distance to the Proposed Project

Three nests were classified as likely occupied by golden eagles: Nests 42, 66, and 105 (**Figures A-5.1** to **A-5.8**). Nest 105 is located just over 1 mile from the gen-tie alignment. Nest 42 is approximately 10 miles, and Nest 66 is approximately 9 miles from the gen-tie alignment.

4.2.2.3 Raptor Nests within 1 Mile of Project Components

Four golden eagle nests, or nests that could be used by golden eagles, were observed within 1 mile of the southern portion of the proposed gen-tie. These are summarized in **Table 4-5** and shown on **Figures A-6.3** to **A-6.5**.

Table 4-5
Golden Eagle Nests within 1 Mile of Project—Southern Gen-Tie

Nest Identification	Nest Type[1]	Project Component within 1 Mile	Approximate Distance to Project Component (miles)	2019 Nest Status	Notes
BS-02-B/10	*Buteo* spp./golden eagle	Gen-tie	0.1	Unknown	Does not have a direct line of sight to the gen-tie
BS-02-C/11	Golden eagle	Gen-tie	0.1	Unknown	Does not have a direct line of sight to the gen-tie
TR-01-A/113	Ferruginous hawk/golden eagle	Gen-tie	0.6	Unknown	
TR-02-A/115	*Buteo* spp./golden eagle	Gen-tie	0.9	Unknown	

Source: Ormat GIS 2019
Note:
[1] A slash ("/") indicates the nest could be used by either type of raptor.

4.2.3 Summary

A total of 23 golden eagle nests, or nests that could be used by golden eagles, are within 1 mile of project components. Information on these nests are summarized in **Table 4-2**, **Table 4-3**, and **Table 4-5**, above.

5.0 RISK ASSESSMENT

The purpose of a risk assessment is to identify project activities that could result in a take of golden eagles. Twenty-three golden eagle nests are within 1 mile of the proposed project. Ormat is not proposing to remove nests during construction of the project; however, nesting eagles could be disturbed by construction or other activities within 1 mile of the nest during the breeding season, which is defined as January 1 to August 31 of each year. This is especially true for nests with a clear sight line to the proposed activity. This disturbance would be considered indirect take. Such disturbance could preclude initiation of breeding activity, cause in-use nest abandonment, cause temporary loss of an eagle's territory, or reduce eagle productivity.

Proposed permanent vegetation removal would constitute foraging habitat loss for golden eagles. As summarized in the project environmental assessment (see Section 3.3.4 in the Draft Environmental

Assessment), construction of the proposed power plants, well pads, new and improved roads, pipelines, and aggregate pit would temporarily remove approximately 189.9 acres of vegetation. Approximately 60.4 acres would be reclaimed, and approximately 129.5 acres would not be reclaimed. Construction of the proposed gen-tie would temporarily remove approximately 640 acres of vegetation. Approximately 595 acres would be reclaimed, and approximately 45 acres would not be reclaimed.

The vegetation types that would be most affected within 1 mile of nests are primarily invasive annual grassland and intermountain basins mixed salt desert scrub; other types that would be affected, to a lesser extent, are intermountain basins big sagebrush shrubland, great basin xeric mixed sagebrush shrubland, and intermountain basins greasewood flat.

Other nonconstruction, project-related activities, such as vegetation treatments (i.e., herbicide applications), may also disturb breeding eagles, especially those activities with an extended duration and a high intensity of human presence in the nest vicinity during the breeding season.

Kochert et al. (2002) attribute over 70 percent of golden eagle mortality to direct and indirect anthropogenic causes. Accidental trauma, including collisions with vehicles, power lines, or other structures, is the leading cause of death 27 at percent. This is followed by electrocution at 25 percent, gunshot at 15 percent, and poisoning at 6 percent (Franson et al. 1995; Kochert et al. 2002). Kochert at al. (2002) also note that golden eagles are vulnerable to collision and electrocution when landing on power poles. Less-adept immature eagles are most susceptible to electrocution, and the risk of electrocution increases when inclement weather hampers flight or when wet feathers increase conductivity (APLIC 2006). Most electrocution mortalities occur during winter in the western United States in areas where natural perches are lacking.

6.0 Eagle Act Compliance Measures

6.1 Take Avoidance and Minimization Strategy

Ormat has committed to compliance with the Eagle Act during project construction and operation, and avoiding or minimizing eagle take. To ensure compliance, the following take avoidance and minimization strategies would be followed:

- Ormat intends to conduct all construction activities within 1 mile of golden eagle nests outside of the breeding season. The breeding season is defined as the period including initial courtship and pair bonding, egg laying, incubation, brooding, fledging, and post-fledging dependency of the young. The breeding season extends from January 1 to August 31 of each year.
- If Ormat determines that construction within 1 mile of golden eagle nests during the breeding season is necessary, Ormat would conduct a pre-disturbance, ground-based survey to determine if nest(s) are in use, as described below:
    - If construction within 1 mile of golden eagle nests is proposed to occur during the initial courtship and pair-bonding phase prior to egg laying, Ormat would

coordinate with the BLM, USFWS, and NDOW prior to conducting surveys to confirm appropriate survey methodology that would not result in eagle take in and of itself. Follow-up monitoring may be necessary to conclusively determine nest-use status.

- If construction within 1 mile of golden eagle nests is proposed to occur after the egg laying phase described above, ground-based surveys within 14 days of the proposed construction activity would be done to determine nest-use status.
- In either case, surveys would be done by a qualified avian biologist with experience conducting raptor nesting surveys.
- If the nest status is determined to be alternate (i.e., inactive or unoccupied) and with the BLM, USFWS, and NDOW concurrence, proposed construction within 1 mile of the nest could commence. To ensure the nest status remains unchanged, monthly ground-based nest monitoring would be done while construction is ongoing within 1 mile of the nest during the breeding season.

- If initial surveys or follow-up monitoring, as described above, determine the nest is in use, construction within 1 mile of the in-use nest would not commence, until the breeding season ends (after young have fledged and after post-fledging dependency of the young), or until the in-use nest fails for natural reasons. In these cases, and with the BLM, USFWS, and NDOW concurrence, construction could commence.

6.2 EAGLE TAKE PERMIT CONTINGENCY

- In the case that disturbance-related take of golden eagles is unavoidable, as determined by the USFWS, Ormat would apply for an eagle take permit application under the Eagle Act (50 CFR 22.26) for disturbance-related take of golden eagles during the breeding season. If an eagle take permit application is necessary, Ormat would coordinate with the BLM and USFWS as early as possible.

6.3 APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

Ormat has committed to implementing additional environmental protection measures (in addition to the take avoidance and minimization measures outlined in **Section 6.1**) to further avoid or minimize potential adverse environmental impacts from the proposed project. Measures would generally aid in conserving golden eagle foraging habitat in the project area. These measures are summarized below.

- The project would minimize surface disturbance to the smallest area necessary.
- Before construction, Ormat would submit a noxious plant management plan to the BLM to monitor and control noxious weeds. To prevent the spread of invasive, nonnative species, all contractors would be required to power wash their vehicles and equipment, including the body and undercarriage, before bringing them onto BLM-administered lands. All gravel and fill material used would be certified as weed free.
- Temporarily disturbed areas would be reclaimed as soon as reclamation is feasible. Revegetation and periodic maintenance would prevent erosion and protect habitat.

Suitable, BLM-approved revegetation methods would be used. Topsoil would be stockpiled and applied to enhance revegetation success.

- To prevent undue degradation and the removal of habitat, cover, and food, Ormat would use existing roads whenever possible; cross-country travel would be restricted to designated construction areas.
- The proposed gen-tie line would comply with raptor protection standards described in the Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006 (APLIC 2006). Ormat would equip all power poles with BLM-approved raptor deterrents. Gen-tie structure drawings demonstrating compliance with Avian Power Line Interaction Committee-recommended clearance between energized and energized-to-ground components are shown in **Appendix C**.
- Ormat would minimize construction noise by avoiding or minimizing actions that may typically generate greater noise levels or generate distinctive impact noise.

6.4 BLM-Required Stipulations

Ormat will be required to follow additional BLM-required stipulations as a condition of project approval. These measures would further avoid or minimize potential adverse environmental impacts from the proposed project. Applicable stipulations are summarized below.

6.4.1 Vegetation

- Following construction activities, areas of disturbed land no longer required for operations would be reclaimed to promote the reestablishment of native plant and wildlife habitat.

6.4.2 Wildlife

- Ormat would prepare a habitat restoration plan to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan would identify revegetation, soil stabilization, and erosion reduction measures that would be implemented to ensure that all temporary use areas are restored. The plan would require restoration to occur as soon as possible after completion of activities, to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.
- The proposed gen-tie line would provide raptor protection in compliance with the standards described in the Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 2006 (APLIC 2006).
- Ormat would construct all power poles to be eagle safe and/or to utilize raptor anti-electrocution devices or equipment.

6.5 Additional Mitigation Measures

6.5.1 Habitat Enhancement

- If rocks are removed from project areas during grading, they will be collected and placed in piles to enhance eagle foraging habitat. Rock piles would be placed in areas at least 1 mile from proposed project activities and infrastructure.

6.5.2 Carcass Removal Program

- To reduce the occurrence of collisions between project vehicles and golden eagles, roadkill (non-protected species) will be removed from project access roads. Ormat will coordinate this program with the BLM, USFWS, and NDOW to acquire permits and authorizations, if required.

7.0 References

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Appendix A
Maps

These maps contain sensitive information and cannot be shown without the consent of the BLM, FWS, and Ormat

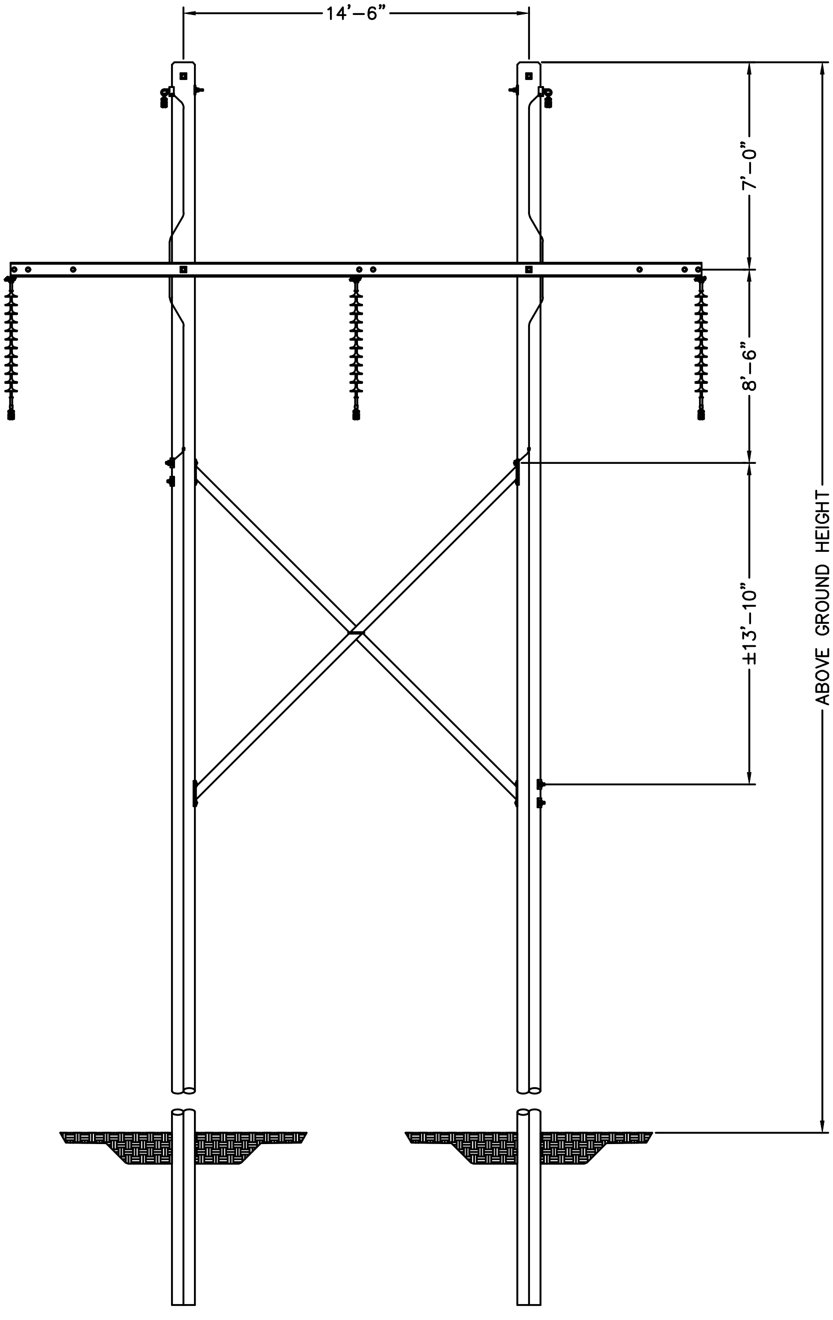
Appendix B
WRC (2019) Survey Report

This appendix contains sensitive information and cannot be shown without the consent of the BLM, FWS, and Ormat

Appendix C
Gen-Tie Structure Drawings

NOTES:

1. ALL DIMENSIONS ARE TO THE CENTER OF THE TOP BOLT OF EACH ATTACHMENT.
2. WHERE THERE IS ONLY ONE BOLT USED FOR ATTACHMENT, DIMENSIONS ARE TO THE CENTER OF THE SINGLE BOLT.
3. EMBEDMENT DEPTH - 10% + 2'.
4. INSTALL POLE TOP CONE FOR ANTI-PERCHING AS REQUIRED.



ORMAT	REVISION NO.	DATE	TRI SAGE CONSULTING	ENGINEER:	JIM BENGOCHEA
ORMAT NORTH VALLEY 120KV LINE H-FRAME STRUCTURE, TANGENT 0°-2° FIGURE 5	ISSUED FOR POD	9/18/2019	5418 Longley Lane, Suite A Reno, NV 89511 Ph. (775) 336-1302 Fax: (775) 336-1306	PHONE NUMBER:	(775) 336-1302
				PROJECT NUMBER:	NV_01
				PREPARED BY:	JMB
				CHECKED:	KLD
				APPROVED:	JMB

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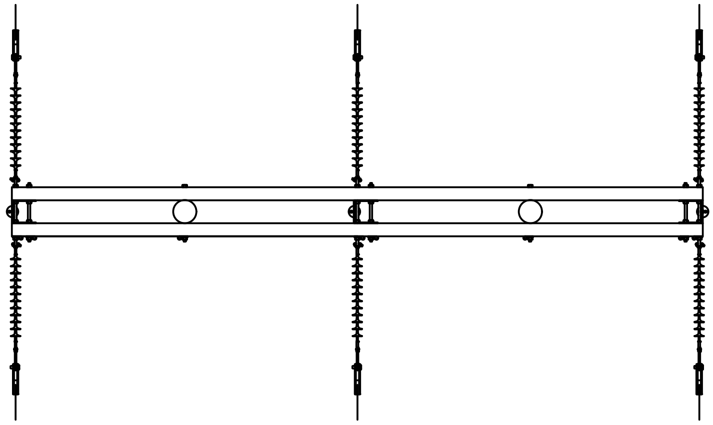
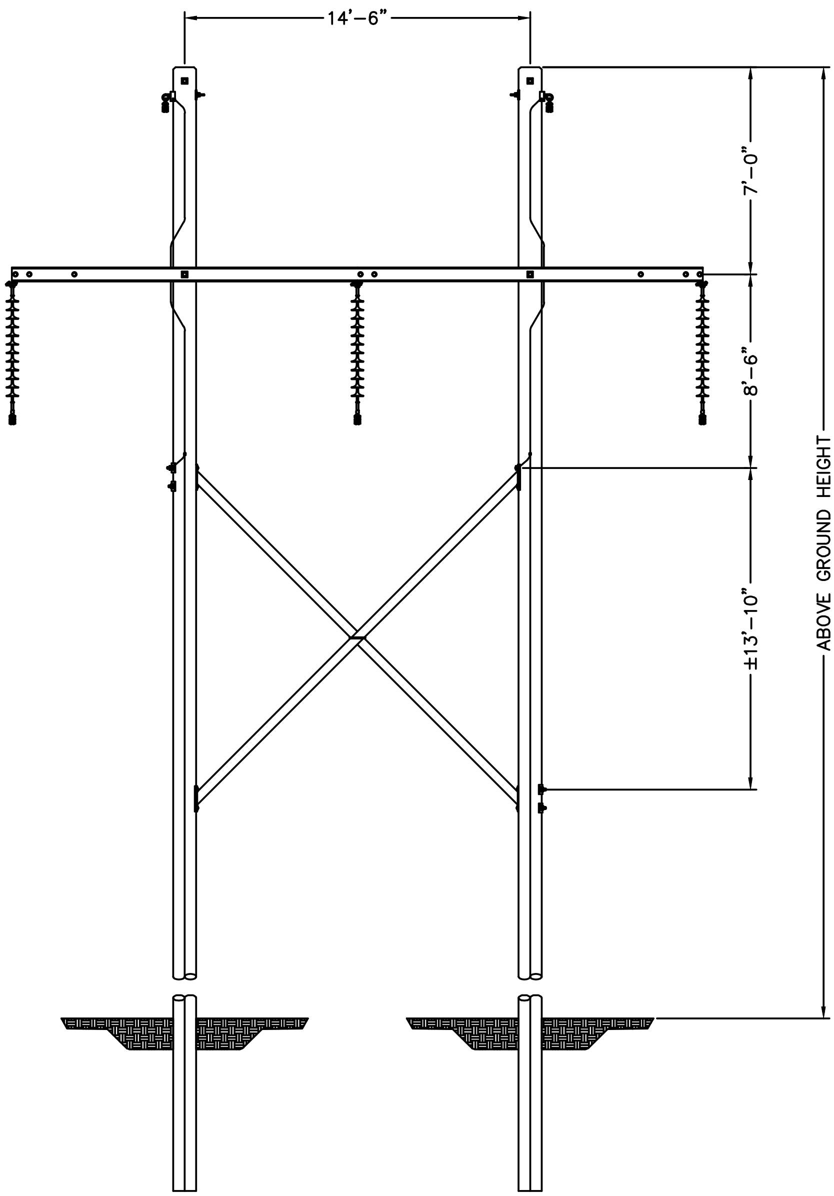


PLAN VIEW



NOTES:

1. ALL DIMENSIONS ARE TO THE CENTER OF THE TOP BOLT OF EACH ATTACHMENT.
2. WHERE THERE IS ONLY ONE BOLT USED FOR ATTACHMENT, DIMENSIONS ARE TO THE CENTER OF THE SINGLE BOLT.
3. EMBEDMENT DEPTH - 10% + 2'.
4. INSTALL POLE TOP CONE FOR ANTI-PERCHING AS REQUIRED.

ORMAT

ORMAT NORTH VALLEY 120KV LINE

H-FRAME STRUCTURE, TANGENT DEADEND 0°-2°

FIGURE 6

REVISION NO.	DATE
ISSUED FOR POD	9/18/2019

TRI SAGE CONSULTING

5418 Longley Lane, Suite A

Reno, NV 89511

Ph. (775) 336-1302

Fax: (775) 336-1306

ENGINEER:	JIM BENGOCHEA
PHONE NUMBER:	(775) 336-1302
PROJECT NUMBER:	NV_01
PREPARED BY:	JMB
CHECKED:	KLD
APPROVED:	JMB

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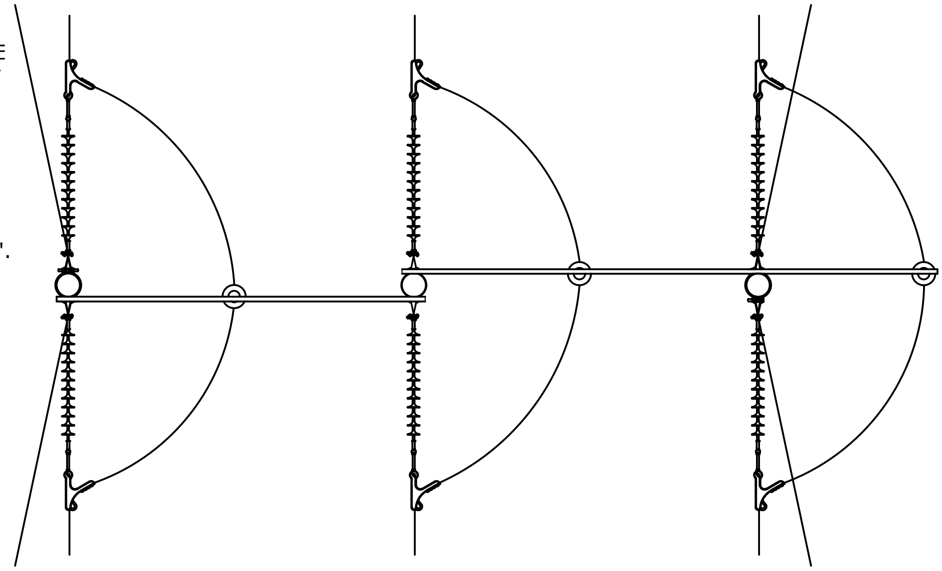
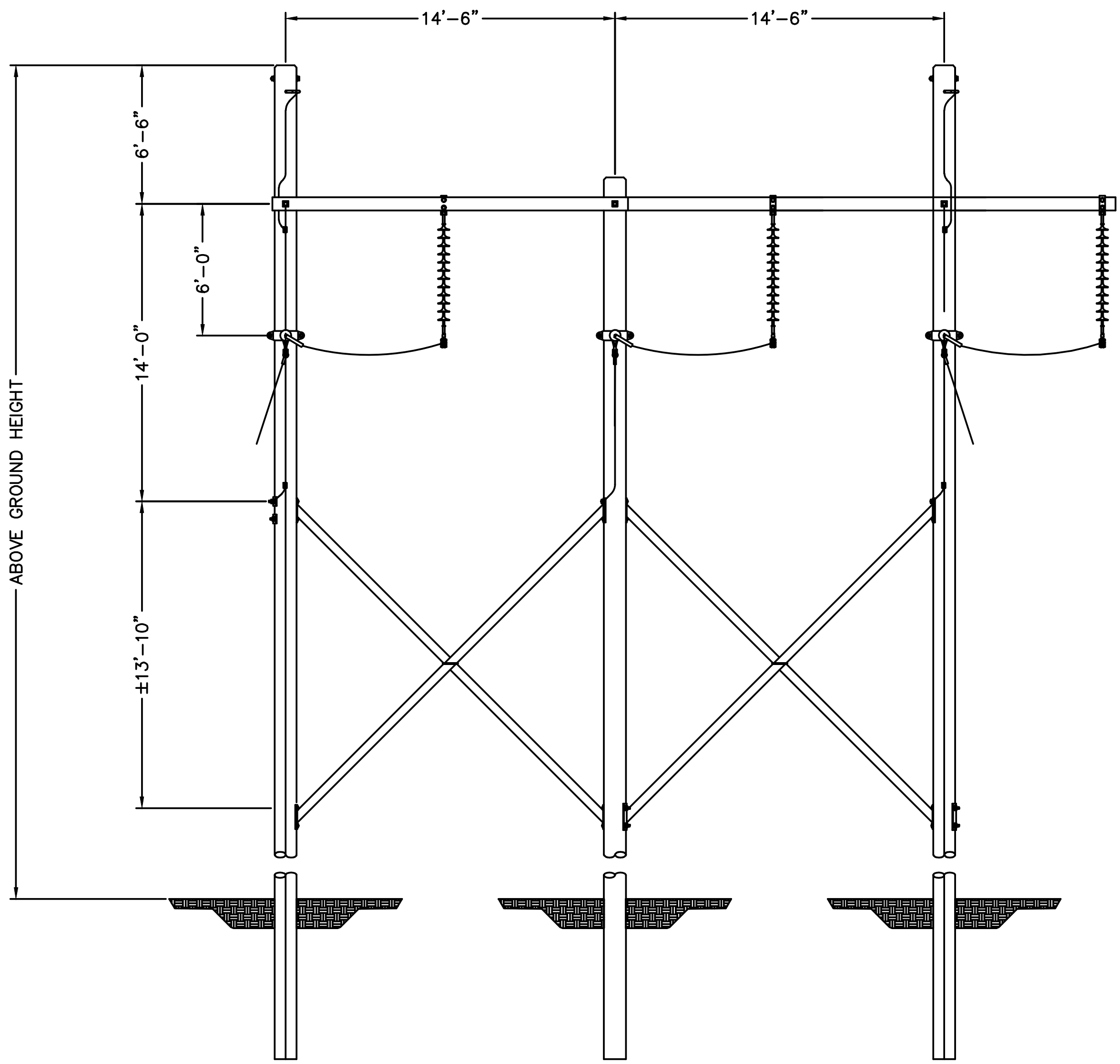
NOTES:

1. ALL DIMENSIONS ARE TO THE CENTER OF THE TOP BOLT OF EACH ATTACHMENT.
2. WHERE THERE IS ONLY ONE BOLT USED FOR ATTACHMENT, DIMENSIONS ARE TO THE CENTER OF THE SINGLE BOLT.
3. EMBEDMENT DEPTH - 10%+2'.
4. INSTALL POLE TOP CONE FOR ANTI-PERCHING AS REQUIRED.



PLAN VIEW



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ORMAT

ORMAT NORTH VALLEY 120KV LINE
3-POLE STRUCTURE, TANGENT DEADEND 0°-5°
FIGURE 7

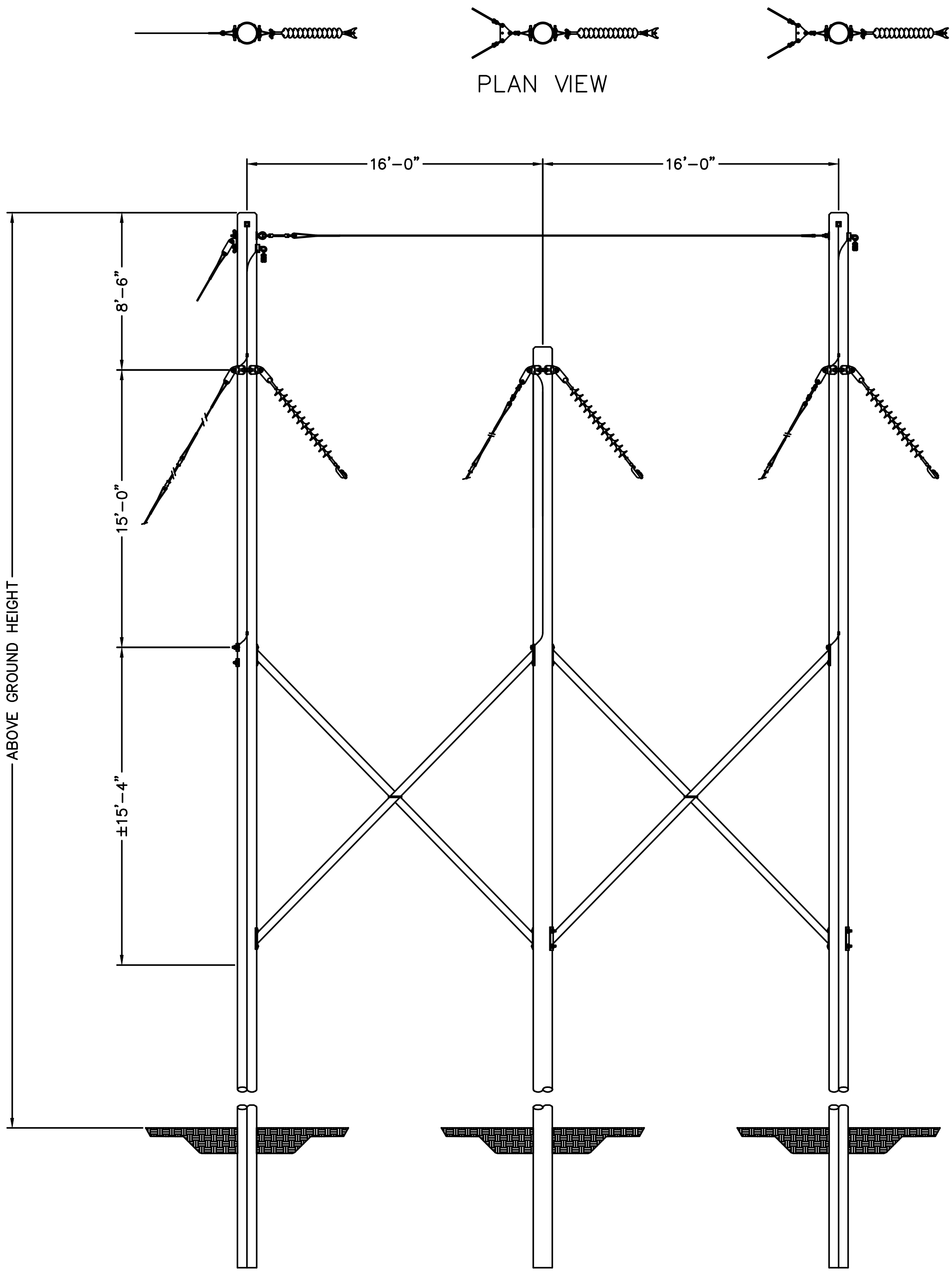
REVISION NO.	DATE
ISSUED FOR POD	9/18/2019

TRI SAGE CONSULTING
5418 Longley Lane, Suite A
Reno, NV 89511
Ph. (775) 336-1302
Fax: (775) 336-1306

ENGINEER:	JIM BENGOCHEA
PHONE NUMBER:	(775) 336-1302
PROJECT NUMBER:	NV_01
PREPARED BY:	JMB
CHECKED:	KLD
APPROVED:	JMB

NOTES:

1. ALL DIMENSIONS ARE TO THE CENTER OF THE TOP BOLT OF EACH ATTACHMENT.
2. WHERE THERE IS ONLY ONE BOLT USED FOR ATTACHMENT, DIMENSIONS ARE TO THE CENTER OF THE SINGLE BOLT.
3. EMBEDMENT DEPTH - 10%+2'.
4. INSTALL POLE TOP CONE FOR ANTI-PERCHING AS REQUIRED.



ORMAT

ORMAT NORTH VALLEY 120KV LINE
3-POLE STRUCTURE, RUNNING ANGLE 35°-60°
FIGURE 8

REVISION NO.	DATE
ISSUED FOR POD	9/18/2019

TRI SAGE CONSULTING
5418 Longley Lane, Suite A
Reno, NV 89511
Ph. (775) 336-1302
Fax: (775) 336-1306

ENGINEER:	JIM BENGOCHEA
PHONE NUMBER:	(775) 336-1302
PROJECT NUMBER:	NV_01
PREPARED BY:	JMB
CHECKED:	KLD
APPROVED:	JMB

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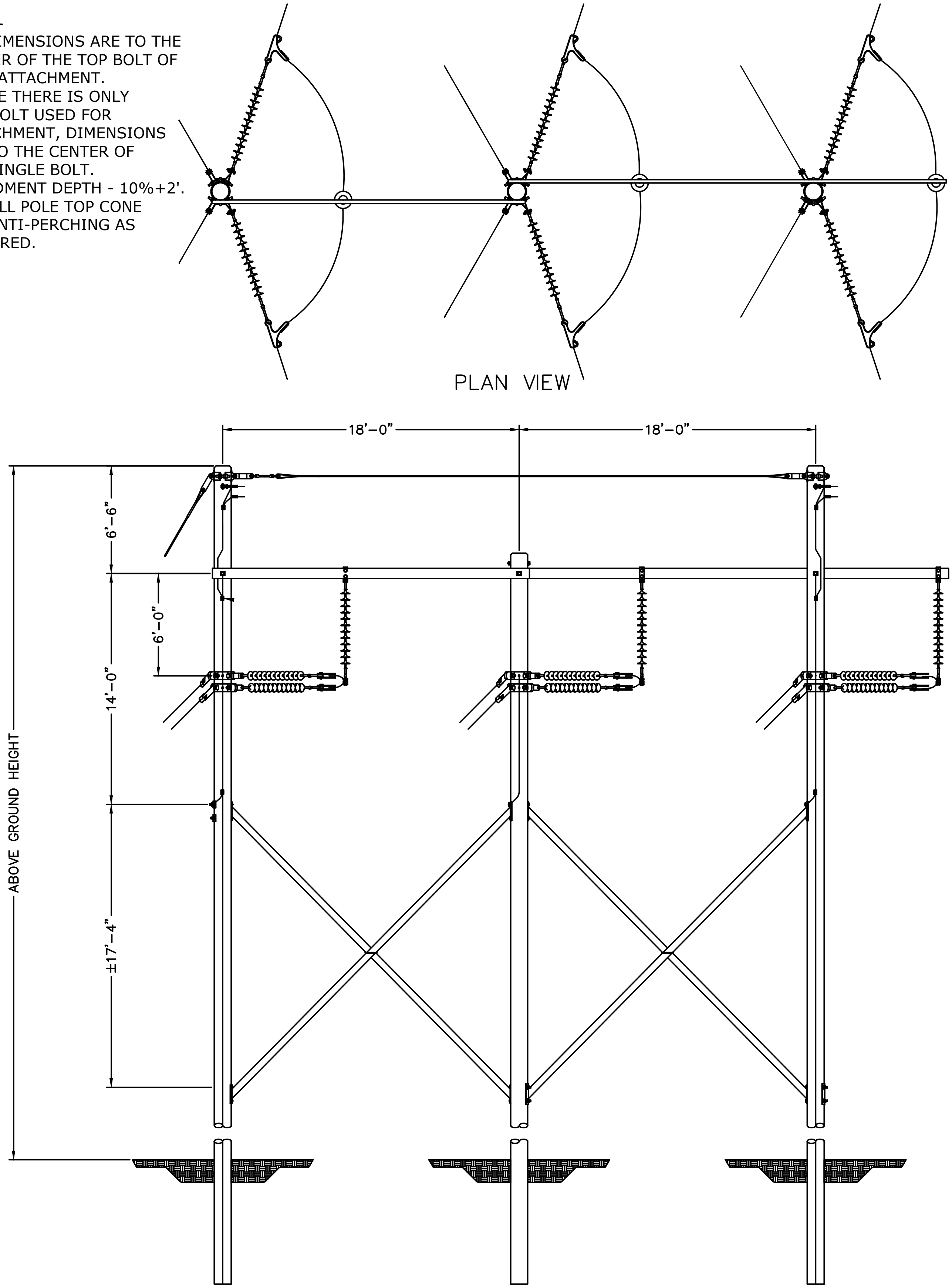
NOTES:

1. ALL DIMENSIONS ARE TO THE CENTER OF THE TOP BOLT OF EACH ATTACHMENT.
2. WHERE THERE IS ONLY ONE BOLT USED FOR ATTACHMENT, DIMENSIONS ARE TO THE CENTER OF THE SINGLE BOLT.
3. EMBEDMENT DEPTH - 10%+2'.
4. INSTALL POLE TOP CONE FOR ANTI-PERCHING AS REQUIRED.



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ORMAT

ORMAT NORTH VALLEY 120KV LINE
3-POLE STRUCTURE, DEADEND ANGLE 5°-90°
FIGURE 9

REVISION NO.	DATE
ISSUED FOR POD	9/18/2019

TRI SAGE CONSULTING
5418 Longley Lane, Suite A
Reno, NV 89511
Ph. (775) 336-1302
Fax: (775) 336-1306

ENGINEER:	JIM BENGOCHEA
PHONE NUMBER:	(775) 336-1302
PROJECT NUMBER:	NV_01
PREPARED BY:	JMB
CHECKED:	KLD
APPROVED:	JMB

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Appendix E

Visual Resources Analysis Materials

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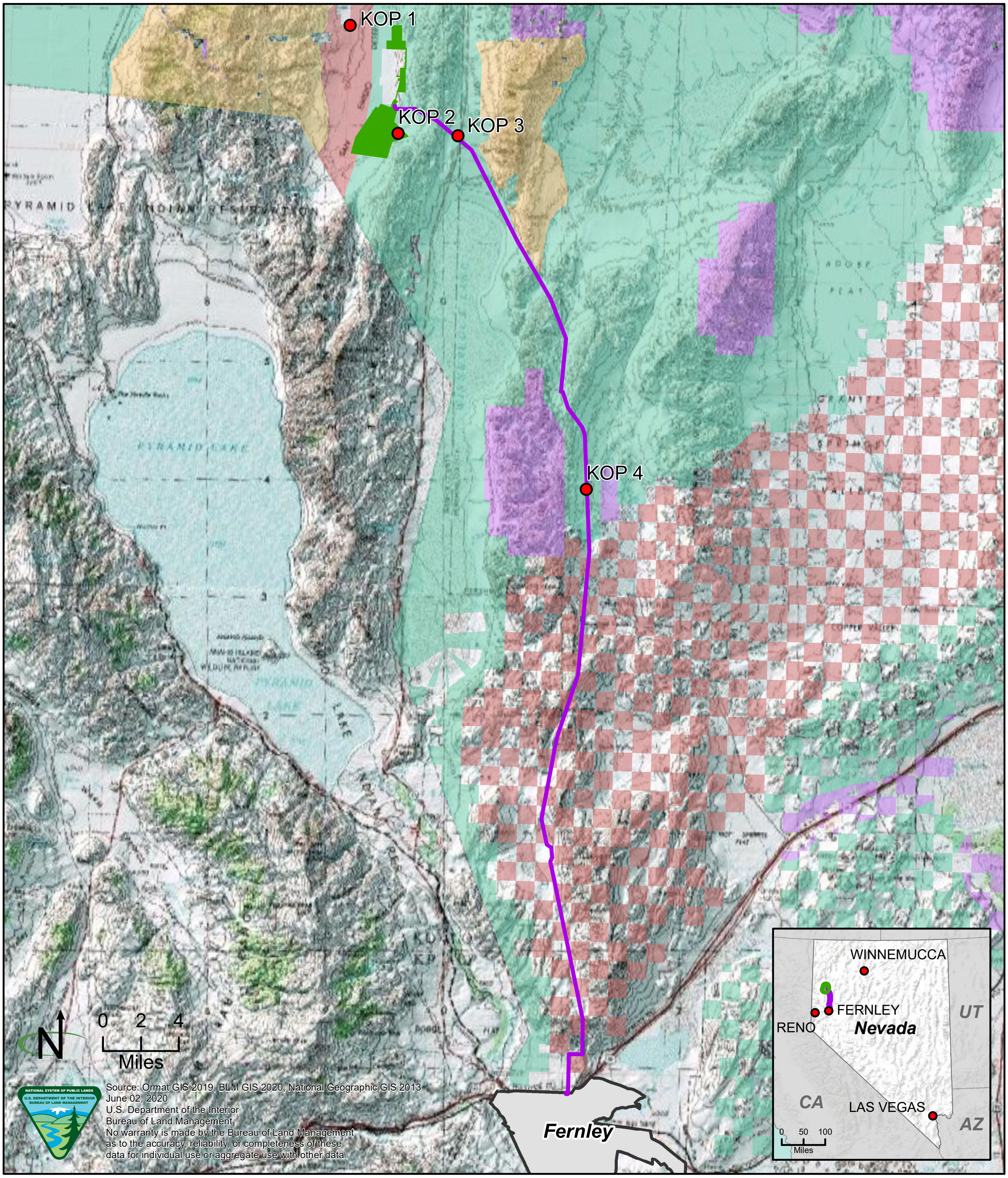


VRM Class and KOPs

- Proposed gen-tie
- Area of Interest
- KOPs
- VRM class I
- VRM class II
- VRM class III
- VRM class IV

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 11/25/0219
District Office: Winnemucca District Office
Field Office: Black Rock Field Office
Land Use Planning Area: WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name
San Emidio II - North Valley Geothermal

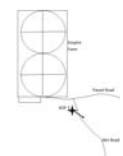
2. Key Observation Point (KOP) Name
KOP 1

3. VRM Class at Project Location
Class IV

4. KOP Location
(T.R.S)
T. 30N, R. 22E, Sec. 36

(Lat. Long)
40°25'52.92"N, 119°27'1.04"W

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Flat in foreground and middleground	Low to mid-rise shrubs, overall continuous simple form	None Evident
LINE	Regular horizontal in foreground and middleground, diagonal in background	Generally flat with weak undulation	None Evident
COLOR	Light and dark tans, moderate brown in background	Tan in foreground and middleground, brown in background	None Evident
TEX-TURE	Smooth in foreground, moderate in background	Light to moderately coarse with some vegetation height variation	None Evident

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Horizontal and vertical	Linear forms from pipelines and access roads	Linear form from pipelines, slight verticality from power plant and transmission line poles
LINE	Horizontal and vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Light browns	Tans and greens	Light brown access road, brown wood structures, tan pipelines and power plant
TEX-TURE	Fine and smooth	Fine to moderate	Fine to moderate

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
FORM				✓				✓			✓	
LINE			✓					✓			✓	
COLOR				✓				✓				✓
TEXTURE			✓					✓				✓

2. Does project design meet visual resource management objectives? ✓ Yes ___No
(Explain on reverses side)

3. Additional mitigating measures recommended
___Yes ✓ No (Explain on reverses side)

Evaluator's Names: Photos and Contrast Evaluation by Peter Gower
Date: 11/25/2019

(Continued on Page 2)

Comments from item 2.

The buildings’ exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

The proposed facilities repeat basic element present in the landscape character, as there are already non-natural lines and forms, namely geothermal plant facilities, utility poles and transmission lines, roadways, fence lines, and other human-made structures. The horizon line would be discontinuous as power lines and facilities generally would not protrude above the skyline.

Reclaimed areas would be re-contoured to blend with surrounding topography to the extent possible. Suitable, BLM-approved re-vegetated methods would be used, and stockpiled topsoil used. Existing roads would be used whenever possible, and cross-country travel would be restricted to designated construction areas.

Nighttime lighting would be limited to those required to safely conduct the operations. The lights would be shielded or directed to focus direct light on the immediate work area to minimize impacts to night skies and dark spaces.

VRM Class IV Objective is to provide for activities that require major modifications of the existing character of the landscape. These activities may dominate the view and be the major focus of the viewer attention. Visual changes to the landscape would be weak to none as contrasts can be seen, but do not dominate the view.

Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 11/25/2019
District Office: Winnemucca District Office
Field Office: Black Rock Field Office
Land Use Planning Area: WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name San Emidio II - North Valley Geothermal	4. KOP Location (T.R.S) T. 29N, R. 23 E, Sec. 28	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 2		
3. VRM Class at Project Location Class III	(Lat. Long) 40°21'1.37"N, 119°24'6.65"W	

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Downslope in foreground with flat middleground, rising diagonal terrain in background	Simple forms, very low vegetation in middleground	No structures (small steam plume visible from flow test)
LINE	Horizontal in middleground, diagonal in background	Weak and low scattered	None evident
COLOR	Light and dark tans, white patches, brown in background	Tan in foreground and middleground, brown in background	None evident
TEX-TURE	Smooth in foreground and middleground, moderately rugged in background	Smooth with light coarseness in foreground	None evident

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Horizontal and vertical	Linear forms from pipelines and access roads	Linear form from pipelines, slight verticality from power plant and transmission line poles
LINE	Horizontal and vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Light browns	Tans and greens	Light brown access road, brown wood structures, tan pipelines and power plant
TEX-TURE	Fine and smooth	Fine to moderate	Fine to moderate

SECTION D. CONTRAST RATING __SHORT TERM __LONG TERM

1.	FEATURES											
	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
DEGREE OF CONTRAST	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS: FORM			✓				✓				✓	
ELEMENTS: LINE			✓				✓				✓	
ELEMENTS: COLOR			✓				✓				✓	
ELEMENTS: TEXTURE			✓				✓				✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___No
(Explain on reverses side)

3. Additional mitigating measures recommended
___Yes ✓ No (Explain on reverses side)

Evaluator's Names: Peter Gower
Date: 11/25/2019

(Continued on Page 2)

Comments from item 2.

The buildings' exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

The proposed facilities repeat basic element present in the landscape character, as there are already non-natural lines and forms, namely geothermal plant facilities, utility poles and transmission lines, roadways, fence lines, and other human-made structures. The horizon line would be discontinuous as power lines and facilities generally would not protrude above the skyline.

Reclaimed areas would be re-contoured to blend with surrounding topography to the extent possible. Suitable, BLM-approved re-vegetated methods would be used, and stockpiled topsoil used. Existing roads would be used whenever possible, and cross-country travel would be restricted to designated construction areas.

Nighttime lighting would be limited to those required to safely conduct the operations. The lights would be shielded or directed to focus direct light on the immediate work area to minimize impacts to night skies and dark spaces.

VRM Class III Objective is to partially retain the existing character of the landscape, and activities may attract attention but should not dominate the view. Visual changes to the landscape would be weak as contrasts can be seen, but do not dominate the view.

Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is being proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

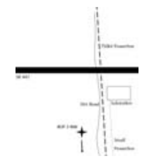
Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 11/25/2019
District Office: Winnemucca District Office
Field Office: Black Rock Field Office
Land Use Planning Area: WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name San Emidio II - North Valley	4. KOP Location (T.R.S) T. 29N, R. 23E, Sec. 25	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 3 (NW)		
3. VRM Class at Project Location Class III	(Lat. Long) 40°20'58.99"N, 119°20'29.78"W	



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Flat in foreground, undulating in middleground	Continuous low shrubs and grasses	Vertical transmission line poles
LINE	Horizontal to rolling	Regular and continuous	Vertical, meandering road on hillside
COLOR	Tan and orange	Tan to orange	Metallic and brown
TEX-TURE	Even and moderately coarse foreground, gradation in middleground	Even and moderately coarse	Crosshatch metal towers and vertical wood poles

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Vertical	Linear forms from transmission line	Linear form from transmission line poles
LINE	Vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Browns	Tans, browns, and greens (depending on season)	Light brown access road, brown wood pole structures
TEX-TURE	Lightly coarse	Fine to moderately coarse	FIne to moderately coarse

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1. DEGREE OF CONTRAST		FEATURES: LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM				✓				✓				✓
	LINE				✓				✓				✓
	COLOR				✓				✓				✓
	TEXTURE				✓				✓				✓

2. Does project design meet visual resource management objectives? ✓ Yes ___No (Explain on reverses side)

3. Additional mitigating measures recommended ___Yes ✓ No (Explain on reverses side)

Evaluator's Names: Peter Gower
Date: 11/25/2019

(Continued on Page 2)

SECTION D. (Continued)

Comments from item 2.

The buildings' exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

The proposed facilities repeat basic element present in the landscape character, as there are already non-natural lines and forms, namely geothermal plant facilities, utility poles and transmission lines, roadways, fence lines, and other human-made structures. The horizon line would be discontinuous as power lines and facilities generally would not protrude above the skyline.

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Nighttime lighting would be limited to those required to safely conduct the operations. The lights would be shielded or directed to focus direct light on the immediate work area to minimize impacts to night skies and dark spaces.

VRM Class III Objective is to partially retain the existing character of the landscape, and activities may attract attention but should not dominate the view. Visual changes to the landscape would be none as contrasts cannot be perceived, because activities repeat basic elements present in the existing landscape character.

Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is being proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 11/25/2019

District Office: Winnemucca District Office

Field Office: Black Rock Field Office

Land Use Planning Area: WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name
San Emidio II - North Valley

2. Key Observation Point (KOP) Name
KOP 3 (SE)

3. VRM Class at Project Location
Class III

4. KOP Location
(T.R.S)
T. 29N, R. 23E, Sec. 25

(Lat. Long)
40°20'58.99"N, 119°20'29.78"W

5. Location Sketch

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Flat in foreground, steeper diagonal terrain in middleground and background	Simple shrubs and grasses	Vertical transmission line poles
LINE	Horizontal to rolling	Regular and continuous	Vertical, SR 447 barely visible
COLOR	Tan and orange in foreground, browns in middleground	Tan to orange and brown	Metallic and brown
TEX-TURE	Moderately coarse foreground, heavy in middleground	Even and moderately coarse	Crosshatch metal towers and vertical wood poles

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Vertical	Linear forms transmission line	Linear form from transmission line poles
LINE	Vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Browns	Tans, browns, and greens (depending on season)	Light brown access road, brown wood pole structures
TEX-TURE	Lightly coarse	Fine to moderately coarse	Fine to moderately coarse

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1\.

DEGREE OF CONTRAST		FEATURES											
		LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS	FORM				✓				✓				✓
	LINE				✓				✓				✓
	COLOR				✓				✓				✓
	TEXTURE				✓				✓				✓

2. Does project design meet visual resource management objectives? ✓ Yes ___No
(Explain on reverses side)

3. Additional mitigating measures recommended
___Yes ✓ No (Explain on reverses side)

Evaluator's Names Date
Peter Gower 11/25/2019

(Continued on Page 2)

Comments from item 2.

The buildings' exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

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Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is being proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

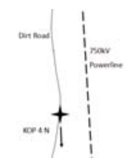
Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date:	05/23/2019
District Office:	Winnemucca District Office
Field Office:	Black Rock Field Office
Land Use Planning Area:	WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name San Emidio II - North Valley	4. KOP Location (T.R.S) T. 26N, R. 25E, Sec. 32	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 4 N		
3. VRM Class at Project Location Class III	(Lat. Long) 40° 4'53.48"N, 119°12'14.25"W	



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Sloping and undulating. Access road and transmission line	Continuous shrub cover except in access road corridor	Transmission line towers, otherwise no structures
LINE	Horizontal, banded, simple	Banded, horizontal	Vertical
COLOR	Tans and greens	Greens (will change to tans in summer and fall)	Metallic
TEX-TURE	Medium	Medium density, consistent cover	Sparse

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Horizontal and vertical	Linear form from access road	Vertical towers and horizontal access road
LINE	Horizontal and vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Light brown	Tans and greens	Light brown access road, brown wood structures
TEX-TURE	Fine and smooth	Fine to moderate	Fine to moderate

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1.

DEGREE OF CONTRAST	FEATURES											
	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
ELEMENTS: FORM			✓					✓			✓	
ELEMENTS: LINE			✓					✓			✓	
ELEMENTS: COLOR				✓				✓				✓
ELEMENTS: TEXTURE			✓					✓			✓	

2. Does project design meet visual resource management objectives? ✓ Yes ___No
(Explain on reverses side)

3. Additional mitigating measures recommended
___Yes ✓ No (Explain on reverses side)

Evaluator's Names Date
Peter Gower 11/25/2019

(Continued on Page 2)

Comments from item 2.

The buildings' exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

The proposed facilities repeat basic element present in the landscape character, as there are already non-natural lines and forms, namely geothermal plant facilities, utility poles and transmission lines, roadways, fence lines, and other human-made structures. The horizon line would be discontinuous as power lines and facilities generally would not protrude above the skyline.

Reclaimed areas would be re-contoured to blend with surrounding topography to the extent possible. Suitable, BLM-approved re-vegetated methods would be used, and stockpiled topsoil used. Existing roads would be used whenever possible, and cross-country travel would be restricted to designated construction areas.

Nighttime lighting would be limited to those required to safely conduct the operations. The lights would be shielded or directed to focus direct light on the immediate work area to minimize impacts to night skies and dark spaces.

VRM Class III Objective is to partially retain the existing character of the landscape, and activities may attract attention but should not dominate the view. Visual changes to the landscape would be weak to none as contrasts can be seen, but do not dominate the view.

Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is being proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

Form 8400-4
(June 2018)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
VISUAL CONTRAST RATING WORKSHEET

Date: 05/23/2019

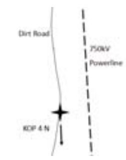
District Office: Winnemucca District Office

Field Office: Black Rock Field Office

Land Use Planning Area: WDO RMP 2015

SECTION A. PROJECT INFORMATION

1. Project Name San Emidio II - North Valley	4. KOP Location (T.R.S) T. 26N, R. 25E, Sec. 32	5. Location Sketch
2. Key Observation Point (KOP) Name KOP 4 S		
3. VRM Class at Project Location Class III	(Lat. Long) 40° 4'53.48"N, 119°12'14.25"W	



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Sloping and undulating - access road and transmission line	Continuous shrub cover except in access road corridor	Transmission line towers, otherwise no structures
LINE	Horizontal, banded, simple	Banded, horizontal	Vertical
COLOR	Tans and greens	Greens (will change to tans in summer and fall), tan grasses	Metallic
TEX-TURE	Medium	Medium density, consistent cover	Sparse

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	Horizontal and vertical	Linear form from access road	Vertical towers and horizontal access road
LINE	Horizontal and vertical	Lines created from power poles and access road	Vertical towers and horizontal access road
COLOR	Light brown	Tans and greens	Light brown access road, brown wood structures
TEX-TURE	Fine and smooth	Fine to moderate	Fine to moderate

SECTION D. CONTRAST RATING __SHORT TERM ✓ LONG TERM

1\.

DEGREE OF CONTRAST	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
ELEMENTS	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE	STRONG	MODERATE	WEAK	NONE
FORM			✓					✓			✓	
LINE			✓					✓			✓	
COLOR				✓				✓				✓
TEXTURE			✓					✓			✓	

2\. Does project design meet visual resource management objectives? ✓ Yes ___No
(Explain on reverses side)

3\. Additional mitigating measures recommended
___Yes ✓ No (Explain on reverses side)

Evaluator's Names: Peter Gower

Date: 11/25/2019

(Continued on Page 2)

Comments from item 2.

The buildings' exteriors and pipelines would be painted consistent with BLM visual color guidelines to blend with surrounding areas and minimize their visibility.

The proposed line would parallel the larger LADWP 500 kV distribution line for most of its length. The overhead conductors used on the gen-tie line power poles would have a matte surface to reduce sunlight reflection and glare.

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Completed by Gabrielle Lukins 3/23/2020

Additional Mitigating Measures (See item 3)

No additional migration measures required outside of what is being proposed within the Plan of Operations and applicant-committed environmental protection measures.

Completed by Gabrielle Lukins 3/23/2020

Visual Resource Photo Log

Date (MM/DD/YYYY)	Time (hh:mm)	Photo #	KOP # (4 digit sequential #, starting from 0001)	KOP Name	Elevation (feet)	Type of Feature Point Represents (stationary, along a route, boundary)	Observer Height	Comments and Methodology (description of the reasoning behind determining the KOP and description of the KOP)
11/25/19	12:24	KOP 1	0001	KOP 1	4,030	NW project boundary looking south to AOI	6 feet	Viewpoint is from Empire Farm looking southeast toward the project site/area of influence (AOI)
11/25/19	12:58	KOP 2	0002	KOP 2	4,218	SE project boundary looking west/northwest toward AOI	6 feet	Viewpoint toward the AOI from an elevated location directly adjacent to the project area
11/25/19	11:49	KOP 3	0003	KOP 3 (SE)	4,248	View southeast along existing transmission lines and proposed gen-tie line	6 feet	Point is along the proposed transmission line route; location is adjacent to a substation and State Route 447
11/25/19	11:49	KOP 3	0003	KOP 3 (NW)	4,248	View northwest along existing transmission lines and proposed gen-tie line	6 feet	Point is along the proposed transmission line route; location is adjacent to a substation and State Route 447
05/23/19	17:11	KOP 4	0004	KOP 4 (S)	5,399	View looking south along existing transmission line and proposed gen-tie line	6 feet	Point is along the proposed transmission line route near VRM Class II
05/23/19	17:11	KOP 4	0004	KOP 4 (N)	5,399	View looking north along existing transmission line and proposed gen-tie line	6 feet	Point is along the proposed transmission line route near VRM Class II

1. KOP 1. Viewpoint is from Empire Farms looking southeast toward the project site/area of influence. Photo taken November 25, 2019.

2. KOP 2. Viewpoint toward the area of influence from an elevated location directly adjacent to the project area. Photo taken November 25, 2019.

3. KOP 3 (SE). Point is along the proposed transmission line route; location is adjacent to a substation and State Route 447. Photo taken November 25, 2019.

4. KOP 3 (NW). Point is along the proposed transmission line route; location is adjacent to a substation and State Route 447. Photo taken November 25, 2019.

5. KOP 4 (S). Point is along the proposed transmission line route near VRM Class II. Photo taken May 23, 2019.

6. KOP 4 (N). Point is along the proposed transmission line route near VRM Class II. Photo taken May 23, 2019.

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Appendix F

~~Draft~~ Kangaroo Mouse Monitoring and Mitigation Plan

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FINAL PALE AND DARK KANGAROO MOUSE MONITORING PLAN

NORTH VALLEY GEOTHERMAL DEVELOPMENT PROJECT AT THE SAN EMIDIO GEOTHERMAL FIELD

Prepared by:

Ormat Nevada, Inc.
6140 Plumas St.
Reno, Nevada 89519

Submitted to:

Bureau of Land Management
Winnemucca District

March 2021

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TABLES

APPENDICES

Acronyms and Abbreviations

	FULL PHRASE
AIM	Assessment, Inventory, and Monitoring
AOI	area of interest
BLM	United States Department of the Interior, Bureau of Land Management
DKM	dark kangaroo mouse
EA	environmental assessment
gen-tie	generation tie
kV	kilovolt
NDOW	Nevada Department of Wildlife
Ormat	USG Nevada LLC, a subsidiary of Ormat Nevada, Inc.
PKM	pale kangaroo mouse
Plan	Pale and Dark Kangaroo Mouse Monitoring Plan
project	North Valley Geothermal Development Project at the San Emidio Geothermal Field
SWReGAP	Southwest Regional Gap Analysis Project
US	United States
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WDO	Winnemucca District Office

1.0 INTRODUCTION

ORNI 36 LLC, a subsidiary of Ormat Nevada, Inc. (hereinafter collectively referred to as Ormat), is proposing the North Valley Geothermal Development Project at the San Emidio Geothermal Field (project) in portions of Washoe, Churchill, Pershing, and Lyon Counties (project area). The project includes construction and operation of two 20-megawatt, closed-loop binary geothermal power plants, geothermal fluid production and injection wells, well pads, access roads, geothermal fluid pipelines, ancillary support facilities, and an electrical substation. It also includes construction and operation of an overhead generation tie (gen-tie) power line with associated facilities that would connect the proposed electrical substation to the Eagle Substation near Fernley, Nevada.

The United States Department of the Interior, Bureau of Land Management (BLM) Winnemucca District Office (WDO) published a revised draft environmental assessment (EA) for the project on November 27, 2020. In the revised draft EA, the BLM WDO analyzed potential actions to minimize impacts on dark kangaroo mouse (DKM [*Microdipodops megacephalus*]) and pale kangaroo mouse (PKM [*M. pallidus*]) individuals and habitat caused by the development of the proposed project. These actions include avoidance, minimization, and restoration of impacts in kangaroo mouse habitat.

To facilitate avoidance, minimization, and restoration of impacts in kangaroo mouse habitat, Ormat developed this Pale and Dark Kangaroo Mouse Monitoring Plan (Plan) with input from the BLM WDO and the Nevada Department of Wildlife (NDOW). Ormat would implement the Plan prior to project implementation.

1.1 PLAN PURPOSE

The Plan would enable Ormat to minimize the project impacts on the species and its habitat; it also would inform management and land use decisions and contribute to improvements in long-term management and conservation of kangaroo mice in the region.

Plan objectives include the following:

- Better understand and describe DKM and PKM occupancy, distribution, and habitat characteristics in the project area.
- Better understand and describe project effects on DKM and PKM occupancy, distribution, and habitat characteristics.
- Determine and apply appropriate mitigation measures for project effects on DKM and PKM and their habitat.
- Monitor the effectiveness of DKM and PKM habitat restoration efforts.

The Plan represents a pilot effort. Plan objectives, methodologies, and other considerations may be adapted throughout the course of monitoring based on the initial results and outcomes.

1.2 AGENCY COORDINATION

1.2.1 Coordination to Date

Ormat developed this Plan with input from the BLM WDO and the NDOW. The NDOW is a cooperating agency for the project EA.

In 2019, Ormat coordinated with the BLM WDO and NDOW to identify small mammal trap sites during project baseline data collection to support the draft EA. As part of the Biological Baseline Report (BLM 2020) preparation, the Ormat used ground-truthed vegetation community data and other data to determine the amount of suitable habitat for both DKM and PKM in the project area. Baseline data collection methodology and results are summarized in the project Biological Baseline Report (BLM 2020).

Calls between Ormat, the BLM WDO, and NDOW to discuss the Plan's purpose, survey and monitoring methodology, and mitigation measures were held on July 23, 2020; July 30, 2020; August 14, 2020; and September 28, 2020.

1.2.2 Future Coordination

The BLM WDO and the NDOW would receive and have the opportunity to review deliverables associated with this Plan (e.g., annual monitoring reports; see **Section 4.1**, Monitoring Plan, below). Because the Plan represents a pilot effort, adaptations to monitoring objectives, methods, or other aspects of the Plan may be necessary. In this case, Ormat will continue to coordinate with the BLM WDO and the NDOW as part of adaptive management discussions. Any changes to the Plan would need to be coordinated through and approved by the BLM WDO.

2.0 EXISTING SPECIES AND HABITAT CONSIDERATIONS

2.1 SPECIES INFORMATION

Kangaroo mice, genus *Microdipodops*, belong to the rodent family Heteromyidae and are restricted in distribution to sandy habitats in the Great Basin Desert of western North America. Compared with other members of the rodent family, *Microdipodops* has a small geographical distribution and number of species (Schmidly et al. 1993; Patton 2005; Hafner et al. 2007). PKM and DKM are the only two species currently recognized in the genus. Kangaroo mice are considered to be rather uncommon members of the nocturnal desert rodent community (Hall 1941; Hafner 1981; Hafner et al. 1996). Hafner et al. (2008) note that in the experience of the authors, in sandy habitats of the Great Basin, usually one or two species of kangaroo rat are numerically dominant, followed by three to five less-common species; kangaroo mice are invariably among the last species to be recorded during trapping efforts.

PKM is a sand-obligate desert rodent (Hafner et al. 2008). DKM is distributed throughout the Great Basin (Hafner and Upham 2011). Morphologically and ecologically, PKM appears to be more specialized than DKM. While DKM tolerates a variety of sandy substrates and floral associations throughout the Great Basin, PKM is restricted typically to fine, loose, sandy soils (with little or no gravel overlay), usually at elevations below the sagebrush (*Artemisia* spp.) community.

DKM is known to occur on stabilized sand dunes and in fine, gravelly soils dominated by big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* spp.), and horsebrush (*Tetradymia* spp.) (O'Farrell and Blaustein 1974; Wilson and Ruff 1999). Research conducted before the two species of kangaroo mouse were differentiated concluded that DKM showed a preference for sandy soils (Hall and Linsdale 1929). More recent work suggests the species shows a preference for gravelly soils (Ghiselin 1970). The geomorphic surface containing the DKM's preferred habitat is commonly valley bottoms and alluvial fans dominated by sagebrush, rabbitbrush, and horsebrush (Wilson and Ruff 1999).

PKM is generally restricted to valley floors with stabilized dunes containing fine, wind-blown sand (Wilson and Ruff 1999). It also has been reported in gravelly soil, where its habitat overlaps with that of the DKM (O'Farrell and Blaustein 1974). Hafner et al. (2008) characterize PKM as a highly-specialized sand-obligate species. Hafner et al. (2008) note that percentage trapping success for PKM is usually an order of magnitude smaller than percentage trapping success for the one or two abundant species that are typically encountered in communities of nocturnal desert rodents in the Great Basin.

2.2 Species Occupancy and Distribution in the Project Area

During preparation of the Baseline Biological Report (BLM 2020), the BLM WDO determined that PKM and DKM have potential to occur in the project area, and recommended surveys for these species. The BLM WDO provided survey protocol for *Microdipodops* (**Appendix B**). Ormat coordinated with the BLM WDO and the NDOW to identify trap sites, as shown on Figure A-13 of the Biological Baseline Report, as well as trapping effort, or the number of traps per site. This is summarized in **Table 1**.

Ormat contractors conducted early summer surveys at all trap sites for 4 consecutive nights. If *Microdipodops* were detected during early summer surveys, late summer surveys in that individual trap site were not required. Late summer surveys in the other trap sites continued to determine if *Microdipodops* were detected in other survey areas. Late summer surveys continued until *Microdipodops* were detected at a trap site, or until the 4-night survey period ended.

Ormat contractors conducted early summer small mammal trapping surveys at all trap sites on June 6–9 and 19–26, 2019; however, due to safety concerns, trapping at the II trap site was discontinued after 1 night of trapping. The 40 trap locations at this site were redistributed into trap site LL, which was established nearby in observed suitable habitat. The BLM WDO and NDOW did not identify this area as a trapping site; Ormat's contractors chose it based on observations of suitable habitat conditions in the field and on its proximity to site II and the proposed transmission line.

Late summer surveys were conducted at sites AA, BB, CC, DD, FF, GG, HH, JJ, and LL, between August 5 and 12, 2019.

Table 1
Small Mammal Trap Sites

Trap Site	Number of Traps	Target Species Captures	UTM Easting[2]	UTM Northing[2]
AA	20	—	296583	4471510
BB	20	—	294219	4469843
CC	20	—	294804	4471601
DD	20	—	294663	4470880
EE	20	1 individual	295719	4476882
FF	10	—	295836	4471518
GG	10	—	296583	4471510
HH	10	—	310412	4388489
II[1]	40	—	—	—
JJ	30	—	311599	4393862
KK	60	1 individual	308452	4409246
LL	40	—	310740	4391152

Source: Ormat GIS 2019; BLM 2020
[1] Trapping at site II was discontinued after 1 night.
[2] Universal Transverse Mercator (UTM) coordinates depict the transect start coordinates.

Dark kangaroo mice were observed at sites EE (one individual trapped) and KK (one individual trapped) during early summer surveys. Both sites are in the Intermountain Basins Mixed Salt Desert Scrub vegetation community. Late summer surveys at sites AA, BB, CC, DD, FF, GG, HH, JJ, and LL did not trap kangaroo mice.

When the kangaroo mice were trapped during surveys, a tissue sample was collected from each before it was released; genetic processing was undertaken to determine the species.[1] The first tissue sample, from trapping site EE, was delivered to the BLM WDO. The other sample was delivered to the University of Nevada, Reno (Matocq Lab) on August 28, 2019, for genetic processing. However, to date, Ormat has not received the results of the genetic testing; thus, species identification is assumed and has not been confirmed by genetic testing.

2.3 Project Area Habitat Conditions

Information on habitat conditions in the project area are provided in the sections below.

2.3.1 Vegetation Ground Truthing

The Southwest Regional Gap Analysis Project (SWReGAP) land cover types in the project area were ground truthed (i.e., verified and corrected as necessary) in May 2019 and February 2020 (BLM 2020). The most common changes to the published SWReGAP land cover types resulting from the ground-truth surveys were reassigning several land cover types to Invasive Annual Grassland and Invasive Annual and Biennial Forbland. This conversion follows recent extensive wildfires in the southern half of the geothermal unit area (the 2017 Tohakum 2 Fire) and gen-tie alignment (the 2017 Truckee Fire) (BLM 2020).

[1] Where range overlap between pale and dark kangaroo mouse is predicted, genetic confirmation of species identity is required. This is because color and other morphological characteristics alone cannot be used to differentiate between these two cryptic species.

Table 2, below, summarizes the ground-truthed SWReGAP land cover types in the project area. This includes in the area of interest (AOI; as described in the Draft EA) where geothermal development is proposed, and the gen-tie alignment, with a 300-foot corridor around the alignment centerline. Figure A-5 in the Biological Baseline Report depicts ground-truthed vegetation.

Table 2
Vegetation

SWReGAP Cover Type	Characterization	Acres
Invasive Annual Grassland	Areas that are dominated by introduced annual grass species, such as cheatgrass (*Bromus tectorum*) and others.	1,893.7
Intermountain Basins Mixed Salt Desert Scrub	Open-canopied shrublands of typically saline basins, alluvial slopes, and plains. Vegetation composed of one or more *Atriplex* species, such as shadscale or fourwing saltbush. Other shrubs present to codominate may include Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), and others. Black greasewood (*Sarcobatus vermiculatus*) is generally absent; but if it is present, it does not codominate.	1,393.7
Intermountain Basins Greasewood Flat	Occurs near drainages on stream terraces and flats and around sparsely vegetated playas. Soils are saline, with a shallow water table, and flood intermittently; however, they remain dry for most growing seasons. Open to moderately dense shrublands dominated or codominated by black greasewood, fourwing saltbush (*Atriplex canescens*), or shadscale (*Atriplex confertifolia*). Often surrounded by mixed salt desert scrub.	986.7
Intermountain Basins Big Sagebrush Shrubland	Occurs in broad basins between mountain ranges, plains, and foothills. Soils are typically deep, well drained, and nonsaline. These shrublands are dominated by big sagebrush. Perennial herbaceous components usually contribute less than 25 percent vegetation cover.	978.7
Invasive Annual and Biennial Forbland	Areas that are dominated by introduced annual and/or biennial forb species, such as saltlover (*Halogeton glomeratus*), kochia (*Kochia scoparia*), Russian thistle (*Salsola* spp.), and others.	481.8
Great Basin Xeric Mixed Sagebrush Shrubland	Occurs on dry sites with typically shallow, rocky, nonsaline soils. Shrublands are dominated by black sagebrush (*Artemisia nova*) and low sagebrush (*Artemisia arbuscula*); they may be codominated by big sagebrush or yellow rabbitbrush.	97
Intermountain Basins Semidesert Grassland	Occurs in lowland and upland xeric swales, playas, alluvial flats, and plains. Substrates are often well-drained sandy or loamy soils. The dominant perennial bunch grasses and shrubs within this system are all drought resistant; they include Indian ricegrass (*Achnatherum hymenoides*), three-awn (*Aristida* spp.), blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Hesperostipa comata*), and others; they may include scattered and dwarf shrubs.	74.2
Recently Mined or Quarried	Areas where mining or quarries are visible in the imagery and are 5 acres or greater in size.	49.9
Intermountain Basins Playa	Barren and sparsely vegetated playas (generally less than 10 percent plant cover). Salt crusts are common, with small saltgrass (*Distichlis spicata*) beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The water is prevented from percolating through the soil by an impermeable soil layer and is left to evaporate.	46.7
Disturbed	Areas that are barren or have relatively low vegetation cover that are associated with some form of generic human alteration or management regime (e.g., heavy grazing).	32.1
Total		**6,034.4**

Sources: Ormat GIS 2019; USGS 2005; BLM 2020

2.3.2 Soils

Table 3 lists and characterizes the soil map units in the project's AOI with respect to habitat qualities important to the DKM and PKM (e.g., landscape position, surface texture, and drainage). **Table 4** lists and characterizes the soil map units in the gen-tie alignment portion of the project area, including a 300-foot corridor around the gen-tie alignment. Figure A-4 in the Biological Baseline Report depicts soil map units in the project area.

Table 3
Soils, Area of Interest

Soil Map Unit	Landscape Position	Surface Texture	Drainage	Approximate Acres
422—Fulstone very stony loam, 4 to 15 percent slopes	Fan remnants	Very stony loam	Well drained	40
500—Smaug very fine sandy loam, 2 to 8 percent slopes	Lake plains	Very fine sandy loam	Well drained	450
518—Bucklake-Pickup-Wylo association	Mountains	Very stony loam	Well drained	60
542—Mazuma-Ragtown association	Lake plains	Silt loam	Well drained	490
546—Mazuma association	Lake plains	Very fine sandy loam	Well drained	590
1060—Trocken-Mazuma association	Alluvial fans	Very gravelly sandy loam	Well drained	1,780
1444—Umberland silty clay loam, ponded	Lake plains	Silty clay loam	Somewhat poorly drained	510

Sources: Web Soil Survey 2019; Ormat GIS 2019; BLM 2020

Table 4
Soils, Gen-Tie Alignment

Soil Map Unit	Landscape Position	Surface Texture	Drainage	Approximate Acres
141—Arclay-Acrelane-Soar association	Mountains	Very gravelly coarse sandy loam	Well drained	140
157—Hawsley sand, 0 to 2 percent slopes	Sand sheets	Sand	Somewhat excessively drained	40
172—Bluewing gravelly sandy loam, 2 to 8 percent slopes	Barrier beaches	Gravelly sandy loam	Excessively well drained	60
180—Biga-Granshaw-Labkey association	Fan remnants	Gravelly coarse sandy loam	Well drained	20
210—Dorper-Aboten-Kumiva association	Fan remnants	Very gravelly very fine sandy loam	Well drained	10
410—Granshaw-Labkey association	Alluvial fans	Gravelly coarse sandy loam	Well drained	30
431—Grumblen-Pickup association MLRA 27	Mountain slopes	Very gravelly loam	Well drained	40
484—Yody-Pineval association	Fan remnants	Gravelly sandy loam	Well drained	30
500—Isolde-Typic Torriorthents-Dune land complex	Dunes	Fine sand	Excessively drained	40

Soil Map Unit	Landscape Position	Surface Texture	Drainage	Approximate Acres
503—Isolde fine sand, 4 to 15 percent slopes	Dunes	Fine sand	Excessively drained	20
518—Bucklake-Pickup-Wylo association	Mountains	Very stony loam	Well drained	70
535—Cleaver-Bundorf association	Fan remnants	Gravelly sandy loam	Well drained	<10
542—Mazuma-Ragtown association	Lake plains	Silt loam	Well drained	<10
650—Labkey gravelly sandy loam, 2 to 8 percent slopes	Fan skirts	Gravelly sandy loam	Somewhat excessively drained	10
653—Labkey-Mazuma association	Longshore bars (relict)	Gravelly sandy loam	Somewhat excessively drained	110
933—Old Camp-Rubble land association	Mountains	Very stony loam	Well drained	10
991—Shawave-Slipback-Granshaw association	Fan aprons	Gravelly sandy loam	Well drained	60
992—Shawave-Deadyon-Slipback association	Fan remnants	Gravelly sandy loam	Well drained	10
1050—Ceejay-Olac-Rock outcrop association	Hills	Very stony loam	Well drained	60
1060—Trocken-Mazuma association	Alluvial fans	Very gravelly sandy loam	Well drained	50
1062—Olac-Old Camp-Ceejay association	Hills	Extremely stony loam	Well drained	110
1201—Acrelane-Wedekind-Arclay association	Mountains	Very gravelly coarse sandy loam	Well drained	120
1210—Biga-Granshaw-Labkey association	Fan remnants	Gravelly coarse sandy loam	Well drained	140
1240—Labkey-Mazuma association	Bars	Gravelly sandy loam	Somewhat excessively drained	30
1320—Osobb-Rezave-Fireball association MLRA 27	Hillslopes	Extremely stony sandy loam	Well drained	70
1330—Sutcliff-Kleinbush-Washoe association	-	-	Well drained	150
1331—Sutcliff-Bundorf-Kleinbush association	Fan remnants	Very stony loam	Well drained	260
1410—Slipback-Shawave-Nodur association	Fan remnants	Sandy loam	Well drained	270
1444—Umberland silty clay loam, ponded	Lake plains	Silty clay loam	Somewhat poorly drained	<10
1601—Olac-Old Camp-Ceejay association	Hills	Very stony loam	Well drained	30
1602—Ceejay-Olac-Rock outcrop association	Hills	Very stony loam	Well drained	70
1607—Cleaver-Bundorf association	Fan remnants	Gravelly sandy loam	Well drained	20
7013—Hawsley loamy sand, 2 to 8 percent slopes	Sand sheets	Sand	Somewhat excessively drained	60
7044—Pirouette-Rezave-Fireball association	Hills	Very stony very fine sandy loam	Well drained	30
7201—Pirouette-Singatse-Hawsley association	Hills	Very cobbly very fine sandy loam	Well drained	50

Sources: Web Soil Survey 2019; Ormat GIS 2019; BLM 2020

2.3.3 Existing Habitat Disturbance Factors

2.3.3.1 Fire and Nonnative, Invasive Vegetation

Approximately 1,894 acres of the SWReGAP land cover type Invasive Annual Grassland was mapped in the project area. Most of these are in the southern portion of the AOI and southern portion of the gen-tie alignment, following recent extensive wildfires (i.e., the 2017 Tohakum 2 Fire and 2017 Truckee Fire). These wildfires have converted other land cover types to one dominated by cheatgrass (*Bromus tectorum*) and other invasive annual species. Other nonnative, invasive plants commonly observed in burned areas are Russian thistle (*Salsola tragus*) and tall tumblemustard (*Sisymbrium altissimum*).

2.3.3.2 Development

Existing and previous geothermal development activities are present in the project area (BLM 2010). In 1988, the 3.6-megawatt AMOR II geothermal power plant went into commercial operation. In 2012 the current 11.8-megawatt San Emidio geothermal power plant replaced the AMOR II facility, which was decommissioned and removed. Associated access roads, temporary pipelines, and well pads for exploration drilling activities are also present. Existing facilities are depicted on Figure A-4, Existing Geothermal Utilization and Electrical Transmission Facilities—San Emidio Geothermal Unit, of the draft EA.

The proposed 120-kilovolt (kV) gen-tie line would mostly parallel an existing 500 kV transmission line. This is the 846-mile Pacific DC Intertie, which distributes electricity from the Pacific Northwest to the Los Angeles area using high-voltage, direct current. It originates near the Columbia River at the Bonneville Power Administration Celilo Converter Station near The Dalles, Oregon, and is connected to the Los Angeles Department of Water and Power Sylmar Converter Station north of Los Angeles. An associated access road is present throughout much of the gen-tie alignment; Ormat's proposed gen-tie would primarily utilize this existing road for access.

Past and existing developed areas typically provide poor habitat conditions due to compacted soils and nonnative, invasive plants, such as saltlover (*Halogeton glomeratus*), Russian thistle, and tall tumblemustard. Linear development features, such as roads, fragment habitat and spread nonnative, invasive plants. Roads may also increase the incidence of injury or mortality from vehicle strike, especially if vehicle use occurs during evening or night hours.

2.3.3.3 Range

Active grazing of cattle and sheep occurs in the project area. Range improvements consist of watering areas for livestock, such as those located near the access road from State Route 447. Areas around range improvements, such as watering areas, typically provide poor habitat conditions due to compacted soils and a lack of native vegetation cover. There is limited fencing; livestock grazing largely takes place on the open range.

2.3.3.4 Recreation

Recreation in the project area mostly occurs along the proposed gen-tie alignment, and typically includes motorized and nonmotorized activities. Roads fragment habitat, facilitate weed spread, and contribute to injury or mortality, as described above.

2.3.4 Kangaroo Mouse Habitat Delineation

Ground-truthed vegetation community data (see **Section 2.3.1**) and other data were reviewed to determine the amount of suitable habitat for both DKM and PKM in the project area and a 0.25-mile buffer around the project area. For each species, the potential habitat suitability was qualified as low, medium, or high.[2]

To determine habitat and assign potential, existing habitat and range models developed for PKM (USGS 2018a; Hafner et al. 2008; Dilts et al. n.d.) and DKM (USGS 2018b; Hafner and Upham 2011) were reviewed. Ground-truthed vegetation community data (see **Section 2.3.1**) and wildfire perimeter data (BLM GIS 2019) were incorporated to attribute habitat changes since modeling was completed. Since vegetation was verified in the field within a 300-foot-wide corridor of the gen-tie alignment, vegetation types were extrapolated and digitized within a 0.25-mile buffer of the project area using recent, high-quality aerial imagery. Ormat also reviewed section-scale NDOW occurrence data and database occurrences from Arctos (2018) and VertNet (2019) for DKM and PKM in the vicinity of the project area.

To determine which areas provide habitat for each species, it was assumed that the entire project area and 0.25-mile buffer provided suitable habitat. This area was populated with the United States Geological Survey (USGS) habitat models for each species. The USGS model was used first because it models habitat, as opposed to range, and appeared to most closely align with NDOW occurrence data for each species. The USGS habitat layer was then manually edited and refined with modeled range information from Hafner et al. (2008) and Dilts et al. (n.d.) for PKM, and Hafner and Upham (2011) for DKM. This produced a map of the project area showing habitat for both species, for DKM only, or non-habitat for both species.

A qualitative rating for the potential was then assigned to the delineated habitat. A low-potential rating was assigned to all areas modeled as non-habitat. Because disturbed areas and invasive vegetation typically provide low-quality habitat for both species, areas ground truthed as the vegetation types Recently Mined or Quarried, Disturbed, Invasive Annual Grassland, and Invasive Annual and Biennial Forbland were also assigned a rating of low potential. Next, areas within a fire perimeter were given a value of medium potential, though areas of modeled non-habitat and ground-truthed vegetation were weighted more than fire perimeters. Finally, remaining areas were assigned a value of high potential.

Based on the methodology described above, acres of low-, moderate-, and high-potential habitat for DKM, and for both species, are summarized in **Table 5**. Habitat types are shown on **Figures A-1.1** through **A-1.5** in **Appendix A**.

Table 5
Kangaroo Mouse Habitat

Common Name *Scientific Name*	**Non-Habitat**	**Low-Potential Habitat**	**Medium-Potential Habitat**	**High-Potential Habitat**
Dark kangaroo mouse *Microdipodops megacephalus*	730 acres	3,444 acres	962 acres	8,403 acres
Pale (*M. pallidus*) and dark kangaroo mouse	1,298 acres	4,406 acres	435 acres	6,059 acres

Source: BLM 2020

[2] ArcGIS shapefiles of potentially suitable habitat are on file with the BLM WDO. The ArcGIS shapefiles include detailed metadata describing the habitat delineation methodology.

3.0 PROPOSED ACTION AND DISTURBANCE

3.1 PROPOSED ACTION

The Proposed Action analyzed in the draft EA includes construction and operation of two 20-megawatt, closed-loop binary geothermal power plants, geothermal fluid production and injection wells, well pads, access roads, geothermal fluid pipelines, ancillary support facilities, and an electrical substation. It also includes construction and operation of an overhead generation tie (gen-tie) power line with associated facilities that would connect the proposed electrical substation to the Eagle Substation near Fernley, Nevada. The Proposed Action is described in detail in the draft EA; parts of the Proposed Action that are relevant to kangaroo mouse habitat conditions are summarized below. Unless otherwise noted, all information describing the Proposed Action, other than the proposed gen-tie line, is from the Project Utilization Plan (Ormat 2020); the details of the proposed gen-tie line are in Ormat's Plan of Development (Ormat 2019).

3.1.1 Surface Disturbance

Proposed surface disturbance associated with project geothermal utilization components would total up to approximately 190 acres of temporary disturbance, and up to approximately 130 acres of permanent disturbance. Disturbance would be associated with two new geothermal power plants, well pads, geothermal fluid pipelines, new and upgraded access roads, an aggregate pit, an electrical substation, and ancillary features, such as office buildings and storage facilities (see **Table 6**, below). Proposed components are shown on **Figures A-1.1** through **A-1.5** in **Appendix A**.

Table 6
Proposed Disturbance—Geothermal Utilization

Component	Acre Disturbance	
	Temporary	Permanent
Power plants[1]	30	30
Pipelines	36.7	18.5
Well pads	105	62.5
Access roads[2]	13	13
Aggregate pit	5	5
Total	**189.7**	**129.3**

Source: Ormat 2020
[1]The substation and ancillary features, such as offices, restrooms, a control room, a maintenance building, and smaller auxiliary buildings, would be constructed within the power plants' footprints.
[2] Includes acres of disturbance from new roads and upgrades to existing roads.

Electricity generated from the project would be connected to the NV Energy power grid via a proposed 58-mile-long, overhead 120 kV gen-tie line. In order to accommodate gen-tie construction equipment and activities, temporary work areas, approximately 300 feet by 300 feet, would be necessary at each gen-tie structure site. Several stringing sites and angle points, which would each have an area of approximately 300 feet by 300 feet, would also be necessary to install the conductor for the 120 kV gen-tie. Stringing sites would be located approximately every 10,000 to 15,000 feet along the gen-tie. Temporary material storage yards would be required for gen-tie construction materials. These staging areas would be located at existing well pads or the power plant site at the gen-tie's northern end.

After construction, the temporary work areas would be reclaimed and restored, with the exception of a 20-foot by 30-foot pad, which Ormat would use for future maintenance on gen-tie infrastructure.

3.1.2 Applicant-Committed Environmental Protection Measures

Applicant-committed environmental protection measures are part of the Proposed Action. They are described in detail in the draft EA; those relevant to kangaroo mouse habitat conditions are summarized below.

3.1.2.1 Prevent or Control Fire

Ormat would equip all construction and operating equipment with applicable exhaust spark arresters. Fire extinguishers would be available on-site. Water that is used for construction and dust control would be available for firefighting. Personnel would be allowed to smoke only in designated areas. Ormat has prepared a fire contingency plan (Appendix B of the draft EA) should a fire start in the AOI or along the gen-tie.

3.1.2.2 Prevent Soil Erosion and Noxious Weeds

Ormat would follow BLM stormwater BMPs, as applicable, on public lands, as described below.

Cut and fill activities would be minimized when selecting the power plant site and pipeline routes. Off-site stormwater would be intercepted in ditches and channeled to energy dissipaters, as necessary, to minimize erosion around the power plant. To minimize erosion from stormwater runoff, access roads would be maintained, consistent with road development best management practices.

Before construction, Ormat would submit an invasive plant management plan to the BLM WDO to monitor and control noxious weeds. To prevent the spread of invasive, nonnative species, all contractors would be required to power wash their vehicles and equipment, including the body and undercarriage, before bringing them onto BLM-administered lands. All gravel and fill materials used would be certified as weed free.

3.1.2.3 Protect Surface Water and Groundwater

Geothermal fluids would not be discharged to the ground under normal operating conditions. Controls such as frequent inspections, ultrasonic pipeline testing, flow and pressure monitoring, and well pump and pipeline valve shutdown features would minimize the potential for accidental discharges of geothermal fluids. A spill prevention, control, and countermeasure plan would also be developed (Appendix B of the draft EA).

3.1.2.4 Protect Wildlife

Ormat would commit to conducting preconstruction biological surveys. Temporarily disturbed areas would be reclaimed as soon as is feasible. Revegetation and periodic maintenance would prevent erosion and protect habitat. Suitable, BLM-approved revegetation methods would be used. Topsoil would be stockpiled and applied to enhance revegetation success. To prevent undue degradation and the removal of habitat, cover, and food, Ormat would use existing roads whenever possible; cross-country travel would be restricted to designated construction areas. Ormat would minimize construction noise by avoiding or minimizing actions that may typically generate greater noise levels or generate distinctive impact noise.

3.1.2.5 Protect Cultural Properties and Visual Resources

Ormat would avoid all National Register of Historic Places-eligible and unevaluated resources.

3.1.3 Reclamation

Once drilling is complete, approximately half of the drill pad area would be reclaimed. The remaining half, typically including the drill sump, would be kept clear for ongoing operations and the potential need to work on or redrill the well. Areas to be reclaimed would be recontoured to a final or intermediate contour that would blend with the surrounding topography to the extent possible. Areas to be reclaimed would be ripped, tilled, or disked on contour, as necessary; stockpiled topsoil would be applied. A BLM-approved seed mixture would be applied.

Road reclamation would involve recontouring the roads back to the original contour and seeding with a BLM-approved seed mix. Other techniques to improve reclamation success, such as ripping, scarifying, replacing topsoil, pitting, and mulching, may be conducted if determined necessary.

Pipeline reclamation would include removing all pipeline and supports, and breaking up and burying support foundations in place. As described above, the surface would be reclaimed.

Ormat would completely remove all other aboveground facilities from the site, and would break down concrete foundations and bury them in place. As described above, the surface would be reclaimed.

Ormat would attempt to close or restrict vehicle access to areas that have been seeded until reclamation success criteria have been achieved. Stormwater diversion measures would remain in place until successful revegetation is attained.

3.2 EFFECTS ON KANGAROO MICE

3.2.1 Effects on Kangaroo Mice

Effects may include injury or mortality during initial grading activities. Nocturnal species that use burrows during the day may be especially susceptible to injury or mortality during grading or clearing activities. Increased traffic and newly established access roads in the area may result in an increase of vehicle-wildlife collisions, resulting in injury or mortality. Although temporary in nature, effects may occur as a result of increased noise levels associated with construction activities. Noise may cause wildlife to avoid the area or result in a disruption of normal behavioral patterns. Additionally, project structures may provide roosting opportunities for raptors, owls, and other predatory birds that prey on small mammal species, thus increasing predation pressure.

3.2.2 Effects on Habitat Conditions

Table 7 summarizes the temporary and permanent habitat removal for kangaroo mice.

3.2.3 Measures to Minimize Effects

Ormat would avoid, minimize, and restore impacts in kangaroo mouse habitats according to the BLM-required stipulations in the draft EA (see Table 3-9 in the draft EA).

Table 7
Kangaroo Mouse Habitat Removal

Habitat Type	Total Acres[1]	Temporary Removal (AOI [acres])	Permanent Removal (AOI [acres])	Temporary Removal (Gen-Tie [acres])	Permanent Removal (Gen-Tie [acres])
Dark kangaroo mouse high potential	8,403	176.8 (2%)	118.6 (1%)	154 (2%)	12 (<1%)
Dark kangaroo mouse medium potential	962	0.0 (0%)	0.0 (0%)	35 (4%)	5 (<1%)
Dark kangaroo mouse low potential	3,444	13.1 (<1%)	11.0 (<1%)	25 (1%)	0 (0%)
Dark kangaroo mouse non-habitat	730	0.0 (0%)	0.0 (0%)	15 (2%)	0 (0%)
Pale and dark kangaroo mouse high potential	6,059	0.0 (0%)	0.0 (0%)	217 (4%)	6 (<1%)
Pale and dark kangaroo mouse medium potential	435	0.0 (0%)	0.0 (0%)	13 (3%)	1 (<1%)
Pale and dark kangaroo mouse low potential	4,406	0.0 (0%)	0.0 (0%)	170 (4%)	20 (<1%)
Pale and dark kangaroo mouse non-habitat	1,298	0.0 (0%)	0.0 (0%)	41 (3%)	2 (<1%)

Source: Ormat GIS 2019; BLM 2020
[1] As described in **Section 2.3.4**, the kangaroo mouse habitat delineation was done in the project area and a 0.25-mile buffer around these areas, which is approximately 25,737 acres.

4.0 MONITORING PLAN

4.1 MONITORING PLAN

4.1.1 Monitoring Objectives and Considerations

The Plan objectives are to:

- Better understand and describe DKM and PKM occupancy, distribution, and habitat characteristics in the project area.
- Better understand and describe project effects on DKM and PKM occupancy, distribution, and habitat characteristics.
- Determine and apply appropriate mitigation measures for project effects on DKM and PKM and their habitat.
- Monitor the effectiveness of DKM and PKM habitat restoration efforts.

The Plan aims to achieve these objectives through a descriptive, rather than an experimental, approach. That is, monitoring will collect data, which can then be synthesized, analyzed, and evaluated as the data relate to the objectives. The Plan proposes to better describe the ecological niche of the species in the project area, by trapping across a habitat gradient (in low- to high-potential habitat areas) and describing, in greater detail than currently exists, habitat conditions in occupied and unoccupied areas. This will allow defensible relationships to be drawn between species and habitat conditions.

The Plan proposes to monitor and describe "before and after" conditions associated with proposed habitat disturbance and interim reclamation, and correlate these changed conditions with any observed changes in species occupancy and distribution in these areas. Habitat restoration effectiveness monitoring results could inform or be integrated into mitigation measures to offset impacts on the species' habitat from future projects in the region.

The Plan would not use an experimental approach (i.e., the manipulation and measurement of independent and dependent variables). An experimental approach is not proposed for several reasons. First, the project area is large and includes diverse and complex site conditions, including multiple soil and habitat types, past and current geothermal development activities, legacy effects of past and current rangeland management practices, and disturbance from wildfire and nonnative plant invasion (see **Section 2.3**, Project Area Habitat Conditions). Second, the Proposed Action (see **Section 3.1**, Proposed Action) includes multiple types of potential direct and indirect effects on the species and habitat conditions, including but not limited to vegetation removal and soil disturbance, interim site reclamation, and noise and artificial lighting from construction and operation. Finally, due to the nature of geothermal development, there is some uncertainty in the spatial and temporal distribution of project activities. For example, the decision to construct a specific well pad, and its precise location, are often influenced by exploration or production results at a previously-developed well. Given these considerations, an experimental approach to addressing the Plan objectives would be difficult to design and implement. This is also partially due to logistical and resource constraints, such as available budget and monitor availability.

The Plan does not propose to describe species abundance throughout the project area. To do so, mark-recapture surveys would be required. However, BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**) does include protocol for marking trapped individuals, and recording if they are subsequently recaptured. This protocol would be followed to track unique captures; data could be used to better understand approximate numbers of individuals present at and near the monitoring point. Similarly, the Plan does not propose species distribution modeling. Instead, distribution would be informed by trapping results and extrapolation made based on existing habitat (e.g., vegetation, soil, and other environmental covariate) conditions in nearby areas.

The synthesis of this data collection process could contribute to the regional evaluation of DKM and PKM status, help understand the effectiveness of habitat restoration efforts, and address a projected risk of further protection for these vulnerable species.

The Plan represents a pilot effort. Plan objectives, methodologies, and other considerations may be adapted throughout the course of monitoring based on the initial results and outcomes. In this case, Ormat would coordinate with the BLM WDO and the NDOW as part of adaptive management discussions. Any changes to the Plan would need to be coordinated through and approved by the BLM WDO.

4.1.2 Proposed Monitoring Methods

4.1.2.1 Survey Methods

To account for the low detectability of *Microdipodops* due to their rarity on the landscape, and to ensure that scientifically valid and repeatable data are collected, trapping methods will follow those described in the BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**). These are outlined below, along with specific methodologies developed for this Plan.

Ormat (or its designated biologist) would obtain an NDOW scientific collection permit before trapping begins. The permit application would include the biologist's qualifications for small mammal trapping and proper handling, identification, and tissue sampling techniques. If determined to be necessary during permit approval, Ormat (or its designated biologist) would consult with a mammologist/species expert to ensure that handling, measurement, and tissue sample collection are properly conducted.

4.1.2.1.1 Survey Design

A 328-foot-long (100-meter-long) linear trap transect (Jones et al. 1996; Price et al. 2000; Pearson and Ruggiero 2003) would be established at each monitoring point.

The trap grid design is similar to the layout used in Upham and Hafner (2013), as recommended in the BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**). Two Sherman live traps would be deployed at or near (within a 7-foot (2-meter) radius of) a point at each 33-foot interval along the transect, for a total of 20 traps per transect, and 200 traps total in the project area.

Trap pairs should be at least 3 feet (one-meter) away from the nearest shrub, whenever possible (i.e., traps will be placed in open microhabitats [Price 1978; Thompson 1982; Price et al. 1984]). The UTM location for each trapping station will be recorded with a global positioning system unit to facilitate accurate transect location across monitoring years.

4.1.2.1.2 Survey Duration and Seasonal Timing

As described in the BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**), both the DKM and PKM are nocturnal rodents and require nocturnal trapping. Trap sites will be left in place for four consecutive nights per trapping location. Trapping would be done between May 1 and September 15. Trapping would be done two times per trapping location, once in the early summer (between May 1 and June 30), and once in late summer (between approximately July 1 and September 15). Target survey dates will be determined based on daily/nightly temperature and precipitation ranges and would be confirmed with the BLM prior to trapping.

4.1.2.1.3 Other Methods

Animal handling and tissue sampling, survey duration and seasonal timing, baiting, trap check frequency, weather considerations, and incidental mortality procedures will follow recommendations in the BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**).

Genetic testing is needed to confirm species identification (Hafner et al. 2008; Hafner and Upham 2011). Methods outlined in the BLM's May 2019 *Microdipodops* Survey Protocol (**Appendix B**) would be followed for collection of genetic samples. Prior to monitoring, Ormat would identify a commercial laboratory with capacity to conduct testing. Ormat would also identify a secondary commercial laboratory with capacity to conduct testing in the case that the primary laboratory is unavailable to conduct testing.

4.1.2.2 Monitoring Point Selection

This Plan proposes establishment of permanent monitoring points to help characterize and describe conditions in the project area. The number of monitoring points and the number of traps at each point are informed by logistical and resource constraints, such as the available budget, and monitor availability. Monitoring point locations were hand-selected and selected locations were subsequently reviewed by the BLM WDO and NDOW.

Monitoring points have the following characteristics:

- They are in a range of habitat conditions, from high- to low-potential habitat for DKM and PKM, based on the 2019 habitat model developed for the Biological Baseline Report (BLM 2020).
- They are located in areas that:
  - will be protected from future disturbance (i.e., in project avoidance areas),
  - are in an existing disturbed state that is proposed for interim reclamation, and
  - are in undisturbed areas proposed to be disturbed as part of the project.

Ten monitoring points are proposed. They are described in more detail below. An overview of monitoring point locations is on **Figures A-1.1** through **A-1.5** in **Appendix A**. Detailed maps of monitoring point locations, kangaroo mouse habitat types, and proposed development are in **Figures A-2.1** through **A-2.3** in **Appendix A**.

4.1.2.2.1 Monitoring points 1, 2, 3, and 4

These are in the northern portion of the geothermal utilization area (AOI, as shown on **Figure A-2.1** in **Appendix A**). They are in the vicinity of trap site EE, where a presumed DKM was trapped in 2019 (BLM 2020).

Two points (1 and 3) are in areas that have been disturbed during geothermal exploration activities (e.g., on geothermal well pads). They are in low-potential habitat for DKM. These areas will be reclaimed with interim reclamation methods, including seeding.

Two points (2 and 4) are in a project avoidance area. This means that habitat is relatively undisturbed, and it will remain undisturbed through the course of the project.

Ormat expects that monitoring data from these points will give insight into the effectiveness of interim reclamation at reestablishing habitat for DKM. Ormat also expects that the data will show effects on occupancy and habitat conditions in presumably occupied habitat in proximity to proposed construction activities.

4.1.2.2.2 Monitoring points 5 and 6

These are in the southern portion of the AOI, as shown on **Figure A-2.2** in **Appendix A**. Point 5 is in an area that is currently undeveloped; however, the area will be developed during geothermal exploration during construction of well pad 33-28. This point is in high-potential habitat for DKM, though at the interface of the area burned in the 2017 Tohakum 2 Fire, where vegetation is now comprised of invasive annual grasslands. Point 6 is in undisturbed, high-potential habitat for DKM, in a project avoidance area.

Kangaroo mice were not trapped in the southern portion of the AOI during the 2019 baseline survey (BLM 2020). Ormat expects that monitoring data from these points will better characterize species distribution in the project area, and will show effects on habitat conditions in proximity to proposed construction activities.

4.1.2.2.3 Monitoring points 7 and 8

These are in the central-southern portion of the gen-tie alignment, as shown on **Figure A-2.3** in **Appendix A**, within an area of range overlap for both DKM and PKM. They are relatively near trap site KK, where a presumed DKM was trapped in 2019 (BLM 2020). Point 7 is underneath the proposed gen-tie alignment centerline in high-potential habitat for DKM and PKM. Point 8 is in high-potential habitat farther away from the alignment centerline. Ormat expects that monitoring data from these points will better characterize species distribution in the project area, and give insight into gen-tie effects on species occupancy and habitat conditions.

4.1.2.2.4 Monitoring points 9 and 10

These are in the central-southern portion of the gen-tie alignment, as shown on **Figure A-2.3** in **Appendix A**, within an area of range overlap for both DKM and PKM. This area was burned in the 2017 Tohakum 2 Fire. These points are near trap site KK, which is at the interface of the burned and unburned area from the Tohakum 2 Fire; in 2019, a presumed DKM was trapped here (BLM 2020). Point 9 is underneath the proposed gen-tie alignment centerline in low-potential habitat for DKM and PKM. Point 10 is also in low-potential habitat farther away from the alignment centerline.

Ormat expects that monitoring data from these points will better characterize species distribution in the project area, better characterize occupancy in burned areas that were presumed to be occupied habitat, and, potentially, give insight into the effectiveness of disturbed habitat restoration.

A summary of proposed monitoring point characteristics is in **Table 8**.

Table 8
Kangaroo Mouse Monitoring Point Summary

Monitoring Point	Habitat Type	Vegetation	Soil Map Unit	Existing Conditions
1	DKM low potential	Intermountain Basins Mixed Salt Desert Scrub	Trocken-Mazuma association	On existing well pad; vegetation and topsoil removed, soils compacted, interim reclamation proposed
2	DKM high potential	Intermountain Basins Mixed Salt Desert Scrub	Trocken-Mazuma association	Undisturbed; in project avoidance area
3	DKM low potential	Intermountain Basins Mixed Salt Desert Scrub	Trocken-Mazuma association	On existing well pad; vegetation and topsoil removed, soils compacted, interim reclamation proposed
4	DKM high potential	Intermountain Basins Mixed Salt Desert Scrub	Trocken-Mazuma association	Undisturbed; in project avoidance area
5	DKM low potential	Invasive Annual Grassland	Trocken-Mazuma association	Disturbed; burned in the 2017 Tohakum 2 Fire; proposed to be developed
6	DKM high potential	Intermountain Basins Greasewood Flat	Trocken-Mazuma association	Undisturbed; in project avoidance area

Monitoring Point	Habitat Type	Vegetation	Soil Map Unit	Existing Conditions
7	PKM and DKM high potential	Intermountain Basins Mixed Salt Desert Scrub	Sutcliff-Bundorf-Kleinbush association	Undisturbed; under proposed gen-tie
8	PKM and DKM high potential	Intermountain Basins Mixed Salt Desert Scrub	Sutcliff-Bundorf-Kleinbush association	Undisturbed; near proposed gen-tie
9	PKM and DKM low potential	Invasive Annual Grassland	Sutcliff-Bundorf-Kleinbush association	Disturbed; burned in the 2017 Tohakum 2 Fire, under proposed gen-tie; burned area restoration proposed
10	PKM and DKM low potential	Invasive Annual Grassland	Sutcliff-Bundorf-Kleinbush association	Disturbed; burned in the 2017 Tohakum 2 Fire, near proposed gen-tie; burned area restoration proposed

Source: Ormat GIS 2019; BLM 2020

4.1.2.3 Supplementary Data Collection

Additional data collection would be done at each monitoring point. This would consist of the BLM's Assessment, Inventory, and Monitoring (AIM) protocol for Terrestrial Core Field Measurements[3] to facilitate observation of ecological changes over time at each point, and data consistency in future habitat restoration and mitigation efforts on BLM-administered lands. One AIM plot would be established at each monitoring point location; the monitoring point would be the AIM plot center.

AIM data collection would include measurements for, at a minimum, bare ground; vegetation composition; vegetation height; plant canopy gaps; nonnative, invasive plant species; and plant species of management concern. Photographs of representative habitat conditions at each monitoring point would be collected.

Additional data to be collected at each sample point include soil texture and profile characteristics. In order to increase efficiency, supplementary data collection at monitoring points could be done at a separate date than at the kangaroo mouse trapping.

4.1.2.4 Monitoring Implementation and Duration

Monitoring will commence in the 2021 trapping year (Year 1) and continue through the 2025 trapping year (Year 5). Monitoring would continue for a total of 5 years to provide pre- and post-construction data. Prior to each trapping year, Ormat and the BLM would coordinate to determine the anticipated trapping schedule for the year, and make any adjustments to the anticipated schedule if determined to be necessary by the BLM.

4.1.2.5 Reporting

4.1.2.5.1 Annual Reports

Annual reports would be developed and submitted to the BLM WDO for review by December 31 of each monitoring year. Annual monitoring reports would include, at a minimum, the following sections: introduction, methods, results, discussion, and conclusion. Reports would identify

[3] https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page

species' habitat associations based on vegetation and soil characteristics in occupied habitat. Reports would include original datasheets and photographs of monitoring site habitat conditions and individuals captured. Genetic confirmation of the preliminary species identification would be reported. The discussion section should make recommendations for improving monitoring or mitigation efficacy, or both, if warranted. The anticipated trapping schedule for the upcoming year would be included.

Reports would include any relevant geospatial information (i.e., monitoring point locations, transect locations, trap sites, delineated habitat classifications). Geospatial data must be in UTM NAD83, Zone11 and must have associated metadata. All metadata must comply with the Federal Geographic Data Committee metadata standards (www.fgdc.gov/metadata/geospatial-metadata-standards). Project geospatial data will be provided to BLM with metadata that is described within the GIS data itself as well as a summarized word document that describes each layer, shapefile, etc. according to the standards above.

4.1.2.5.2 Final Report

A final report would be developed at the end of the second year of post-construction monitoring or at the end of the fifth monitoring year, whichever is sooner. In addition to the content described above, the final report would synthesize the results of previous monitoring years, and it would discuss the objectives in the Plan purpose.

4.2 MITIGATION MEASURES

In addition to the monitoring described in this Plan, Ormat would commit to on-site mitigation measures designed to restore and enhance key habitat areas for DKM and PKM, and avoid or minimize disturbance in occupied areas. These measures are described in further detail below.

4.2.1 Habitat Avoidance

To the extent possible, Ormat would avoid predicted high-potential habitat for DKM and PKM, and areas where DKM or PKM are detected during monitoring. Habitat avoidance measures include reducing the size of well pads and other associated disturbance to the minimum size possible. This may be accomplished by using equipment requiring a smaller working footprint.

4.2.2 Disturbed Habitat Restoration

Where temporary disturbance of high- and moderate-potential kangaroo mouse habitat is unavoidable, Ormat would restore temporarily disturbed habitat areas by seeding with a BLM-developed seed mix containing native forb and shrub plant species. Precise treatment methods (i.e., seed mix, application rates, and soil amendments), as well as restoration success criteria and contingency measures, will be determined in coordination with the BLM WDO and the NDOW prior to treatments. Areas to be restored would be determined based on the precise amounts of habitat disturbance.

5.0 LITERATURE CITED

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Appendix A
Figures

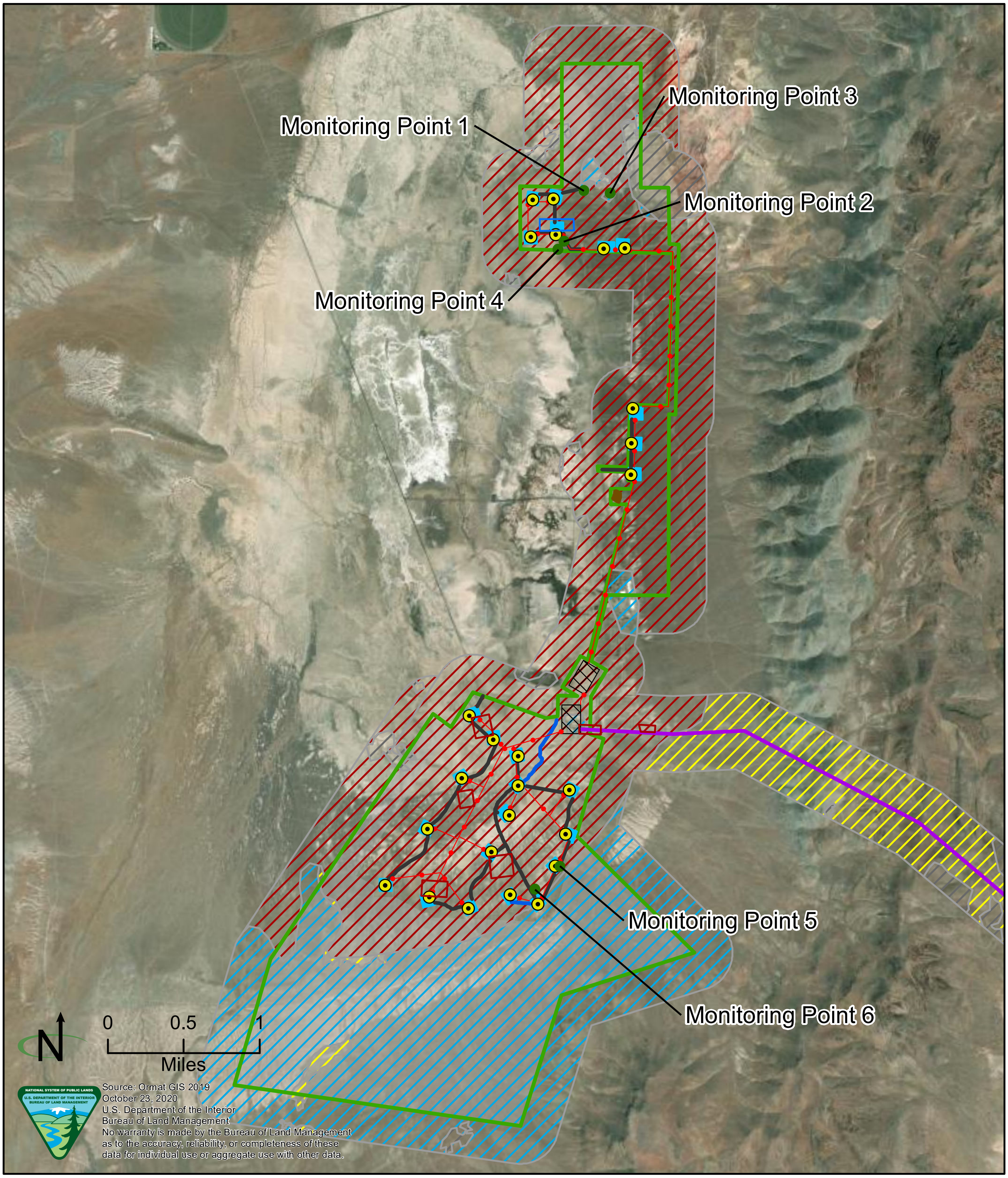


Figure A-1.1. Proposed monitoring locations

- Monitoring points
- Trap area – no captures
- Trap area – individuals captured
- Dark kangaroo mouse, high potential
- Dark kangaroo mouse, medium potential
- Dark kangaroo mouse, low potential
- Non-dark kangaroo mouse, low potential
- Well
- Gen-tie line
- Pipeline
- Road - new
- Road - improve
- Power plant
- Aggregate pit
- Well pad
- Area of Interest

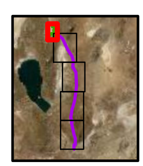


Figure A-1.2. Proposed monitoring locations

- Monitoring points
- Trap area – no captures
- Dark kangaroo mouse, high potential
- Dark kangaroo mouse, medium potential
- Dark kangaroo mouse, low potential
- Non-dark kangaroo mouse, low potential
- Well
- Gen-tie line
- Pipeline
- Road - new
- Road - improve
- Power plant
- Well pad
- Area of Interest

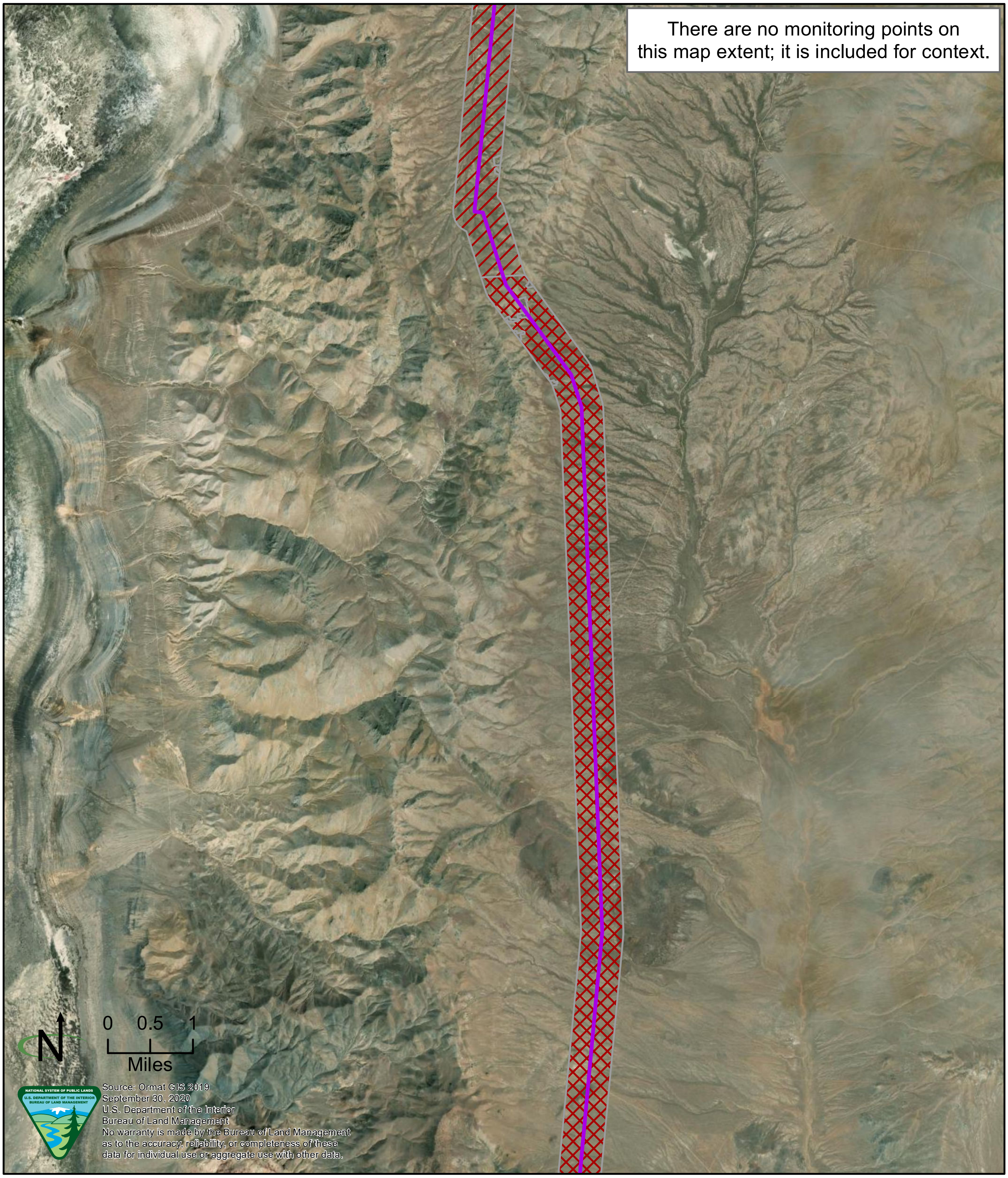
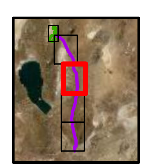


Figure A-1.3. Proposed monitoring locations

- Dark kangaroo mouse, high potential
- Non-dark kangaroo mouse, low potential
- Pale/dark kangaroo mouse, high potential
- Non-pale/dark kangaroo mouse, low potential
- Gen-tie line



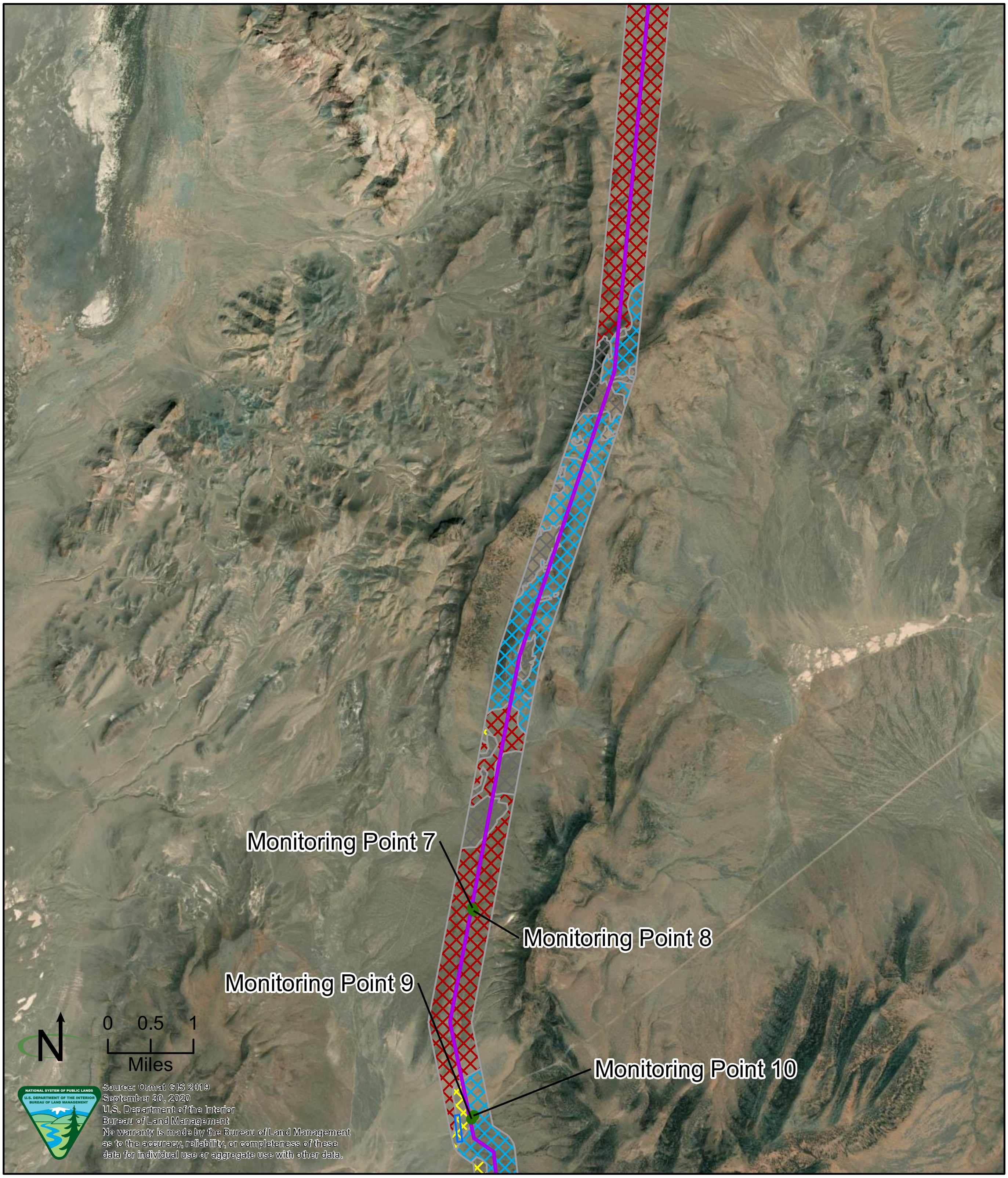
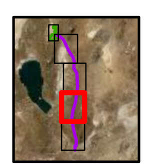


Figure A-1.4. Proposed monitoring locations

- Monitoring points
- Trap area – individuals captured
- Pale/dark kangaroo mouse, high potential
- Pale/dark kangaroo mouse, medium potential
- Pale/dark kangaroo mouse, low potential
- Non-pale/dark kangaroo mouse, low potential
- Gen-tie line



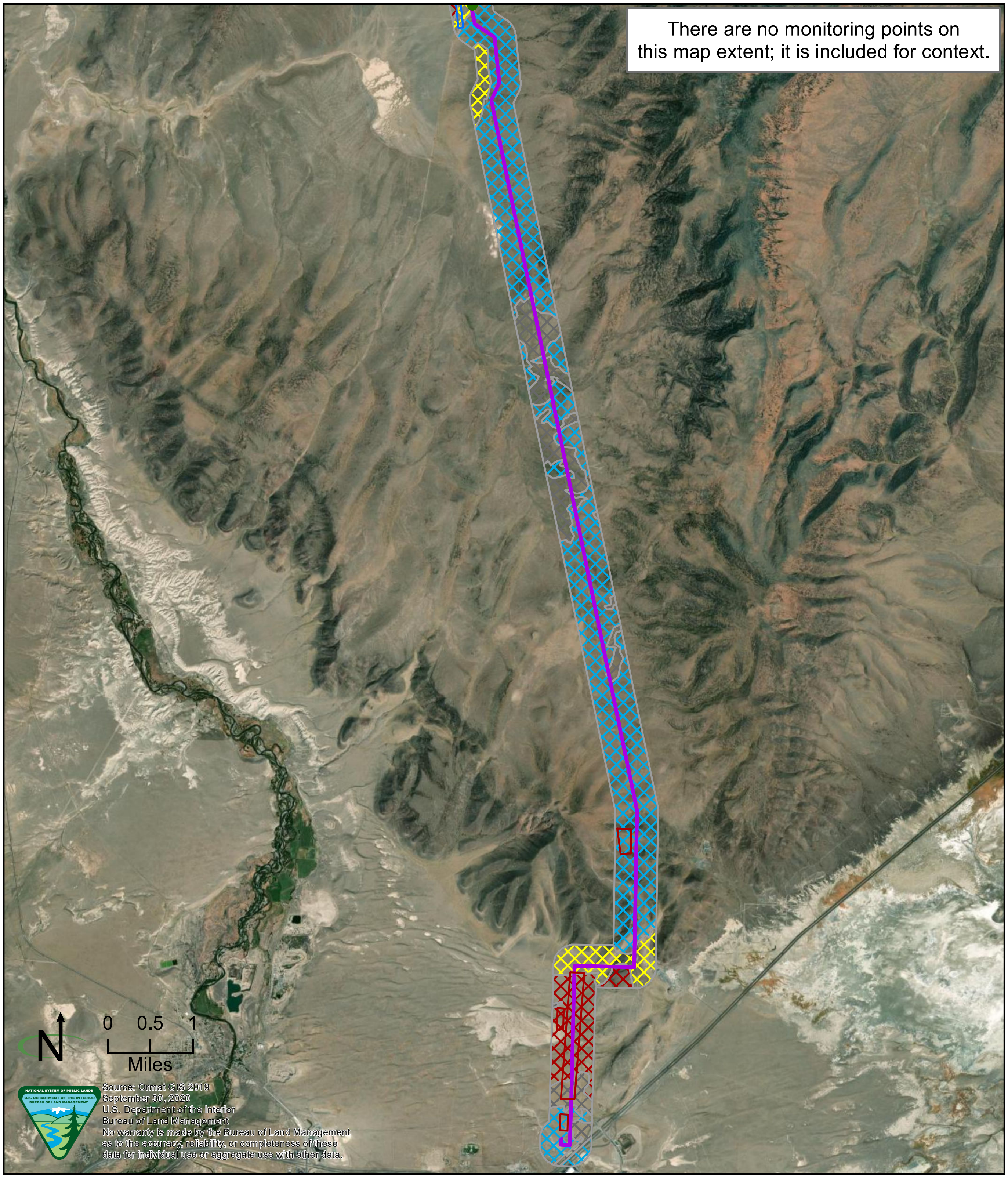
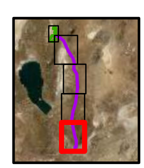


Figure A-1.5. Proposed monitoring locations

- Monitoring points
- Trap area – no captures
- Trap area – individuals captured
- Pale/dark kangaroo mouse, high potential
- Pale/dark kangaroo mouse, medium potential
- Pale/dark kangaroo mouse, low potential
- Non-pale/dark kangaroo mouse, low potential
- Gen-tie line



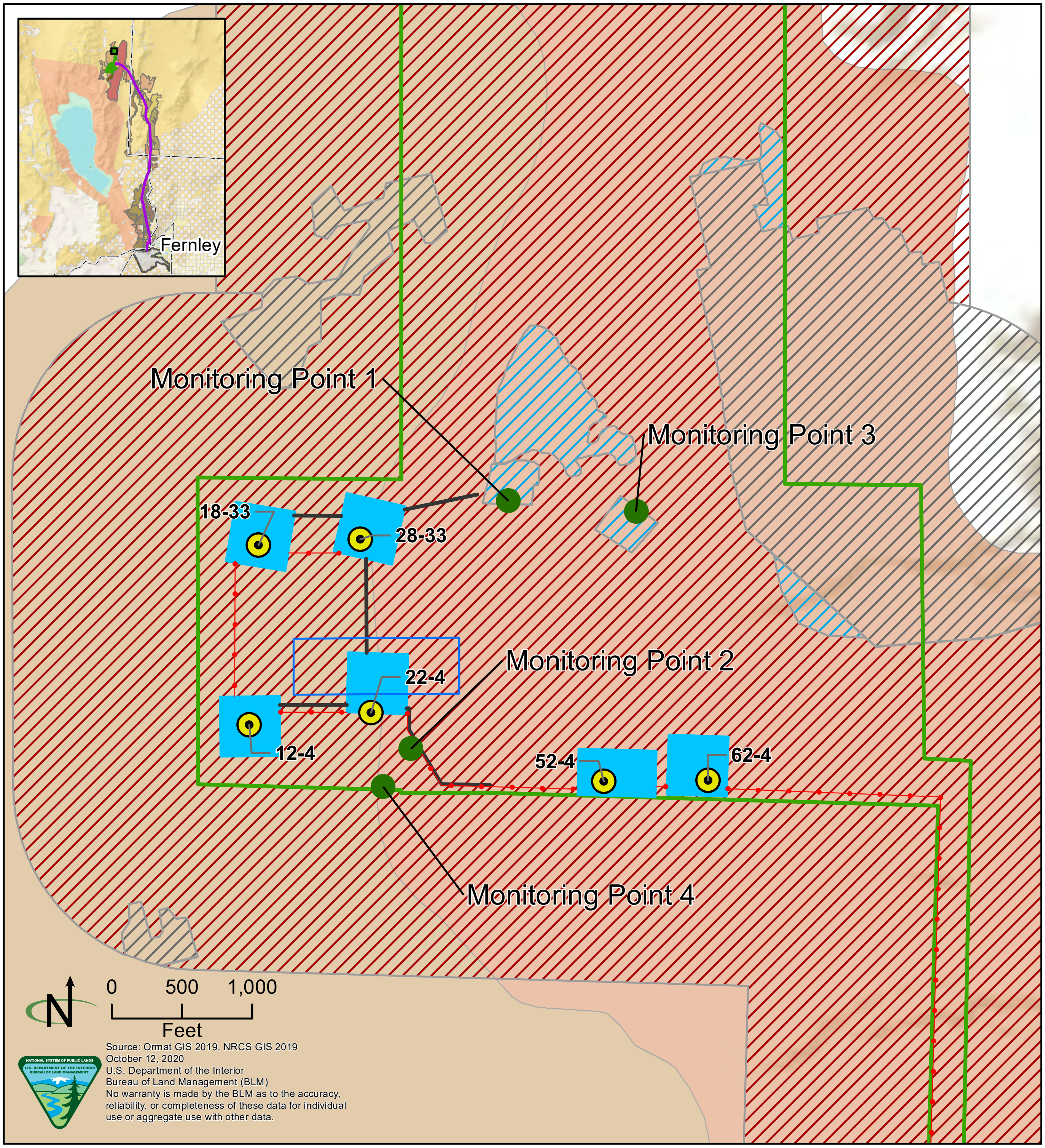


Figure A-2.1
Kangaroo mouse monitoring

- Monitoring points
- Kangaroo mouse trap area – individuals captured
- Dark kangaroo mouse, high potential
- Dark kangaroo mouse, low potential
- Non-dark kangaroo mouse, low potential
- Trocken-Mazuma association
- Umberland silty clay loam, ponded
- Well
- Pipeline
- Road - new
- Well pad
- Area of Interest

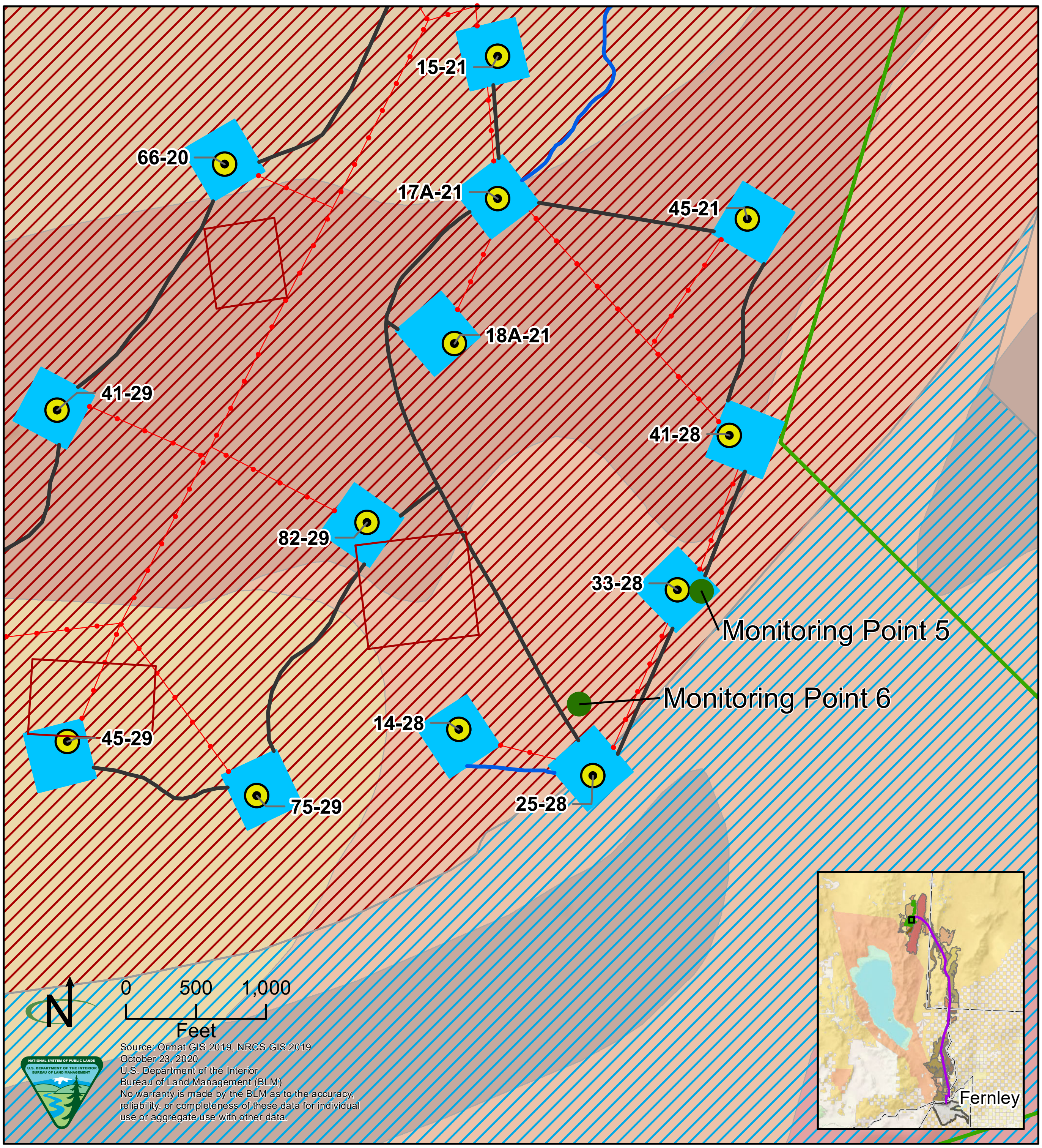


Figure A-2.2
Kangaroo mouse monitoring

- Monitoring points
- Kangaroo mouse trap area – no captures
- Dark kangaroo mouse, high potential
- Dark kangaroo mouse, low potential
- Bucklake-Pickup-Wylo association
- Fulstone very stony loam, 4 to 15 percent slopes
- Mazuma association
- Mazuma-Ragtown association
- Smaug very fine sandy loam, 2 to 8 percent slopes
- Trocken-Mazuma association
- Umberland silty clay loam, ponded
- Well
- Pipeline
- Road - new
- Road - improve
- Well pad
- Area of Interest

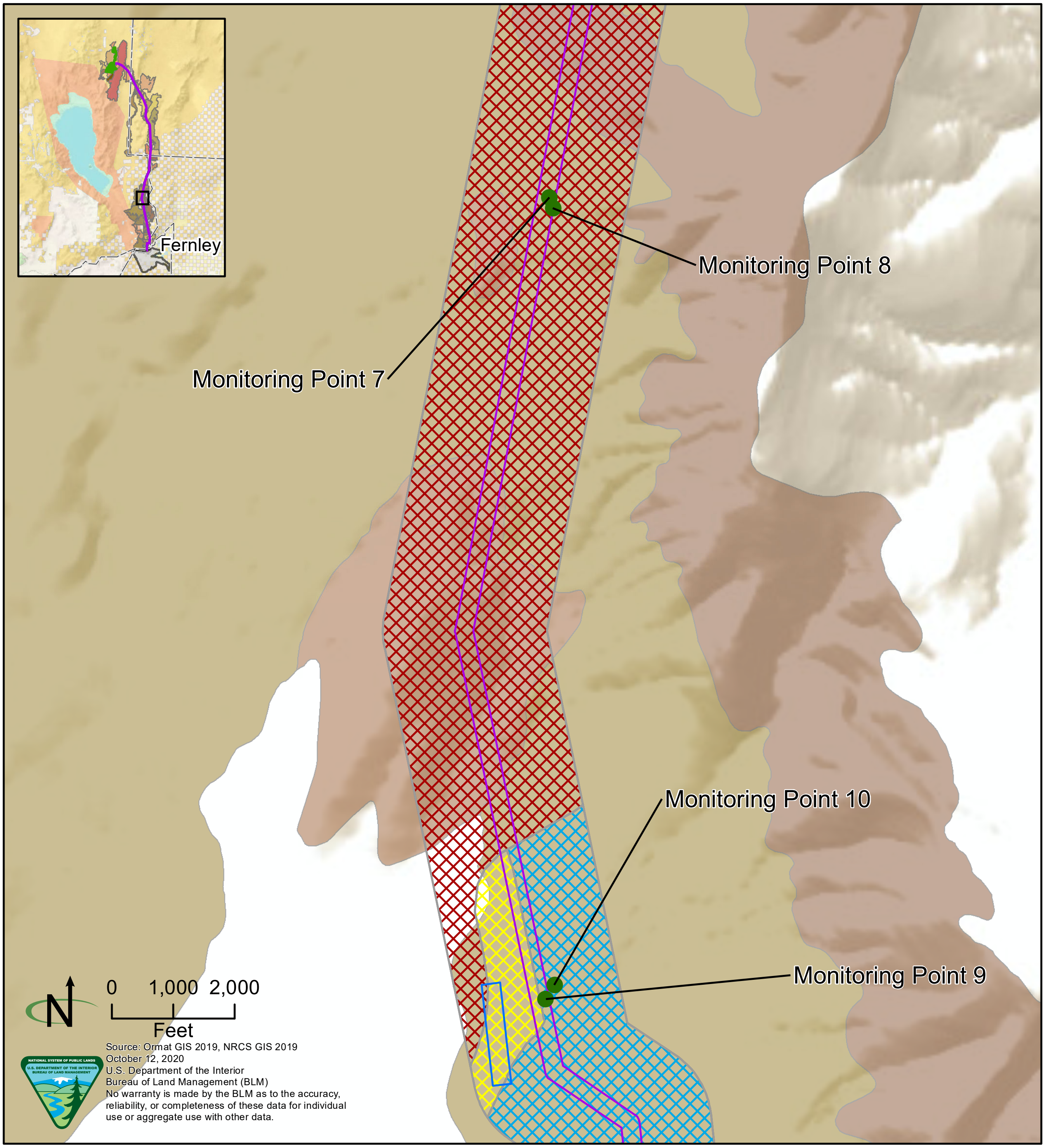


Figure A-2.3
Kangaroo mouse monitoring locations

- Monitoring points
- Trap area – individuals captured
- Pale/dark kangaroo mouse, high potential
- Pale/dark kangaroo mouse, medium potential
- Pale/dark kangaroo mouse, low potential
- Old Camp-Rubble land association
- Osobb-Rezave-Fireball association MLRA 27
- Sutcliff-Bundorf-Kleinbush association
- Gen-tie line

Appendix B
The BLM's May 2019 *Microdipodops* Survey Protocol

Microdipodops Survey Protocol

This protocol was adopted from the *Microdipodops* Survey Protocol developed for the Hycroft Mine Phase II Expansion Project (originally developed through coordination between the Bureau of Land Management (BLM), the Nevada Department of Wildlife (NDOW), and Stantec Consulting Services Inc.) This protocol has been revised and updated by BLM and NDOW.

PURPOSE AND OBJECTIVES

The purpose of the protocol is to survey predicted and known *Microdipodops megacephalus* (dark kangaroo mouse, DKM), and *Microdipodops pallidus* (pale kangaroo mouse, PKM) habitat and populations. The objective(s) to survey for DKM and PKM may be different for each project. Prior to conducting surveys, coordinate with BLM to determine the survey purpose/objective(s). The objectives to survey both DKM and PKM may include:

- Determine detection/no detection of both DKM and PKM over the project area. There are many factors that can account for a species not being verified in a surveyed area including poor sampling technique, animal rarity, unskilled observers, weather, seasonal use patterns and intensity and duration of survey effort. Rarely can the determination of absence be made with certainty. Therefore, the conclusions of these survey results will be stated as detected or not detected rather than present or absent.
- Determine DKM/PKM distribution within the project area, especially in relation to proposed disturbance features or habitat removal actions. Where needed, determine habitat associations in order to allow inference to other potentially impacted areas within the project area or in future or other projects.

SPECIES' INFORMATION

DKM are known to occur on stabilized sand dunes and in fine, gravelly soils dominated by big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus spp.*), and horsebrush (*Tetradymia spp.*) (O'Farrell and Blaustein, 1974b; Wilson and Ruff, 1999). Research conducted before the two species of kangaroo mouse were differentiated, concluded that the DKM showed a preference for sandy soils (Hall and Linsdale, 1929). More recent work suggests that the species shows a preference for gravelly soils (Ghiselin, 1970). The geomorphic surface containing preferred habitat of the DKM is commonly valley bottoms and alluvial fans dominated by sagebrush, rabbitbrush, and horsebrush (Wilson and Ruff, 1999). For more information, see Hafner and Upham (2011) in Appendix B of this protocol.

The PKM is generally restricted to valley floors with stabilized dunes containing fine, wind-blown sand (Wilson and Ruff, 1999). They have also been reported in gravelly soil, where their habitat overlaps with that of the DKM (O'Farrell and Blaustein, 1974b). Hafner et al. (2008) characterize the PKM as a sand-obligate, and Wilson and Ruff (1999) report that the species is found at elevations lower than the big sagebrush-dominated zones. For more information, see Hafner et al. 2008 in Appendix B of this protocol.

Both PKM and DKM have distinct population segments within each of their populations and no gene flow among the genetically distinct units (Andersen et al. 2013). Additionally, the populations sizes of all *Microdipodops* lineages "appear to be low (<500), suggesting that each genetic lineage may have difficulty coping with changing environmental pressures and hence may be at risk of extirpation" (Andersen et al. 2013). Threats to both species include habitat loss due to "wild fires, invasive plants, agriculture and livestock grazing" (Hafner and Upham 2011). "Reduction in *Microdipodops* abundance may signal deterioration of the habitat, and further reduction in their abundance may prove detrimental to the survival of individual populations". (Andersen et al. 2013). PKM and DKM are listed as BLM Special Status Species and Nevada State Protected Mammal (NAC 503.030.1).

SURVEYOR CREDENTIALS

DKM and PKM trapping surveys will be performed by biologists with appropriate education and training, which will include the following:

- Bachelor's degree in biology, natural resources, wildlife ecology, environmental studies, or a similar related field;
- One (or more) season(s) of experience conducting small mammal surveys or under the direct supervision of someone who has this experience and meets the other credential criteria; and
- Hold or be listed as a collector on a valid NDOW Scientific Collection Permit that includes coverage for *Microdipodops*. Make sure to indicate that biologists are trapping under this protocol and for this (and other) specific NEPA projects. Make sure to include a list of all other species that could be encountered during this survey. See scientific collection and permit materials for more information http://www.ndow.org/Forms_and_Resources/Special_Permits/

METHODS

Trapping Locations Multiple sources of information should be used to determine most-effective and meaningful trapping areas. An initial GIS exercise should be undertaken using GAP species distribution models for these two species, historic fire layers, land status, vegetation types from SWReGAP or Landfire, imagery, topography, and shapefiles related to the project area. Historic PKM and DKM occurrence information should be projected. Targeted trapping areas from this GIS exercise should then be compared with range maps available in the above-mentioned Hafner and Anderson papers. Targeted trapping areas should then be field-verified and grids moved, as needed, to accommodate highest quality habitat with greatest connectivity to other suitable habitat within the project area. BLM and NDOW biologists can assist with this collaborative process. Again, survey locations (trap line) should be placed in field-verified habitat of highest integrity (e.g. lack of invasives, intact vegetation communities, minimal soil alteration).

Site visits of the trap locations should occur prior to surveying to determine if there is adequate vegetation that the species has been located in, including open microhabitats within a low semi-stabilized sand dune community composed of rabbitbrush/sagebrush/horsebrush with ricegrass (Ghiselin 1970, Harris 1986). Photos, potential habitat GIS shapefiles, and locations of survey sites should be provided to BLM previous to trapping.

Survey Design

Trap lines will consist of Sherman folding aluminum live traps (8 × 9 × 23 cm; H. B. Sherman Traps, Inc., Tallahassee, Florida). The number of traps will be determined by the BLM and NDOW based on project activity/type, project location, project size/magnitude, habitat conditions (*e.g.,* known DKM/PKM information of the area, potential habitat, etc.), and other information (*e.g.*, guidelines from literature, biologist knowledge, accepted species distribution modelling, etc.). In addition, poly-fill batting material should be placed in traps to provide insulation. If trapping during light rain, all traps will be covered with cardboard tents. The tent provides additional insulation during cold night time temperatures and helps to keep the trap and captured animals dry. If the traps become 80% or more saturated with species (often with *Peromyscus maniculatus,* PEMA), an additional 10% of the trap total would be added to the trap grid. Having traps saturated with PEMA effectively decreases the chance of finding other species, especially those that are rarer or less competitive. Adding 10% more traps may help increase the chance of detecting rare/less competitive species. If the traps become 80% or more saturated with species after adding the additional 10% traps, coordinate with the BLM and NDOW to determine potential for survey method modifications.

The trap grid design is similar to the layout used in Upham and Hafner (2013). Trap stations should be placed at about 10 meter intervals with paired traps at each station, see Figure 1. Trap pairs should be spaced 5-10 meters apart and at least one-meter away from the nearest shrub, whenever possible (i.e., traps will be placed in open microhabitats (Price, 1978; Price et al., 1984; Thompson, 1982). The UTM location for each trapping station will be recorded with a Global Positioning System (GPS) unit.

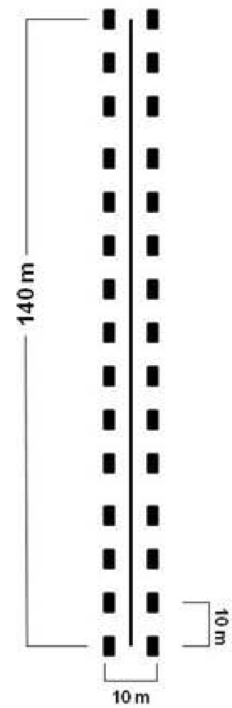


Figure 1. Example Trap Spacing

Animal Handling and Tissue Sampling

Captured animals will be identified to species or genus level before immediate release at the site of capture. All animals will be treated in accordance with guidelines of the American Society of Mammalogists (Sikes et al., 2011). Specifically for *Microdipodops* especially where overlap between *M. pallidus* or *M. megacephalus* distribution in predicted, genetic confirmation of species identity is required (Hafner et al. 2008; Hafner and Upham 2011; M.Matocq pers comm). Pelage color and other morphological characteristics alone cannot be used to discriminate these two cryptic species. The potential for overlap in habitat preferences as well as lack of clarity on the full range of each species allows for further overlap and error in species misclassifications.

To distinguish species, a small tissue sample from each individual is required. To collect this sample, take a small clip from just the tip of one ear with a quick snip from a pair of sharp scissors. Place tissue sample a provided vial with ethanol that is clearly labeled with a unique ID and date which corresponds to the datasheet. Simple, short unique IDs are preferred: for example, a 2-letter code for each trap grid + 4-character month and day +unique number. For example, for trap grid labeled “AA” and kangaroo mouse caught on June 1, the unique ID would be “AA_0601_1”. These transects should be labeled in GIS shapefiles prior to trapping.

Clean scissors with a 10% bleach solution between uses. This ear clip can also be used to identify recaptures made during subsequent trapping nights. Ear clip envelopes should be stored in a cool, dry location. The ear should not bleed profusely or at all during the clip. If this is not the case, reach out to BLM and NDOW biologists for further assistance. At the end of each trapping session, all labeled samples should be sent to the BLM biologist.

All individuals, once handled, should be marked with a small stripe using a non-toxic Sharpie each night in order to keep track of unique captures. If this individual is caught in a subsequent night, simple write “recapture” and the 4-letter code by that trap number. The ear clips can also be used as a “mark” for each kangaroo mouse individual. Again, simply write the 4 letter code and “recapture” and do not take another tissue sample. Recaptured animals do not need to be measured again.

There are many websites about exposure to *Hantavirus*: please access this information to provide insight and guidance about best practices when small mammal trapping. Deer mice carry *Hantavirus*. From the CDC (https://www.cdc.gov/hantavirus/pdf/hps_brochure.pdf), “People get HPS when they breath in hantaviruses. This can happen when rodent urine and droppings that contain a hantavirus are stirred up into the air. People can also become infected when they touch mouse or rat urine, droppings, or nesting materials that contain the virus and then touch their eyes, nose, or mouth. They can also get HPS from a mouse or rat bite.” Correctly handing deer mice with batting or other gloves will prevent mouse bites and care should be made to not place mouse plus droppings plus nesting material in plastic bag and handle deer mice in that manner. Not only are measurements inaccurate, but this practice only furthers the risk of inhalation of the surveyor to rodent droppings and urine. Please make sure to clean traps in a safe manner.

Survey Duration and Seasonal Timing

Both the DKM and PKM are nocturnal rodents and require nocturnal trapping. Trap sites will be left in place for four consecutive nights per trapping location. The number of survey days is based on Nathan and Hafner (2013). O’Farrell and Blaustein (1974b) note that DKM are active March to October and that the species probably hibernates or are less active during winter months (Kenagy, 1973). Though some researchers report winter activity (O’Farrell and Blaustein, 1974a), others state that the PKM hibernates (Wilson and Ruff, 1999). Therefore, surveys will be conducted between the months of May 1 and September 15.

Trapping surveys will occur two times per location, once in the early summer (May 1- June 30), once in late summer (approximately July 1 through September 15). Target survey dates will be determined based on daily/nightly temperature and precipitation ranges.

If *Microdipodops* are detected during surveys, the surveys in that survey area would continue until the survey period (4 consecutive nights) is over and consecutive surveys (late summer) would not be required for that survey area. Consecutive surveys in the other survey areas will continue to determine if *Microdipodops* are detected in all the potential habitat areas. These surveys will continue until *Microdipodops* are detected or until the survey period is over.

Due to overlapping distribution for DKM and PKM in certain regions (Wilson and Ruff, 1999), the results from the genetic confirmation of the species are needed to determine if one or both species were detected. See “Animal Handling and Tissue Sampling” section of this protocol.
If one or both species of kangaroo mouse are detected within the project area, additional information may be required. Coordinate with BLM and NDOW to determine next steps.

Baiting and Trap Check Frequency

Traps will be baited with bird seed available at hardware stores about one hour before sunset and checked within one hour after sunrise, as identified in Hafner and Upham, 2013. During the day, traps will be closed so as to not capture small mammals as their activity reportedly peaks just after sunset and continues through the night (Manley, et al., 2006). Nathan and Hafner (2013) also note that peak activity is within two hours of sunset. In summer months, a second peak may occur two hours before sunrise. Daytime temperatures within the traps may also be harmful, which further justifies nighttime trapping.

Weather Conditions

Trapping will not occur when nighttime low temperatures drop below 32 degrees Fahrenheit or when heavy rain or snow events occur. Should temperature or precipitation hinder trapping survey efforts substantially within a given seasonal survey window, coordination with the BLM and NDOW will occur to determine potential for survey methods modifications. If high rates of small mammal mortality begin to occur due to temperature extremes, cease trapping immediately and coordinate with the BLM and NDOW before moving forward. If mortality occurs, please follow process identified in the "Mortalities" section of this protocol.

Mortalities

While it is understood that those using this protocol are attempting to keep animals alive during trapping and handling, unintended mortality is inevitable. Please use the following directions for reporting mortalities to BLM and NDOW, and also record mortality information in the comment section in the corresponding datasheet.

In the event of mortality, use the following procedure to prepare the specimen in the field OR if you have access to a freezer, immediately place specimen in labeled container in freezer. To prepare specimen in the field, each individual should be placed in its own container (small plastic bottle or a plastic bag with a twist-tie) so that DNA samples won't be cross contaminated. There should be enough of the 95% ethanol solution to completely cover the animal. Before placing the animal in the ethanol, open up the belly and expose the internal organs so that the ethanol can soak in and prevent bacterial decomposition. It is best to open the animal up through the chest cavity such that the heart/lungs are exposed and can be fixed with the ethanol. Cut only through the skin and muscle tissue: do not puncture the internal organs. This may work best with a scalpel or a disposable, single-use razor blade.

Please use single-use latex gloves when preparing animals and make sure to disinfect equipment using the following wash and flame procedure if reusing equipment. To sterilize equipment, clean by using either a) a Trifectant tablet mixed in 1 pint of water or b) a 20% bleach solution, flame scalpel or razor blades with match or lighter and rinse with water. Please follow appropriate wildlife health standards, which include: use single-use gloves for each animal, sterilize equipment after each animal with a disinfectant solution for at least 10 minutes if using the Trifectant.

Treat all mortalities of non-target species as you would for DKM and PKM mortalities. Label all specimen with collection date, collection GPS coordinates (NAD 83, Z11), and trap/transect # from data sheet. Give these specimens either to NDOW or to the BLM biologist who will transfer them to NDOW.

**BLM or NDOW may be able to provide ethanol, specimen containers, and vials: please ask BLM biologist if these materials are available.

REPORTING

Following the DKM and PKM surveys, a report will be compiled that includes methods, results, data sheets (both a scan of the field sheet and entered electronically in an Excel sheet), field maps, and GIS shapefiles of survey locations and important observation locations, such as target species captures and mortalities. This report will be compiled within the final biological baseline survey report for the project. Survey data will also be compiled with the surveying party's annual report to NDOW as required by scientific collection permits stipulations.

After completion of the final biological baseline survey report, the BLM will use the data in the NEPA analysis.

APPENDICES

Appendix A – Data Form and Equipment List (excel format)
Appendix B – Hafner et al. 2008; Hafner and Upham 2011

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Appendix A – Data Form and Equipment List (excel format)

Appendix B – Hafner et al. 2008; Hafner and Upham 2011

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ORIGINAL ARTICLE

Phylogeography of the pallid kangaroo mouse, *Microdipodops pallidus*: a sand-obligate endemic of the Great Basin, western North America

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ABSTRACT

Aim Kangaroo mice, genus *Microdipodops* Merriam, are endemic to the Great Basin and include two species: *M. pallidus* Merriam and *M. megacephalus* Merriam. The pallid kangaroo mouse, *M. pallidus*, is a sand-obligate desert rodent. Our principal intent is to identify its current geographical distribution and to formulate a phylogeographical hypothesis for this taxon. In addition, we test for orientation patterns in haplotype sharing for evidence of past episodes of movement and gene flow.

Location The Great Basin Desert region of western North America, especially the sandy habitats of the Lahontan Trough and those in south-central Nevada.

Methods Mitochondrial DNA sequence data from portions of three genes (16S ribosomal RNA, cytochrome *b*, and transfer RNA for glutamic acid) were obtained from 98 individuals of *M. pallidus* representing 27 general localities sampled throughout its geographical range. Molecular sequence data were analysed using neighbour-joining, maximum-parsimony, maximum-likelihood and Bayesian methods of phylogenetic inference. Directional analysis of phylogeographical patterns, a novel method, was used to examine angular measurements of haplotype sharing between pairs of localities to detect and quantify historical events pertaining to movement patterns and gene flow.

Results Collecting activities showed that *M. pallidus* is a rather rare rodent (mean trapping success was 2.88%), and its distribution has changed little from that determined three-quarters of a century ago. Two principal phylogroups, distributed as eastern and western moieties, are evident from the phylogenetic analyses (mean sequence divergence for cytochrome *b* is *c.* 8%). The western clade shows little phylogenetic structure and seems to represent a large polytomy. In the eastern clade, however, three subgroups are recognized. Nine of the 42 unique composite haplotypes are present at two or more localities and are used for the orientation analyses. Axial data from haplotype sharing between pairwise localities show significant, non-random angular patterns: a north-west to south-east orientation in the western clade, and a north-east to south-west directional pattern in the eastern clade.

Main conclusions The geographical range of *M. pallidus* seems to be remarkably stable in historical times and does not show a northward (or elevationally upward) movement trend, as has been reported for some other kinds of organism in response to global climate change. The eastern and western clades are likely to represent morphologically cryptic species. Estimated times of divergence of the principal clades of *M. pallidus* (4.38 Ma) and between *M. pallidus* and *M. megacephalus* (8.1 Ma; data from a related study) indicate

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that kangaroo mice diverged much earlier than thought previously. The phylogeographical patterns described here may serve as a model for other sand-obligate members of the Great Basin Desert biota.

Keywords

Conservation biogeography, cryptic species, directional analysis, evolutionarily significant units, Great Basin, historical biogeography, *Microdipodops pallidus*, mitochondrial DNA, pallid kangaroo mouse, phylogeography.

INTRODUCTION

Kangaroo mice, genus *Microdipodops* Merriam, belong to the rodent family Heteromyidae Gray and are restricted in distribution to sandy habitats in the Great Basin Desert of western North America. Relative to other heteromyid genera [*Perognathus* Wied-Neuwied and *Chaetodipus* Merriam (pocket mice), *Dipodomys* Gray (kangaroo rats) and *Heteromys* Desmarest (spiny pocket mice)], *Microdipodops* has an unusually small geographical distribution and is depauperate in number of species (Schmidly *et al.*, 1993; Patton, 2005; Hafner *et al.*, 2007). Only two species are currently recognized in the genus: *M. megacephalus* Merriam, the dark kangaroo mouse, and *M. pallidus* Merriam, the pallid kangaroo mouse. Kangaroo mice are also considered to be rather uncommon members of the nocturnal desert rodent community (Hall, 1941; Hafner, 1981; Hafner *et al.*, 1996).

Morphologically and ecologically, *M. pallidus* appears to be more specialized than *M. megacephalus*. Relative to its congener, *M. pallidus* has more highly inflated auditory bullae, larger hind feet, a smaller geographical distribution, and is more stenotopic (Hall, 1941; Hafner, 1981; Hafner *et al.*, 1996). Although *M. megacephalus* tolerates a variety of sandy substrates and floral associations throughout the Great Basin, *M. pallidus* is restricted typically to fine, loose, sandy soils (with little or no gravel overlay) in the lower portion of the Upper Sonoran Life Zone [usually at elevations below the sagebrush (*Artemisia* Linnaeus) community]. Hence, the pallid kangaroo mouse is a highly specialized, sand-obligate organism, and an understanding of its phylogeographical patterns may provide a model for future studies of other sand-obligate organisms in the Great Basin. We used DNA sequencing data from portions of three mitochondrial genes, 16S ribosomal RNA (16S), cytochrome *b* (*Cytb*), and transfer RNA for glutamic acid (tRNA^{Glu}), to reconstruct phylogenetic relationships within *M. pallidus* and interpret those patterns in the context of historical biogeography.

MATERIALS AND METHODS

Study area, specimens examined and field work

Pallid kangaroo mice were sampled from 27 general localities throughout the species' geographical range in the Great Basin Desert (Fig. 1). A total of 98 specimens were used in this molecular study: 95 specimens were collected in the wild between 1999 and 2005, and three specimens (all from Alamo) were collected in 1975 (see Appendix). Mitochondrial DNA sequence data from two specimens from Goldfield (Appendix) were taken from Hafner *et al.* (2006): GenBank accession numbers for 16S and *Cytb* (includes a small, adjoining section of tRNA^{Glu}) are DQ422910, DQ422911 and DQ422937, DQ422938, respectively.

Following Hafner *et al.* (2006), initial outgroup taxa included the sister species, the dark kangaroo mouse (*M. megacephalus*), representative kangaroo rats, the chisel-toothed kangaroo rat (*Dipodomys microps* Merriam) and the desert kangaroo rat (*D. deserti* Stephens), and a pocket mouse, the little pocket mouse (*Perognathus longimembris* Coues). Final selection of outgroup taxa (Appendix) excluded *P. longimembris* because our preliminary analyses and previous phylogenetic analyses showed it to be less closely related to *Microdipodops* than is *Dipodomys*. Our outgroup selection was also supported by other studies (Hafner, 1982; Hafner & Hafner, 1983; Rogers, 1990; Hafner, 1993; Mantooth *et al.*, 2000; Alexander & Riddle, 2005; Hafner *et al.*, 2006, 2007). Sequence data from two outgroup specimens (*D. microps* and *M. megacephalus*) in the Appendix were taken from Hafner *et al.* (2006): GenBank accession numbers for 16S and *Cytb* (includes a small section of tRNA^{Glu}) are DQ422887, DQ422914 and DQ422895, DQ422917, respectively. Animals collected during the course of this study were treated in a humane manner following procedures approved by the American Society of Mammalogists (Gannon *et al.*, 2007) and Occidental College's Institutional Animal Care and Use Committee.

Mitochondrial DNA analyses

Portions of two mitochondrial genes, 16S and *Cytb*, were selected for analysis in this study because of their contrasting evolutionary rates (16S is more conservative than *Cytb*; Ferris *et al.*, 1983; Springer *et al.*, 2001; Hafner *et al.*, 2006, 2007). Different rates of molecular change should facilitate the resolution of clades at both deep (16S) and shallow (*Cytb*) temporal levels, and allow for more detailed phylogenetic inference (Hillis & Dixon, 1991; Meyer, 1994). Laboratory procedures pertaining to DNA extraction, mitochondrial DNA (mtDNA) amplification, purification and sequencing were conducted as described by Hafner *et al.* (2006). Amplifications

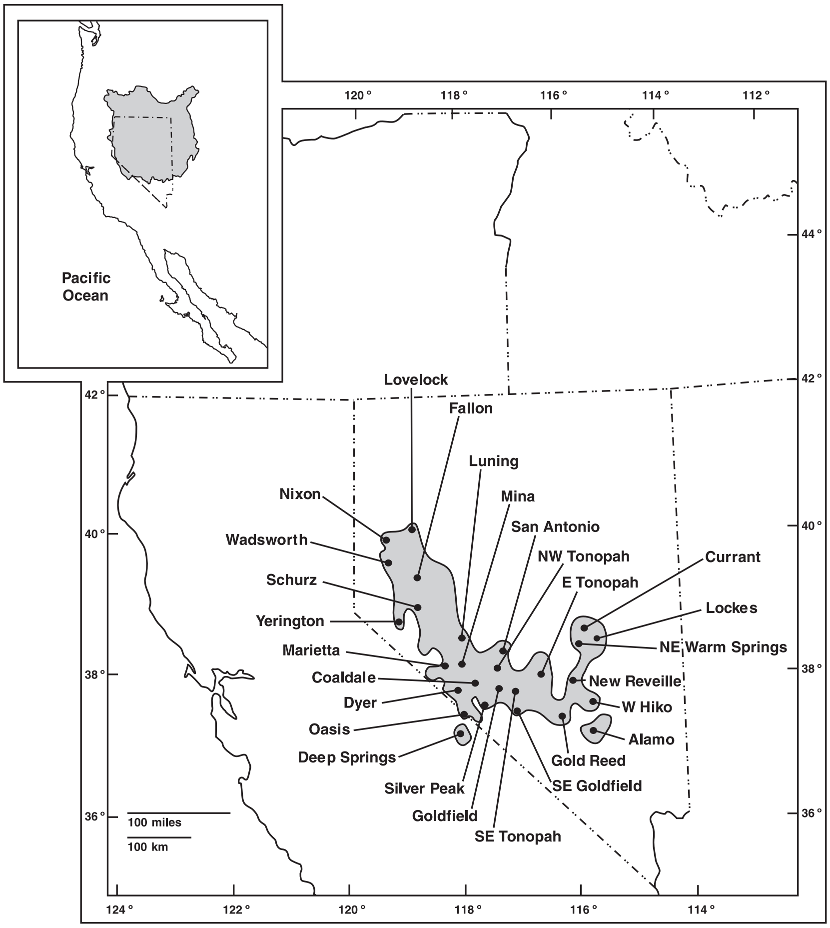

Figure 1 Map showing the distribution of the pallid kangaroo mouse *Microdipodops pallidus* Merriam, and the 27 general localities sampled in this study. The inset map of western North America depicts the Great Basin Desert (shaded area) as defined using floristic data from Cronquist *et al.* (1972). In both maps, the outline of the state of Nevada is shown for orientation.

of 16S and *Cytb* were optimized using the following thermal profile: initial denaturation at 95°C (30 s), followed by 35 cycles of denaturation at 95°C (30 s), annealing at 52°C (60 s), and extension at 72°C (90 s), and a final extension at 72°C for 5 min. Polymerase chain reaction (PCR) and sequencing of the 16S gene were performed using 16Sar and 16Sbr human primers (Palumbi, 1996). The *Cytb* gene was amplified and sequenced using the primers MVZ05 and MVZ04 (Smith & Patton, 1991), which were placed in conserved regions of the 5′ adjacent tRNA^{Glu} and *Cytb* gene, respectively. Regular sequencing yielded a continuous section that includes a small (40 base pairs, bp) portion of tRNA^{Glu}, non-coding bases, and 403 bp of the protein-coding *Cytb* gene. This continuous section of tRNA^{Glu} and *Cytb* was considered only in the phylogenetic analysis of the combined data set (16S + *Cytb* + tRNA^{Glu}), not in the independent *Cytb* analyses.

Double-stranded sequences (light and heavy strands) for each individual were edited and assembled in GeneTool 1.0 (Biotools, Inc., Edmonton, Canada). All new sequences of *M. pallidus* (n = 96) were submitted to GenBank (GenBank accession numbers DQ534206–DQ534301 for 16S; DQ534302–DQ534397 for *Cytb*, includes tRNA^{Glu}). New sequence data for additional outgroup specimens were also submitted to GenBank: two specimens of *M. megacephalus* (GenBank accession numbers DQ870281, DQ870313 for 16S; DQ870362, DQ870405 for *Cytb*, includes tRNA^{Glu}) and a specimen of *D. deserti* (GenBank accession number DQ870428 for 16S; DQ870429 for *Cytb*, includes tRNA^{Glu}). Multiple sequence alignments were performed using ClustalX (Thompson *et al.*, 1997) with the default settings (gap opening = 10, gap extension = 0.20) for 16S, *Cytb* and the combined (16S + *Cytb* + tRNA^{Glu}) data set. All alignments were examined visually and edited manually in MacClade 4.0 (Maddison & Maddison, 2000), with unambiguous alignment at all positions allowing for postulated gaps to be verified without the use of structural models (Leaché & Reeder, 2002; Carranza *et al.*, 2006). Unique haplotypes were identified using Arlequin 3.01 (Excoffier *et al.*, 2005) and all subsequent analyses were based on unique haplotypes. mega 3.1 (Kumar *et al.*, 2004) was used to calculate transition/transversion ratios, estimate base composition and test our data sets for saturation.

Phylogenetic analyses were first performed separately on the 16S (543 bp) and *Cytb* (403 bp) data sets, then on the combined (16S + *Cytb* + tRNA^{Glu}) alignment of 991 bp, to identify possible incongruence between the gene fragments (Wiens, 1998; Leaché & Reeder, 2002; Townsend *et al.*, 2004). The partition homogeneity test (PHT; Farris *et al.*, 1994) was implemented in paup* 4.0b10 (Swofford, 2003) to further determine phylogenetic congruence. Executed under maximum-parsimony settings, the PHT was run with 1000 partition replicates, 10 random taxon-additions per replicate, and no more than 500 equally most parsimonious trees retained per replicate to limit computation times. A non-significant PHT result ($P = 0.89$) allowed for combination of the three mtDNA gene fragments. Maximum parsimony and neighbour-joining methods (PAUP* 4.0b10) were used subsequently to analyse each of our three mtDNA data sets (16S, *Cytb* and combined), and all trees were virtually identical topologically except for minor changes within the terminal branches. Further analysis of our combined data set was conducted using maximum-likelihood approaches (PAUP* 4.0b10), as well as Bayesian methods (MrBayes 2.01; Huelsenbeck & Ronquist, 2001).

Maximum-parsimony analyses were conducted with the following settings: full heuristic searches of equally weighted sites, simple sequence addition, tree bisection–reconnection branch swapping, and multiple parsimonious trees saved. Nodal support for the maximum-parsimony consensus tree was evaluated by calculating 1000 bootstrap pseudoreplicates (Felsenstein, 1985) using PAUP* 4.0b10. Bremer support values (Bremer, 1994) were obtained using both PAUP* 4.0b10 and TreeRot (ver. 2; Sorenson, 1999). PAUP* 4.0b10 was also used to determine the consistency index (CI) and retention index (RI) and to test for the presence of phylogenetic signal (Hillis & Huelsenbeck, 1992).

Estimates of percentage nucleotide sequence divergence were calculated in MEGA 3.1 for each gene fragment and the combined data set using uncorrected *p* distance and the pairwise-deletion option (gaps removed pairwise per comparison). For comparison purposes, genetic distances were also calculated using Kimura's two-parameter model (Kimura, 1980). Uncorrected *p* distance was used to perform neighbour-joining analyses (Nei & Kumar, 2000). Neighbour-joining distance trees were bootstrapped with 1000 pseudoreplicates to assess clade reliability.

The most appropriate model of nucleotide evolution for the combined data set, as suggested by ModelTest (ver. 3.7; Posada & Crandall, 1998), was the general time-reversible model with invariant sites and among-site variation (GTR + I + Γ; Yang, 1994; Gu *et al.*, 1995). This model of evolution, determined under the Akaike information criterion (Johnson & Omland, 2004; Posada & Buckley, 2004), was also used to compare rates of nucleotide substitution with the molecular clock. Maximum-likelihood analyses were conducted using the parameters specified by ModelTest and a full heuristic search under maximum-parsimony settings. A full heuristic bootstrap (200 pseudoreplicates) was then performed on the constructed maximum-likelihood tree.

Bayesian phylogenetic analyses were performed in MrBayes 2.01 using GTR + I + Γ, with the specific model parameters treated as unknowns with uniform priors and estimated by each Bayesian analysis (Leaché & Reeder, 2002). Four incrementally heated chains (Metropolis-coupled Markov chain Monte Carlo; Huelsenbeck & Ronquist, 2001) were run concurrently for 10,000,000 generations and were sampled every 1000 generations. These 10,000 data points were acquired twice in independent Bayesian analyses to make sure the searches were not limited to local optima (Leaché & Reeder, 2002). Stationarity was evaluated graphically by plotting log-likelihood values of sample points against generation time, then eliminating the first 200 trees prior to stationarity as burn-in values. The remaining 9800 equilibrium trees from each independent analysis were used to create a 50% majority-rule consensus tree, where each clade's posterior probability value is indicative of the percentage of samples that recover that particular clade (Huelsenbeck & Ronquist, 2001).

Directional analyses of phylogeographical patterns

Compass orientations between pairs of localities whose individuals share haplotypes represent fine-scale phylogeographical patterns and may provide insights regarding historical trends in gene exchange and movement patterns of kangaroo mice. Directional analyses of phylogeographical patterns (DAPP), a novel approach presented here, relies on axial data (angular measurements of undirected lines, 180° ambiguity) that were measured between all combinations of pairwise localities involved in haplotype sharing among individuals of kangaroo mice. Angular measurements were recorded to the nearest 1° with the aid of a 360° ruler on distribution maps of *M. pallidus*. Angular data were reduced and the mean vector (μ) was calculated for each major geographical unit, as well as the pooled sample of *M. pallidus*. Several uniformity tests were conducted to determine if each sample of orientations between pairwise localities was distributed in a random (isotropic) manner: Rayleigh's uniformity test, Rao's spacing test and Kuiper's test (Batschelet, 1981; Fisher, 1993; Kovach, 2006). The Mardia–Watson–Wheeler test and the Watson U^2 test were used to test whether two samples have the same angular distribution. Oriana software (Kovach, 2006) was used to calculate all circular statistics involved in DAPP.

RESULTS

Field work and geographical distribution

Collecting activities for this study, involving 13,900 trapnights and resulting in the trapping of 128 individuals of *M. pallidus*, yielded an overall trapping success of 0.92% for *M. pallidus*. Despite setting traps at known localities (Hall, 1941; Hafner, 1981) or at new sites in habitats judged (by J.C.H.) to be appropriate for this species, trapping results show that *M. pallidus* is among the least abundant of the nocturnal desert rodents in sandy habitats of the Great Basin (data available on request). Considering only those localities where individuals of *M. pallidus* were captured, the mean trapping success was only 2.88%; the range in trapping success was 0.25% (one capture from 400 trapnights) to 14.0% (14 captures from 100 trapnights).

We note several adjustments to Hall's (1941) portrayal of the geographical distribution of *M. pallidus* in the northwestern, south-central and north-eastern portions of the species' distribution (Fig. 1). Specifically, kangaroo mice around the southern end of Pyramid Lake (the general localities of Nixon and Wadsworth) are identified as *M. pallidus* not *M. megacephalus* (cf. Hall, 1941, 1946; Mantooth *et al.*, 2000); this finding corroborates Hafner (1981) and extends the north-western distribution margin *c.* 50 km. In the south-central portion of the geographical range, the locality of SE Goldfield (at Stonewall Flat) extends the known range of *M. pallidus* southward about 30 km; prior to this study, SE Tonopah (='north shore of Mud Lake', Hall, 1941: 272) represented the southernmost central locality. Lastly, the localities of Currant and NE Warm Springs extend the north-eastern distributional arm of the species about 30 km to the north and west from the locality of Lockes (referred to as 'Locks Ranch' by Hall, 1941: 273). The presence of *M. pallidus* at the NE Warm Springs locality was also reported by Hafner (1981) and Hafner *et al.* (1996).

Mitochondrial DNA sequence characteristics

The combined (16S + *Cytb* + tRNA^{Glu}) data set, including all unique haplotypes of *M. pallidus* and outgroup taxa, shows a total of 238 variable characters (96, 126 and six variable characters, respectively). Rates of nucleotide substitution are in accordance with a molecular clock model (using the combined data set, $\chi^2 = 43.35$, $P > 0.05$ with samples of *M. megacephalus* designated as the outgroup, and $\chi^2 = 29.67$, $P > 0.05$ with species of *Dipodomys* designated as outgroup taxa). Mean base frequencies for A, C, G and T are 0.321, 0.243, 0.168 and 0.269, respectively (0.337, 0.209, 0.195 and 0.260, respectively for 16S and 0.287, 0.294, 0.140 and 0.279, respectively for *Cytb*; data for tRNA^{Glu} available on request). Chi-square tests for possible heterogeneity of base frequencies across all samples are not significant for the combined data set ($\chi^2 = 8.779$, $P = 1.000$) nor for each gene ($\chi^2 = 2.835$, $P = 1.000$ for 16S; $\chi^2 = 8.692$, $P = 1.000$ for *Cytb*); hence, it is doubtful that base compositional heterogeneity causes phylogenetic bias. Mean base frequencies for A, C, G and T for unique *M. pallidus* haplotypes only are 0.338, 0.209, 0.194 and 0.259, respectively, for 16S and 0.287, 0.294, 0.140 and 0.279, respectively, for *Cytb*.

Transition/transversion ratios for 16S, *Cytb* and the combined data set are 2.737, 3.327 and 3.377, respectively (over all positions, using uncorrected *p*, and with only samples of *M. pallidus*). Following the methods of Barker & Lanyon (2000), plots of number of transitions vs. uncorrected *p* distance show no evidence for saturation for 16S nor for *Cytb* for the unique haplotypes of *Microdipodops* studied. However, third-position transitions for *Cytb* show saturation when *D. deserti* and *D. microps* are included in the analyses. Tests for phylogenetic signal in our data sets (over all unique haplotypes and with both species of *Dipodomys* designated as outgroups) show significance for 16S (96 variable characters, 29 haplotypes, $g_1 = -0.697$, $P < 0.01$) and for *Cytb* (126 variable characters, 31 haplotypes, $g_1 = -0.463$, $P < 0.01$).

Haplotypic variation in *M. pallidus*

A total of 42 unique composite haplotypes and 87 polymorphic sites are identified from the combined mtDNA data set that includes 98 individuals of *M. pallidus* from 27 general localities. Considering 16S and *Cytb* separately, there are 24 and 26 unique haplotypes and 39 and 46 polymorphic sites, respectively, for these genes.

Twenty of 27 general localities are represented by multiple individuals and, hence, are available for an assessment of intrapopulational mitochondrial sequence variation (San Antonio is excluded here because it is identified as a locality of contact between divergent haplotypes; see beyond). There is a mean (and range) of 4.45 (2–10) individuals sampled per locality for these 20 localities. Patterns of within-population variation are similar for 16S and *Cytb*. For example, the mean number of haplotypes per locality is 1.95 and 1.90 for 16S and *Cytb*, respectively. For 16S, there is no significant functional relationship between the number of haplotypes and sample size seen at a locality ($b = 0.108$; $P = 0.280$). However, a significant linear trend between the number of haplotypes and sample size per locality is evident for *Cytb* ($b = 0.225$; $P = 0.013$). Lastly, the mean number of polymorphic sites per population is 1.40 and 1.20 for 16S and *Cytb*, respectively.

Phylogenetic analyses

Analysis of the combined (991 bp) mtDNA sequence data for the 42 ingroup haplotypes of *M. pallidus* and the five outgroup species yields 165 characters that are parsimony-informative (66, 90 and four parsimony-informative characters for the separate 16S, *Cytb*, and tRNA^{Glu}, respectively). Parsimony analysis for the combined data set shows 132 most parsimonious trees (CI = 0.732; RI = 0.910). Phylogenetic analyses using maximum-parsimony, neighbour-joining, maximum-likelihood and Bayesian approaches produce trees that are virtually identical in topology; only slight differences in the placement of *M. pallidus* haplotypes at extreme terminal branches are evident. Monophyly of the genus *Microdipodops* is supported strongly in all analyses, and all analyses show that the 42 unique haplotypes of *M. pallidus* form a clear sister clade relative to the samples of *M. megacephalus* (Fig. 2).

Support is also very high for the recognition of two basal clades within the currently recognized species *M. pallidus*: an eastern clade and a western clade (Figs 2 & 3). These clades are distributed parapatrically, except at the San Antonio locality (Fig. 3), where both eastern and western haplotypes are found in sympatry. Of three kangaroo mice examined from San Antonio, one individual represents an eastern haplotype and two individuals are aligned with the western clade.

The western clade shows very little structure and appears to represent a large polytomy (Fig. 2). Although there is little mtDNA differentiation among haplotypes in the western clade (one or two base substitutions), the distributional isolate

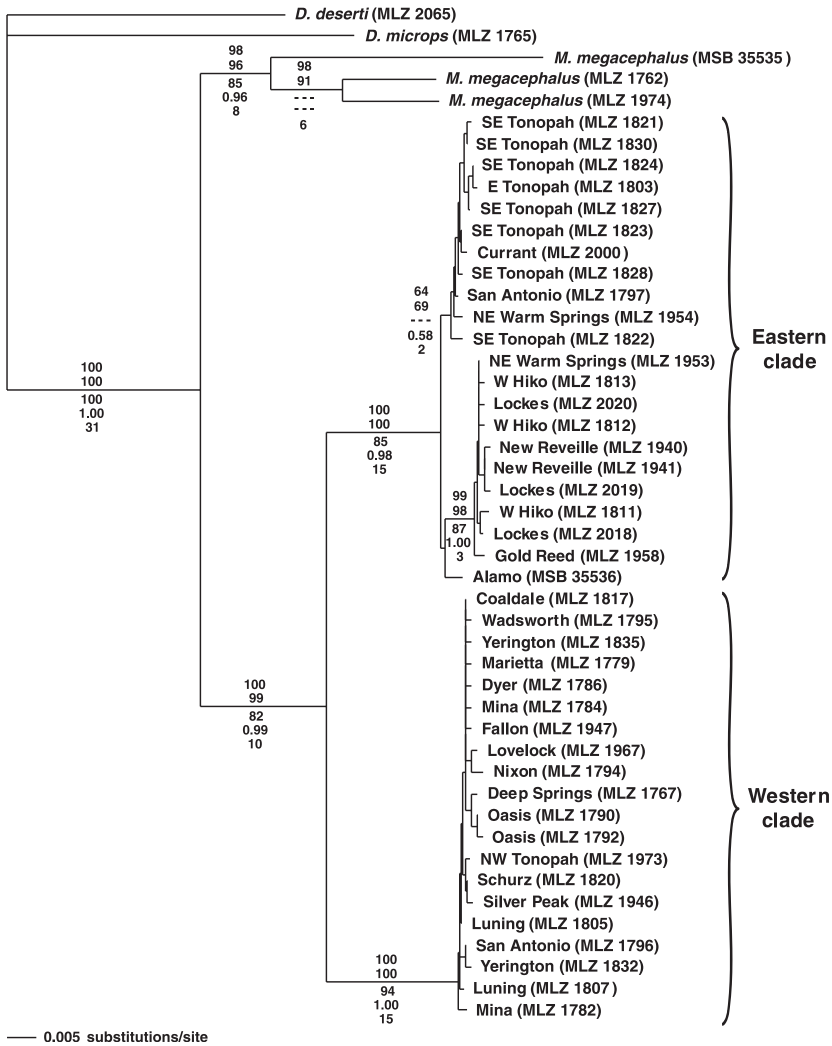

Figure 2 Distance (neighbour-joining) tree based on the composite mtDNA sequence data and showing the relationships among the 42 unique haplotypes of *Microdipodops pallidus* Merriam. Distance and parsimony bootstrap support values are indicated above the nodes, with maximum-likelihood support values, Bayesian posterior probabilities and Bremer decay indices below the nodes.

from the Deep Springs locality forms a weakly resolved clade with the Oasis locality (Figs 1 & 2). Nodal support values for the distance, maximum-parsimony, maximum-likelihood, Bayesian and Bremer analyses are 54, 60, 71, 0.97 and 1, respectively, for this clade.

Haplotypes of the eastern clade seem to assort imperfectly into three geographical subunits: a south-central subunit, an eastern subunit, and a south-eastern peripheral isolate (Figs 2 & 3). The south-central subunit is resolved weakly, and includes haplotypes from seven localities: SE Tonopah, E Tonopah, Currant, San Antonio, NE Warm Springs, Goldfield and SE Goldfield (the latter two localities are not shown in Fig. 2). The eastern subunit is a well supported clade and includes haplotypes from five localities aligned in a north–south distributional prong: NE Warm Springs, W Hiko, Lockes, New Reveille and Gold Reed (Fig. 2). Lastly, the isolated population near Groom Lake (Alamo) appears to represent a distinct matrilineage. Note that our phylogenetic analyses place haplotypes from Currant (two haplotypes, $n = 5$) in the south-central subunit despite Currant's geographical position at the northern tip of the eastern distributional prong (Fig. 3). Moreover, haplotypes from NE Warm Springs (five haplotypes, $n = 5$) are represented in both the south-central subunit (four haplotypes) and the eastern subunit (one haplotype); NE Warm Springs, like Currant, is located at the northern tip of the eastern subunit (Fig. 3).

As expected from its known higher rate of substitution, percentage divergence values for *Cytb* within and among *Microdipodops* clades are routinely larger than corresponding values for 16S (Table 1). For the gene fragments examined here, *Cytb* divergence values at the deeper nodes (e.g. between eastern vs. western clades of *M. pallidus* and the node for the species of kangaroo mice) are approximately twice those of 16S. Eastern and western clades of *M. pallidus* are distinguished by high levels of sequence divergence (*c.* 8% sequence divergence for *Cytb*), as are the currently recognized species of *Microdipodops* (*c.* 13–15% for *Cytb*; Table 1). The peripheral isolate in the western clade (Deep Springs) shows only minimal divergence from other western populations, but the peripheral isolate in the eastern clade, Alamo, is modestly divergent from adjacent eastern populations (Table 1; Fig. 3).

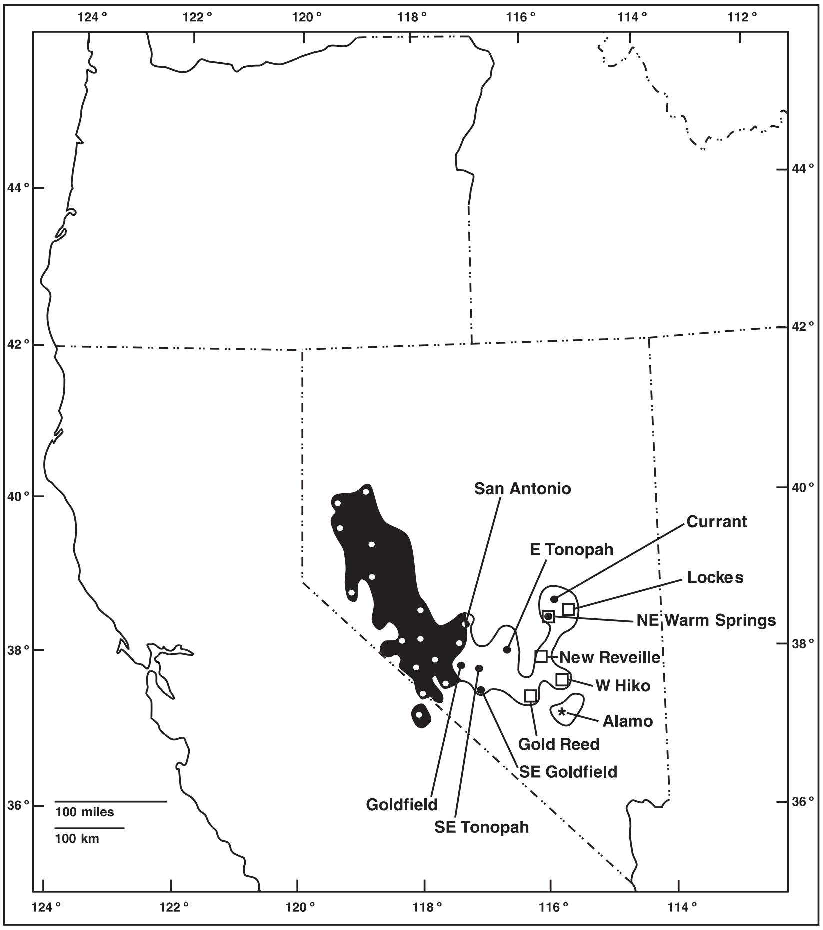

Figure 3 Distribution map of the eastern and western clades of *Microdipodops pallidus* Merriam. Each of the two phylogroups is represented by a main distributional body and a southern peripheral isolate. Note that both principal haplotypes are sympatric at San Antonio. Within the eastern clade, three subunits are recognized: south-central (dots), eastern (squares) and south-eastern (star) subunits. Haplotypes from both south-central and eastern subunits co-occur at NE Warm Springs.

Table 1 Mean pairwise sequence divergence values within and among selected clades of *Microdipodops* examined in this study.

Comparison	16S	*Cytb*	All
Microdipodops pallidus contrasts			
Western clade			
Within western clade	0.28 (0.28)	0.68 (0.69)	0.32 (0.32)
Deep Springs isolate vs. other western clade	0.32 (0.32)	0.60 (0.60)	0.35 (0.36)
Eastern clade			
Within eastern clade	0.76 (0.77)	1.04 (1.05)	0.70 (0.70)
South-central subunit vs. eastern subunit	1.01 (1.02)	1.43 (1.44)	1.02 (1.03)
South-central subunit vs. Alamo isolate	0.95 (0.97)	1.24 (1.25)	0.97 (0.98)
Eastern subunit vs. Alamo isolate	1.11 (1.13)	1.18 (1.19)	1.05 (1.05)
Eastern clade vs. western clade	3.99 (4.12)	7.50 (8.01)	5.20 (5.43)
M. pallidus vs. *M. megacephalus*	6.13 (6.40)	13.21 (14.83)	9.61 (10.36)

Mean percentage divergence estimates for both uncorrected *p* distance and Kimura's two-parameter model (in parentheses) are given for individual genes and the combined data set (All).

Haplotype sharing and orientation analyses

Nine of 42 (21.4%) of the unique composite haplotypes identified in Fig. 2 are present at two or more general localities (Table 2). There are 25 and 20 pairwise combinations of haplotype sharing between localities in the western clade and eastern clade of *M. pallidus*, respectively (Fig. 4), yielding a total of 45 possible pairwise combinations of axial data that are available for DAPP analysis. Orientation data based on haplotype sharing for all pairwise localities of *M. pallidus* show no departure from a uniform distribution (Rayleigh's $Z = 0.141$, $P = 0.87$; Rao's $U = 138$, $P > 0.10$; Kuiper's $V = 0.997$, $P > 0.15$). However, when the axial data are examined separately for the western and eastern clades of *M. pallidus*, clear orientation patterns emerge from the DAPP (Fig. 4). For the western clade ($n = 25$), the mean vector

Table 2 Sharing of unique composite haplotypes of *Microdipodops pallidus* over geography.

Unique haplotype	Number of localities	Distribution
Coaldale MLZ 1817	7	Western Clade: Coaldale (MLZ 1817), Dyer (MLZ 1785, MLZ 1787, and MLZ 1789), Luning (MLZ 1810), Marietta (MLZ 1777 and MLZ 1778), Mina (MLZ 1780, MLZ 1781, and MLZ 1783), Schurz (MLZ 1819) and Silver Peak (MLZ 1945)
SE Tonopah MLZ 1823	5	Eastern Clade: E Tonopah (MLZ 1823, MLZ 1825 and MLZ 1826), E Tonopah (MLZ 1801 and MLZ 1802) Goldfield (MLZ 1746), NE Warm Springs (MLZ 1955) and SE Goldfield (MLZ 2051)
SE Tonopah MLZ 1830	4	Eastern Clade: SE Tonopah (MLZ 1830), Currant (MLZ 2001 and MLZ 2004), Goldfield (MLZ 1743) and NE Warm Springs (MLZ 1952)
Luning MLZ 1805	3	Western Clade: Luning (MLZ 1805, MLZ 1806 and MLZ 1809), San Antonio (MLZ 1798) and Schurz (MLZ 1818)
SE Tonopah MLZ 1824	2	Eastern Clade: SE Tonopah (MLZ 1824) and SE Goldfield (MLZ 2052)
SE Tonopah MLZ 1828	2	Eastern Clade: SE Tonopah (MLZ 1828 and MLZ 1829) and E Tonopah (MLZ 1804
Currant MLZ 2000	2	Eastern Clade: Currant (MLZ 2000, MLZ 2002, and MLZ 2003) and NE Warm Springs (MLZ 1906)
NE Warm Springs MLZ 1953	2	Eastern Clade: NE Warm Springs (MLZ 1953) and Lockes (MLZ 2017)
San Antonio MLZ 1796	2	Western Clade: San Antonio (MLZ 1796) and Yerington (MLZ 1833, MLZ 1836, MLZ 1837, and MLZ 1839)

Nine unique haplotypes, identified in Fig. 2, are present at two or more general localities and are available for directional analyses of phylogeographical patterns (DAPP; see text). In total, there are 45 pairwise combinations of shared haplotypes (25 in the Western Clade and 20 in the Eastern Clade) that provide the basis for directional data.

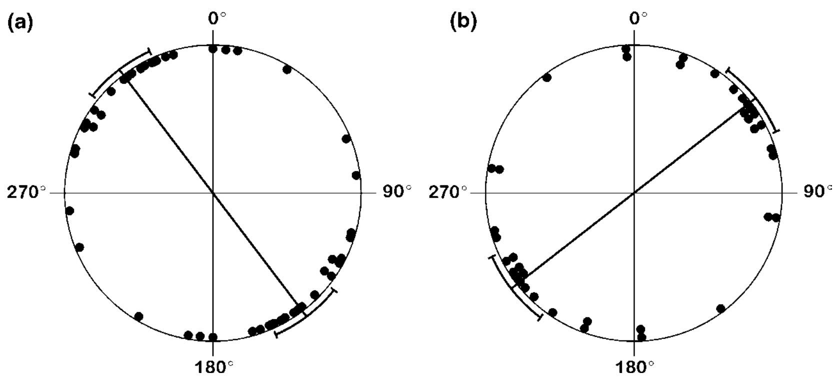

Figure 4 Angular trends derived from orientation analyses of haplotype-sharing patterns between pairs of localities of *Microdipodops pallidus* Merriam. The western (a) and eastern (b) clades show significantly different bidirectional axial patterns over geography (mean orientations and 95% confidence intervals are indicated). The north-west to south-east orientation in the western clade (a) and the north-east to south-west directional pattern in the eastern clade (b) obtained from DAPP (see text) signal different histories of gene flow in the two clades.

$\mu = 142.751°$ (and also 322.751° because of the bidirectional or axial nature of the data) and tests for uniformity are all significant (Rayleigh's $Z = 7.332$, $P < 0.001$; Rao's $U = 161.2$, $P < 0.05$; Kuiper's $V = 2.278$, $P < 0.01$). Angular data for the eastern clade ($n = 20$) show a mean vector $\mu = 51.862°$ (and 231.862°) and also depart significantly from uniformity (Rayleigh's $Z = 6.104$, $P = 0.002$; Rao's $U = 192$, $P < 0.01$; Kuiper's $V = 2.08$, $P < 0.01$). Hence, haplotype sharing between pairwise localities shows a distinct (non-random) north-west to south-east orientation in the western clade and a distinct north-east to south-west directional pattern in the eastern clade (Fig. 4).

DISCUSSION

Abundance of kangaroo mice

Although the reporting of measures of relative abundance (e.g. percentage trap success or capture rate) is not traditional practice in systematic and biogeographical studies, such information is useful to future field biologists, conservationists and wildlife managers who are interested in monitoring the viabilities of populations over time. In a very simple way, the routine reporting of collecting techniques and measures of abundance in systematic and phylogeographical studies may aid in strengthening the intellectual linkage between phylogeography and conservation biology, and we encourage future workers to report these kinds of data. The present conservation status (International Union for Conservation of Nature Red List Category) of *M. pallidus* is 'lower risk, least concern' (Hafner & Hafner, 1998: 80; includes one vulnerable subspecies) and the species is protected in both California and Nevada. Future application of the Mace & Lande (1991) criteria for assessing the conservation status of kangaroo mice requires data pertaining to abundance, especially changing abundance. Data on abundance are important for understanding the conservation status of all species, but these data seem particularly important for those kinds of organism that are considered to be rare in nature.

Hall (1941, 1946) remarked that naturalists considered kangaroo mice to be rare. However, there is very little information in the literature that pertains to estimates of abundance of kangaroo mice, especially for *M. pallidus*. Despite special efforts to collect *M. pallidus* in suitable habitats across its geographical distribution, our general experience is that the pallid kangaroo mouse is a rare member of the nocturnal desert rodent community. Inspection of trapping data in our field notes (data available on request) reveals that *M. pallidus* falls routinely in the rare-species category that predominates the classic 'hollow curve' of number of species vs. species abundance in community ecology (Krebs, 1994; McGill, 2006). In our experience in sandy habitats of the Great Basin, usually one or two species of kangaroo rat are numerically dominant, followed by three to five less-common species; kangaroo mice are invariably among the last species to be recorded in our notebooks when checking traps. Percentage trapping success for *M. pallidus* is usually an order of magnitude smaller than percentage trapping success for the one or two abundant species that we often encounter in communities of nocturnal desert rodents in the Great Basin (data available on request).

Geographical distribution, ecology and conservation biology

Hall (1941) reported an elevational range for *M. pallidus* of 1189–1737 m (3900–5700 ft), and emphasized that this species occurs in habitats above those that support the creosote bush, *Larrea* Cavanilles, and below those that support sagebrush, *Artemisia*. In our experience, *M. pallidus* is found most frequently in floral communities where greasewood, *Sarcobatus* Nees von Esenbeck, and saltbush, *Atriplex* Linnaeus, predominate. The present study confirms the lower elevational and floral limits reported by Hall (1941); *M. pallidus* has never been captured in habitats associated with the Lower Sonoran Life-Zone, and these rodents are found only at their lower elevational extreme in the northern portion of their distribution (Soda Lake: Hall, 1941; Fallon: this study). Hafner *et al.* (1996) extended the upper elevational limit of the species to 1829 m (6000 ft), and this record is affirmed in this study (captures at both NE Warm Springs and Currant). Importantly, at this upper elevational margin, *M. pallidus* was captured within a few metres of *Artemisia* bushes at NE Warm Springs and at Currant. At both these high-elevation localities, *M. megacephalus* was captured in the same trap lines that yielded *M. pallidus*. As noted by Hall (1941), *M. pallidus* occurs on fine, sandy soils supporting vegetation. At every place where we captured *M. pallidus* except one (SE Goldfield), the soil was fine, deep sand with little or no gravel overlay. At SE Goldfield (at the southern margin of the species' range), *M. pallidus* was taken in fine, deep, sandy soil that had an unusually heavy overlay of large-sized (> 10 mm) gravel. In contrast to *M. pallidus*, *M. megacephalus* is usually found on sandy soils with a gravel overlay, at higher elevations, and in habitats dominated by *Artemisia* and/or rabbit brush, *Chrysothamnus* Nuttall. Differences in habitat affinity between the species of kangaroo mice were evaluated by Hafner *et al.* (1996) and their conclusions support the habitat differences for *M. pallidus* and *M. megacephalus* described here.

Three-quarters of a century after Hall's (1941) field work on *M. pallidus*, we document a geographical distribution for the species that is remarkably unchanged. This finding is particularly noteworthy against the backdrop of recent concerns over global warming, documented changes in species distributions, and the positive bias in the literature (Parmesan *et al.*, 1999; Beever *et al.*, 2003; Parmesan & Yohe, 2003; Wagner *et al.*, 2003; Perry *et al.*, 2005). The few minor modifications in our portrayal of the geographical range of *M. pallidus* noted in this study indicate no evidence for any natural, systematic distributional changes. What may appear as a northern range expansion near the southern end of Pyramid Lake (localities of Nixon and Wadsworth; Fig. 1) is actually due to the reidentification of specimens collected from that region. The localities of Currant and NE Warm Springs extend the north-eastern distributional arm of *M. pallidus* northward (and elevationally upward) as compared with Hall's (1941) understanding of the species' distribution. However, neither Hall nor members of his field party visited this remote area (Hall, 1946) and, therefore, the question of a possible natural range adjustment over the ensuing years is moot.

After repeated efforts to collect *M. pallidus* at and near its type locality, Mountain Well (Churchill County, *c.* 35 km east of our Fallon locality, see Fig. 1), we conclude that kangaroo mice are probably locally extinct in this area. There are two other instances where we failed to collect *M. pallidus* from historical sites: Sand Mountain, Churchill County ('37 km south-east Fallon'; Brown, 1973: 777) and Tikaboo Valley, Lincoln County ('eight miles southwest of Hancock Summit'; Hall, 1941: 274; this is *c.* 10–15 km east of our Alamo locality in Emigrant Valley; Fig. 1). Exhaustive trapping was not conducted at Sand Mountain and, therefore, we cannot state that this population is not extant. However, exhaustive trapping in Tikaboo Valley permits us to conclude that kangaroo mice are most likely to be locally extinct in Tikaboo Valley. Although Mountain Well is in the northern portion and Tikaboo Valley is in the southern portion of the species' distributional range, the two areas are similar to the extent that they both harbour small, undisturbed patches of habitat that seem appropriate for *M. pallidus* but, for unknown reasons, kangaroo mice do not occur now in either of these areas.

We agree with Hall (1941) in recognizing two southern distributional isolates for *M. pallidus*: Deep Springs Valley (our locality of Deep Springs), and Emigrant and Tikaboo Valley areas east of Groom Lake (our Alamo locality from Emigrant Valley; Fig. 1). Kangaroo mice from Deep Springs Valley, although only minimally distinct genetically from other populations in the western clade (Fig. 2; Table 1) are isolated geographically from other *M. pallidus* populations (e.g. Oasis) by a rather dramatic ridge of mountains at the southern terminus of the White Mountains (the Gilbert Pass region). Given the valley's small size and isolation, it is not surprising that all 10 animals from Deep Springs are fixed for the same unique haplotype. Given the present extent of livestock grazing and invasive plants in Deep Springs Valley, we suggest that the population of kangaroo mice in Deep Springs Valley be monitored closely to ensure the long-term welfare of this population.

The peripheral isolate from the Emigrant and Tikaboo Valley areas (represented by Alamo on Fig. 1) appears to be a distinct haplotypic lineage of the eastern clade (Fig. 2; Table 1) and is isolated physiographically from all other populations of kangaroo mice to the west and north by the Belted Range, Chalk Mountain, and the Groom Range. Based on morphology, Hall (1941) recognized pale kangaroo mice from the areas east of Groom Lake (in Emigrant Valley and Tikaboo Valley) as a distinct subspecies, *M. p. purus*. Given the phylogeographical and taxonomic importance of this taxon, it is especially important in the context of conservation biology to document its presence and viability today. Unfortunately, access is restricted in the militarily sensitive area of Groom Lake in Emigrant Valley, and kangaroo mice seem no longer to exist in Tikaboo Valley. The samples used in this study from Emigrant Valley were obtained in 1975, before the expansion of the existing boundary of the military range. Unfortunately, no samples of kangaroo mice from this region have been obtained in the ensuing three decades and the conservation status of these kangaroo mice is unknown.

Fire, livestock grazing, invasive plants and agriculture represent the possible 'big four' threat factors with regard to kangaroo mouse habitat. Of the big four, habitat loss associated with agricultural practices (especially alfalfa farming) seems to be the most serious concern for *M. pallidus*, which often occurs in the valley floors where the growth of alfalfa is favoured. In our experience, areas of concern due to expanding agriculture include Lahontan Valley (Fallon), Mason Valley (Yerington), Fish Lake Valley (Oasis and Dyer), and Sand Spring Valley (W Hiko, recognized as Penoyer Valley from Hall, 1941). Wild fires are always an imminent threat throughout the Great Basin but, fortunately, destruction of habitat by wild fires (and the subsequent invasion of introduced weed species) has not been a main factor affecting the distribution and abundance of *M. pallidus*. Livestock (mainly cattle) grazing, common throughout most of the distribution of *M. pallidus* since the 1860s (Wagner *et al.*, 2003), seems to be tolerated by *M. pallidus* in most places. At present, most of the localities of *M. pallidus* are still remarkably free or largely free of invasive plants (e.g. Russian thistle, *Salsola* Linnaeus and cheat grass, *Bromus* Linnaeus) common elsewhere in the Great Basin.

Phyletic patterns and historical biogeography

The molecular data (Figs 2 & 3) identify eastern and western clades of *M. pallidus*, each represented by a principal distributional body and a peripheral isolate. The geographical distributions of the eastern and western clades are approximately equal in size and show nearly the same number of unique haplotypes (22 and 20, respectively). The western clade of *M. pallidus* is distributed in the Lahontan Trough (Reveal, 1979), a low-elevation, north-west-trending region that is part of a geologically complex area known as the Walker Fault Zone (also termed the Walker Belt or Walker Lane: Fiero, 1986; Morrison, 1991; Grayson, 1993; Hafner *et al.*, 2006). Little phylogenetic structure is evident in the western clade, such that a comb-like pattern of relationships emerges (Figs 1 & 2). Reveal (1979) suggested that the Lahontan Trough represented a corridor for the northward range expansion of biota following the Pleistocene. The comb-like pattern of relationships is consistent with a hypothesis of rapid range expansion of kangaroo mice in the Lahontan Trough. However, instead of considering the trough as a unidirectional corridor for northward range expansion since the Pleistocene, we view the Lahontan Trough as a corridor that allowed repeatedly northward and southward distributional range adjustments of *M. pallidus* in response to climatic changes throughout the Pleistocene. The presence of slightly more differentiated haplotypes in the southern portion of the western clade (Fig. 2) indicates that this area (or regions farther south) may have served as a refugium during pluvial maxima. In contrast, it is likely that the distribution of *M. pallidus* in the north was dictated by the waxing and waning of ancient Lake Lahonton (i.e., near existing Pyramid Lake and Walker Lake).

The geographical range of the eastern clade is bounded to the south by the Mojave Desert and to the north by the southern end of the Toiyabe, Taquima, Monitor, Hot Creek, Pancake and Quinn Canyon Ranges. The three subunits of the eastern clade (Fig. 3) appear to be separated physiographically from one another: the Hot Creek and the Kawich Ranges lie between the south-central subunit and the eastern subunit; the Belted Range, Chalk Mountain and the Groom Range separate the eastern subunit from the south-eastern peripheral isolate (Alamo). Six of the seven haplotypes recorded from the localities of Currant and NE Warm Springs do not share affinity with other populations of the eastern subunit but, instead, are genetically more closely related to populations from the south-central subunit (Fig. 3). Presumably, these disjunct haplotypes from Currant and NE Warm Springs represent relictual populations of a once more broadly distributed south-central subunit that was able to flank the southern ends of the Hot Creek and Kawich Ranges and gain access to the sandy habitats to the east and north-east.

The south-eastern peripheral isolate (Alamo) of the eastern clade is genetically distinct from the other eastern subunits (*c.* 1% sequence divergence; Table 1). All three specimens available from this population share the identical haplotype, as might be expected for a small, distributional isolate. Although this isolate is adjacent to the eastern subunit, our mtDNA sequence data do not show a sister-clade relationship with that subunit and, indeed, are unable to resolve the relationships among the three subunits.

Directional analysis of phylogeographical patterns

Historical routes of gene exchange may be detected by angular analyses of haplotype sharing between pairwise localities. The specific, quantitative routes documented in this study (a north-west to south-east orientation in the western clade and a north-east to south-west directional pattern in the eastern clade; Fig. 4) allow us to make two observations. First, the angular trends are consistent with an interpretation that populations of kangaroo mice adjusted their distributions in predominantly northward and southward directions in response to past climatic shifts of warming and cooling of the Pleistocene. Second, the intersection of these two orientation trends in the vicinity of southern Nevada suggests that this area may have represented a broad, refugial region for kangaroo mice at the height of pluvial periods. Unfortunately, the age of these haplotype-sharing patterns is not known at this time.

The telltale signs of historical patterns of gene flow reflected in DAPP are, of course, constrained by mountain ranges and the availability of appropriate sandy habitats. Although it is tempting to assume that one may infer orientation patterns of gene flow from simply a casual inspection of a distribution map, we urge caution in making this assumption without knowledge of actual orientation data from genetic patterns. In addition, we note that many distributions do not show an obvious orientation but, instead, exhibit an amorphous (roughly circular) pattern and, hence, do not allow speculation concerning historical patterns. As examples, the distribution of the western clade of *M. pallidus* shows an obvious north-west to south-east orientation, yet the distribution of the eastern clade is complex and largely amorphous (Fig. 3). It may be instructive to compare the angular trends derived from haplotype-sharing data with that obtained from all possible pairwise combinations of axial locality data. When this is done for the western clade, there are no significant differences between the orientation trend from the haplotype data and all (120) pairwise locality data ($P > 0.05$ for both the Mardia–Watson–Wheeler test and the Watson U^2 test). Non-significant tests here are not surprising, given the general north–south distribution, but this finding does not refute the hypothesis that the orientation patterns reflect historical routes of gene exchange. In contrast, angular distribution tests for the eastern clade show significant differences between the orientation trend from the haplotype-sharing data and data obtained for all possible (66) pairwise combinations of localities (Mardia–Watson–Wheeler $W = 9.905$, $P = 0.01$; Watson $U^2 = 0.241$, $P < 0.02$). Given its complex shape, inspection of the distribution map of the eastern clade probably would not have predicted the orientation trend from haplotype sharing (Figs 3 & 4b).

Corroboration of the principal phylogenetic units

The recognition of two basal (eastern and western) lineages within *M. pallidus* based on mtDNA sequence data is corroborated by other studies using different kinds of character set. Hafner's (1981) study, involving both genetic (isozymic and karyotypic) and phenetic (cranial and external morphometrics and pelage colorimetry) data sets, was first to recognize the eastern and western units within *M. pallidus*. Hafner's (1981) karyotypic data, although summarizing data from only 10 populations, was perhaps the most definitive of the characters he studied. Hafner (1981) recognized two principal chromosomal forms: a western form, termed the 42-α karyotype ($2n = 42$, five pairs of acrocentric autosomes) and an eastern form, the 42-β karyotype ($2n = 42$, all bi-armed autosomes). Despite the limited geographical sampling, Hafner (1981) postulated a boundary between these chromosomal forms in south-central Nevada that is near the boundary identified between the two clades of the present study. It should also be noted that Hafner (1981) recognized a third chromosomal form, a 42-γ, described as being similar to the 42-α karyotype and found at the northern edge of the western distribution (localities of Nixon and Wadsworth).

The geographical range of the western clade defined in this study also agrees remarkably well with Hall's (1941) depiction of the distribution of *M. p. pallidus* based on cranial and external morphology. Indeed, the boundary between Hall's (1941) *M. p. pallidus* and *M. p. ruficollaris* is nearly coincident with the boundary noted here between the western and eastern clades, respectively; Hall's representation of the boundary appears to be positioned only about 15–20 km east of the boundary noted here (Fig. 3). Three subspecies of *M. pallidus* from Hall (1941) comprise our eastern clade and, although this does not provide direct support for our eastern clade, Hall's (1941) recognition of three eastern subspecies is moderately concordant with the genetic subunits that we observe within the eastern clade.

Although Hafner (1981) was able to show multivariate morphological discrimination between most of the eastern and western populations of *M. pallidus* as defined in this study, the kangaroo mice belonging to these clades are nonetheless extremely similar morphologically. It should also be kept in mind that morphological differentiation is slight within the genus and, in fact, the two currently recognized species, *M. pallidus* and *M. megacephalus*, are regarded as classic sibling species (Hafner *et al.*, 1979). Despite the subtle morphological differences between the eastern and western clades of *M. pallidus*, these forms qualify as evolutionarily significant units (for discussion see Moritz, 1994; Blois &

Arbogast, 2006). In addition to showing reciprocally monophyletic patterns for mtDNA data, the eastern and western clades show significant divergence in other nuclear markers, especially the karyotypes.

Cryptic species of kangaroo mice

Average sequence–divergence values for *Cytb* between the eastern and western clades of *M. pallidus* are *c.* 8% (Table 1). As pointed out by Meyer (1994: 278), cytochrome *b* has become an 'industry standard' for phylogenetic studies. The level of sequence divergence of the phylogroups of *M. pallidus* exceeds the mean percentage sequence divergence value for sister species reported by Baker & Bradley (2006) and, thus, suggests that the two clades identified here may be genetically isolated species. It should also be noted that our estimation of sequence divergence of *Cytb* is based on only the first portion of the gene. The first section of *Cytb*, known to contain a functioning redox centre in the electron transport chain (Howell, 1989; Irwin *et al.*, 1991), evolves at a slower rate than the second portion of the gene in rodents (Lara *et al.*, 1996; Spotorno *et al.*, 2004) and other mammals (Irwin *et al.*, 1991). As noted by Spotorno *et al.* (2004), reliance on the first portion of *Cytb* leads to an underestimation of genetic divergence. Thus, the *Cytb* percentage sequence–divergence values presented here should be viewed as conservative estimates of genetic divergence between the phylogroups of *M. pallidus*.

It is most likely that the two main phylogroups within the currently recognized species *M. pallidus* represent morphologically cryptic species of kangaroo mice. However, before these clades are recognized taxonomically, research should be conducted at the region of suspected contact (in south-central Nevada; Fig. 3) to determine the nature of the genetic interactions between the forms. Data from this study have already identified a locality, San Antonio (Fig. 3), where both main haplotypic forms are found together, but nuclear markers (e.g. chromosomes and/or allozymes) must be used to determine if the two forms are isolated genetically from each other.

From a historical biogeographical perspective, it is difficult to explain what factors may have been responsible for the divergence and geographical placement of the two principal cladistic units of *M. pallidus*. However, we note that there is a chain of north–south trending mountain ranges (the southern end of the Toquima Range, San Antonio Mountains, Lone Mountain, Weepah Hills, Split Mountain, Clayton Ridge and Montezuma Range) that coincides with the boundary of the eastern and western cladistic units. Field reconnaissance and examination of topographic maps indicates that these ranges may represent a physiographic baffle between the clades, limiting dispersal (and presumably gene exchange). Two likely low-elevation routes surmount these ranges, and we have already detected both principal haplotypes near one of these areas (San Antonio locality, Fig. 3). Although we have not assessed possible ecological differences between the habitats on either side of this physiographic baffle, we do note that the mean elevations for localities associated with the eastern (1586 m) and western (1411 m) units are significantly different ($F = 10.525$, $P = 0.003$) and isophene contours of several climatic characters parallel this north–south physiographic baffle (Houghton *et al.*, 1975). These differences in elevation and climate may signal biotic differences that are important to kangaroo mice. Interestingly, when the distributions of *M. pallidus* and *M. megacephalus* are superimposed (Fig. 5), the border between the eastern and western phylogroups of *M. pallidus* coincides identically with the distributional margin of the range of *M. megacephalus* in south-central Nevada. The coincidence of these boundaries, although indirect evidence, suggests ecological differences in areas to the east and west and, in turn, may indicate differences in the niche of the eastern and western clades of *M. pallidus*.

The divergence of the two main clades of *M. pallidus* may be placed in a temporal context of cladogenic events within the family Heteromyidae (Hafner *et al.*, 2007). Based on fossil calibration of independent molecular sequence data (cytochrome *c* oxidase subunit *I* and 12S and 16S ribosomal RNA genes), Hafner *et al.* (2007) estimated that the divergence of *M. pallidus* and *M. megacephalus* occurred 8.1 Ma. Comparing this time divergence estimate with mtDNA sequence divergence estimates from our study (uncorrected *p* distance for the combined data set; Table 1) yields an estimate of 4.38 Ma as the time of divergence of the eastern and western phylogroups of *M. pallidus*. Hence, divergence between the eastern and western forms occurred at a time (early Pliocene) before the formation of the extensive sandy habitats within the Great Basin by depositional and eolian processes of the Pleistocene and Holocene (Morrison, 1964; Smith, 1982; Mehringer, 1986; Eissmann, 1990). The estimated times of divergence of kangaroo mice and the discovery of fossil kangaroo mice from the late Blancan (about 2.9–1.9 Ma) outside the Great Basin (Remeika *et al.*, 1995; Cassiliano, 1999; Jefferson & Lindsay, 2006) now paint a picture of a relatively ancient heteromyid lineage that did not evolve *in situ* (cf. Hafner, 1978).

CONCLUSIONS

Applicability of DAPP

The use of angular measurements pertaining to haplotype sharing over geography combined with circular statistical analyses appears to be a promising approach in phylogeographical studies. Orientation data derived from haplotype sharing between pairwise localities provides a means of detecting and quantifying the 'signatures' of past events pertaining to movement patterns and gene flow. Each individual distribution map of haplotype sharing between pairwise localities contributes a tiny piece of the geographical history of that matrilineage. However, when angular data are measured for haplotype sharing between all pairwise localities and summarized using the methods of circular statistics, it is

Figure 5 Superimposition of the geographical ranges of *Microdipodops pallidus* Merriam (black and white distributions) and *M. megacephalus* Merriam (grey-shaded distribution) showing the coincidence of the distributional boundary between the eastern and western phylogroups of *M. pallidus* with the distributional border of *M. megacephalus* in south-central Nevada. The inset shows a reduced distribution map of *M. megacephalus* for comparison. The mean elevation of *M. pallidus* localities in the area of overlap of the eastern clade with the distribution of *M. megacephalus* is significantly different (and higher) than the mean elevation of the localities in the western clade (see text for discussion).

possible to quantify patterns of haplotype sharing and subject those patterns to rigorous statistical analysis. As shown in this study, it is possible to test for randomness (uniformity in orientation), calculate a compass trend (a mean vector, μ) that represents a fingerprint of historical routes of gene exchange, and to test for significant differences between two trends. Future workers may want to extend this analysis of orientation data by examining not only shared unique haplotypes, but also orientation data from haplotypes one, two, or three mutational steps removed. Perhaps it is also possible to ascribe an unambiguous direction to the orientation data by including information regarding ancestral haplotypes and outgroup comparisons. The DAPP approach may also be used with other kinds of genetic marker.

A biogeographical model for sand-obligate organisms

The phylogeographical patterns described here may serve as a model for other kinds of sand-obligate organisms in the Great Basin. Sand-obligate forms, for example, *D. deserti* and the dune-obligate beetle *Eusattus muricatus* LeConte, would be expected to show patterns similar to those described here if they are responding to the same Earth-history events. Key predictions from this study suggest that other sand-obligate forms will show eastern and western phylogroups that diverged about 4 Ma, a contact zone in the south-central region of the Great Basin (vicinity of Tonopah, Nevada), a comb-like pattern of rapid range expansion through the Lahontan Trough in the western unit, and non-random historical routes of gene exchange (specifically, a north-west to south-east orientation in the western clade and a north-east to south-west directional pattern in the eastern clade). Unfortunately, studies addressing the genetic variation of *E. muricatus* (Britten & Rust, 1996; Epps *et al.*, 1998, 2000) did not include thorough sampling across the geographical range of the species and, therefore, comparisons with this study are impossible; however, divergence estimates from allozymic data by Epps *et al.* (1998) suggest divergence times much lower than those estimated here. A comparison between the patterns shown here for *M. pallidus* and *D. deserti* would be particularly interesting as both are sand-obligate heteromyid rodents, but nothing has been published on the phylogeography of *D. deserti*.

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BIOSKETCHES

John C. Hafner is the Director and Curator of Birds and Mammals in the Moore Laboratory of Zoology and Professor of Biology at Occidental College, Los Angeles. His research focuses on bird and mammal evolutionary biology, particularly the systematics and macroevolution of New World rodents of the superfamily Geomyoidea.

Nathan S. Upham is finishing his Master's degree at Occidental College, where he has been studying the moonlight response of nocturnal desert rodents in the Great Basin. His present research interests are focused on the interaction between past climate fluctuations and speciation processes in mammals.

Emily Reddington has interests in bird and mammal biology and is now completing her Master's thesis at Occidental College on the population genetics and conservation biology of kangaroo mice.

Candice W. Torres is currently a doctoral student with research interests in the behaviour, genetics and chemical ecology of ants.

Editor: John Lambshead

APPENDIX

Localities and number of specimens examined in this study. Specimens are deposited in either the Moore Laboratory of Zoology (MLZ; Occidental College) or the Museum of Southwestern Biology (MSB; University of New Mexico). Principal localities for *M. pallidus* are shown in bold and are listed alphabetically; principal localities are shown in Fig. 1.

Microdipodops pallidus (n = 98). **ALAMO**: 4.5 miles S, 32.5 miles W Alamo, 4600 feet, Lincoln County, Nevada (n = 3, MSB 35,536–35,538). **COALDALE**: 1.8 miles S, 5.3 miles E Coaldale, 4797 feet, Esmeralda County, Nevada (n = 1, MLZ 1817). **CURRANT**: 4.9 miles S, 28.2 miles W Currant, 6000 feet, Nye County, Nevada (n = 5, MLZ 2000–2004). **DEEP SPRINGS**: 7.2 miles S, 4.0 miles W Deep Springs, 4920 feet, Inyo County, California (n = 2, MLZ 1767, 1768); 4.6 miles S, 3.9 miles W Deep Springs, 5000 feet, Inyo County, California (n = 2, MLZ 1769, 1770); 2.4 miles S, 2.3 miles W Deep Springs, 5050 feet, Inyo County, California (n = 6, MLZ 1771–1776). **DYER**: 7.0 miles N, 0.5 miles W Dyer, 4900 feet, Esmeralda County, (n = 5, MLZ 1785–1789). **FALLON**: 4.3 miles N Fallon, 3900 feet, Churchill County, Nevada (n = 1, MLZ 1947). **GOLDFIELD**: 12.0 miles N, 2.5 miles W Goldfield, 4860 feet, Esmeralda County, Nevada (n = 2, MLZ 1743, 1746). **SE GOLDFIELD**: 4.6 miles S, 19.8 miles E Goldfield, 4950 feet, Nye County, Nevada (n = 2, MLZ 2051, 2052). **GOLD REED**: 3.0 miles S, 4.3 miles E Gold Reed, 5330 feet, Nye, County, Nevada (n = 2, MLZ 1958, 1959). **W HIKO**: 6 miles N, 31 miles W Hiko, 4800 feet, Lincoln County, Nevada (n = 4, MLZ 1811–1814). **LOCKES**: 9.6 miles S, 3.8 miles W Lockes, 4800 feet, Nye County, Nevada (n = 4, MLZ 2017–2020). **LOVELOCK**: 2.5 miles N, 22.5 miles W Lovelock, 3950 feet, Pershing County, Nevada (n = 1, MLZ 1967). **LUNING**: 9.8 miles N, 10.8 miles E Luning, 5350 feet, Mineral County, Nevada (n = 5, MLZ 1805–1809); 12.7 miles N, 9.2 miles E Luning, 5050 feet, Mineral County, Nevada (n = 1, MLZ 1810). **MARIETTA**: 0.4 miles S, 0.5 miles E Marietta, 4950 feet, Mineral County, Nevada (n = 3, MLZ 1777–1779). **MINA**: 8.9 miles S, 1.2 miles E Mina, 4400 feet, Mineral County, Nevada (n = 5, MLZ 1780–1784). **NEW REVEILLE**: 0.9 miles N, 10.3 miles E New Reveille, 4900 feet, Nye County, Nevada (n = 2, MLZ 1940–1941). **NIXON**: 6.4 miles N, 1.0 miles W Nixon, 4200 feet, Washoe County, Nevada (n = 1, MLZ 1794). **OASIS**: 0.2 miles S, 1.5 miles E Oasis, 5050 feet, Mono County, California (n = 2, MLZ 1790, 1791); 1.0 miles S, 4.0 miles E Oasis, 5100 feet, Mono County, California, (n = 2, MLZ 1792, 1793). **SAN ANTONIO**: 0.5 miles S San Antonio, 5400 feet, Nye County, Nevada (n = 3, MLZ 1796–1798). **SCHURZ**: 7.3 miles N, 2.6 miles W Schurz, 4287 feet, Mineral County, Nevada (n = 3, MLZ 1818–1820). **SILVER PEAK**: 5.1 S, 1.1 miles E Silver Peak, 4300 feet, Esmeralda County, Nevada (n = 2, MLZ 1945, 1946). **E TONOPAH**: 0.5 miles N, 32.0 miles E Tonopah, 5600 feet, Nye County, Nevada (n = 4, MLZ 1801–1804). **NW TONOPAH**: 9.2 miles N, 8.1 miles W Tonopah, 4850 feet, Nye County, Nevada (n = 1, MLZ 1973). **SE TONOPAH**: 11.0 miles S, 10.0 miles E Tonopah, 5200 feet, Nye County, Nevada (n = 5, MLZ 1821–1825); 10.6 miles S, 10.0 miles E Tonopah, 5200 feet, Nye, County, Nevada (n = 5, MLZ 1826–1830). **WADSWORTH**: 1.0 miles N, 1.0 miles W Wadsworth, 4200 feet, Washoe County, Nevada (n = 1, MLZ 1795). **NE WARM SPRINGS**: 19.2 miles N, 13.4 miles E Warm Springs, 6000 feet, Nye County, Nevada (n = 5, MLZ 1906, 1952–1955). **YERINGTON**: 11.7 miles S, 3.5 miles E Yerington, 4690 feet, Lyon County, Nevada (n = 3, MLZ 1832–1834); 11.1 miles S, 2.8 miles E Yerington, 4640 feet, Lyon County, Nevada (n = 5, MLZ 1835–1839).

Microdipodops megacephalus. 5.3 miles S, 1.6 miles E Geyser, 5900 feet, Lincoln County, Nevada (n = 1, MLZ 1974); 3.7 miles N, 3.2 miles E San Antonio, 5600 feet, Nye County, Nevada (n = 1, MLZ 1762); 5.5 miles S, 9.2 miles W Winnemucca, 4300 feet, Humboldt County, Nevada (n = 1, MSB 35535).

Dipodomys deserti. 10.7 miles S, 25.0 miles W Gerlach, 3950 feet, Washoe County, Nevada (n = 1, MLZ 2065).

Dipodomys microps. 6 miles N, 0.5 miles W Bishop, 4200 feet, Inyo County, California (n = 1, MLZ 1765).

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ORIGINAL ARTICLE

Phylogeography of the dark kangaroo mouse, *Microdipodops megacephalus*: cryptic lineages and dispersal routes in North America's Great Basin

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ABSTRACT

Aim The rodent genus *Microdipodops* (kangaroo mice) includes two sand-obligate endemics of the Great Basin Desert: *M. megacephalus* and *M. pallidus*. The dark kangaroo mouse, *M. megacephalus*, is distributed throughout the Great Basin and our principal aims were to formulate phylogenetic hypotheses for this taxon and make phylogeographical comparisons with its congener.

Location The Great Basin Desert of western North America.

Methods DNA sequence data from three mitochondrial genes were examined from 186 individuals of *M. megacephalus*, representing 47 general localities. Phylogenetic inference was used to analyse the sequence data. Directional analysis of phylogeographical patterns was used to examine haplotype sharing patterns and recover routes of gene exchange. Haplotype–area curves were constructed to evaluate the relationship between genetic variation and distributional island size for *M. megacephalus* and *M. pallidus*.

Results *Microdipodops megacephalus* is a rare desert rodent (trapping success was 2.67%). Temporal comparison of trapping data shows that kangaroo mice are becoming less abundant in the study area. The distribution has changed slightly since the 1930s but many northern populations now appear to be small, fragmented, or locally extinct. Four principal phylogroups (the Idaho isolate and the western, central and eastern clades) are evident; mean sequence divergence between phylogroups for cytochrome *b* is *c*. 8%. Data from haplotype sharing show two trends: a north–south trend and a web-shaped trend. Analyses of haplotype–area curves reveal significant positive relationships.

Main conclusions The four phylogroups of *M. megacephalus* appear to represent morphologically cryptic species; in comparison, a companion study revealed two cryptic lineages in *M. pallidus*. Estimated divergence times of the principal clades of *M. megacephalus* (*c*. 2–4 Ma) indicate that these kangaroo mice were Pleistocene invaders into the Great Basin coincident with the formation of sandy habitats. The north–south and web patterns from directional analyses reveal past routes of gene flow and provide evidence for source–sink population regulation. The web pattern was not seen in the companion study of *M. pallidus*. Significant haplotype–area curves indicate that the distributional islands are now in approximate genetic equilibrium. The patterns described here are potentially useful to conservation biologists and wildlife managers and may serve as a model for other sand-obligate organisms of the Great Basin.

Keywords

Conservation biogeography, cryptic species, directional analysis, Great Basin, haplotype–area curves, kangaroo mice, *Microdipodops megacephalus*, mitochondrial DNA, phylogeography, source–sink dynamics.

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INTRODUCTION

A principal goal in conservation biology is the conservation of genetic diversity in natural populations (Frankham, 1996; Jones *et al.*, 1996; Van Dyke, 2008). Over the past two decades, the basic methods of phylogeography have proven invaluable in providing a framework for surveying genetic variation in natural populations (Avise, 2000) and phylogeographical studies have yielded much useful data for conservation biologists, evolutionary biologists, and wildlife managers. In addition to identifying patterns of genetic variation, one of the most exciting aspects of phylogeographical studies is the production of biogeographical models and the discovery of morphologically cryptic species.

With the ever-increasing loss of natural habitat in the Great Basin of western North America (Mack, 1981; Whisenant, 1990; Knapp, 1996; Pellant *et al.*, 2004; Mensing *et al.*, 2006), recent attention has focused on the conservation biology of organisms in the Great Basin, including the endemic kangaroo mice of the heteromyid rodent genus *Microdipodops* Merriam (e.g. Hafner *et al.*, 2008). Although there is a dearth of detailed information on the ecology and general natural history of these rodents, available data indicate that kangaroo mice are ecological specialists that are restricted to open, sandy habitats (Hall, 1941; Hafner *et al.*, 1996). Not surprisingly, kangaroo mice are found in some of the most arid regions of the Great Basin Desert, exhibit a patchy distribution, and are generally considered by desert naturalists to be rare (Hall, 1941; Hafner, 1981; Hafner *et al.*, 1996, 2008). It follows that a comprehensive understanding of the phylogeographical patterns for *Microdipodops* will provide the necessary footing for informed conservation management decisions and, simultaneously, provide a model for future studies of other sand-dwelling and sand-obligate organisms in the Great Basin.

Two species of kangaroo mice are currently recognized: the dark kangaroo mouse, *Microdipodops megacephalus* Merriam, and the pallid kangaroo mouse, *M. pallidus* Merriam (Patton, 2005). As indicated by their vernacular names, the present species-level taxonomy of the genus reflects a philosophy that emphasizes morphological differentiation and dates to the middle of the last century (Hall, 1941, 1946). It is now known that pelage colour varies greatly over geography in both taxa and, as such, simple darkness or paleness of the pelage is now considered an unreliable means of identifying kangaroo mice (Hafner, 1981). Indeed, discrimination of the two forms using only morphological characters is difficult and the forms are considered 'classic sibling species' (Hafner *et al.*, 1979, p. 8).

The remarkable phenotypic similarity of the two forms of kangaroo mice belies their evolutionary past. Although once thought to be young 'species in the making' (Hall, 1941; p. 237), *M. megacephalus* and *M. pallidus* are now known to be genetically isolated from each other (Hafner *et al.*, 1979) and, indeed, represent rather ancient lineages that diverged about 8 Ma (Hafner *et al.*, 2007). The recent phylogeographical study of *M. pallidus* (Hafner *et al.*, 2008) showed that this taxon was a sister clade to *M. megacephalus* and that *M. pallidus* represented two trenchant evolutionary lineages. Hence, the taxon *M. pallidus* is likely to be a complex of two morphologically cryptic species awaiting formal systematic treatment and taxonomic revision (Hafner *et al.*, 2008).

The present study treats the molecular phylogenetics and historical biogeography of *M. megacephalus*. This research is designed as a companion study to Hafner *et al.*'s (2008) analysis of *M. pallidus* and, as such, completes a phylogeographical survey of the genus. Relative to *M. pallidus*, *M. megacephalus* seems to be morphologically and ecologically less specialized (Hall, 1941; Hafner, 1981; Hafner *et al.*, 2008) and its geographical range (*c.* 180,000 km^2) is about 4.5 times larger than that of *M. pallidus*. To facilitate comparisons with the phylogeographic patterns shown for *M. pallidus* (Hafner *et al.*, 2008), we sequenced the same three mitochondrial gene fragments used in that study to infer phylogenetic relationships in this study. Additionally, we incorporated the methodology of directional analyses introduced in Hafner *et al.* (2008) to trace historical patterns of gene exchange.

MATERIALS AND METHODS

Fieldwork and specimens examined

Specimens of the dark kangaroo mouse were sampled throughout its distribution in the Great Basin Desert. Of 63 specific localities sampled, localities less than *c.* 5 km apart were pooled yielding 47 localities that are hereafter referred to as general localities (Fig. 1 & Appendix S1 in Supporting Information). Specimens from a general locality were treated as a population for purposes of this study. The molecular study relied on sequence data from three mitochondrial gene fragments, 16S ribosomal RNA (16S), cytochrome *b* (cyt *b*) and transfer RNA for glutamic acid ($tRNA^{Glu}$), and involved 186 specimens of *M. megacephalus* (Appendix S1): 172 specimens were collected between 1999 and 2007 specifically for this study, 11 specimens were collected in 1975 and 1976 in the course of a related project, and toe-clip samples were obtained from three museum specimens for analyses of ancient DNA. Mitochondrial DNA (mtDNA) sequence data from 21 specimens were taken from Hafner *et al.* (2006): GenBank accession numbers for 16S and cyt *b* are DQ422889–DQ422909 and DQ422916–DQ422936, respectively. All sequences of cyt *b* (either from GenBank or newly generated) include a small, 5′ adjoining section of $tRNA^{Glu}$.

Outgroup taxa selected for analysis included the pallid kangaroo mouse (*M. pallidus*), the chisel-toothed kangaroo rat (*Dipodomys microps* Merriam) and the desert kangaroo rat (*D. deserti* Stephens) (Appendix S1). Outgroup samples for *M. pallidus* represented the two (eastern and western) lineages identified in Hafner *et al.* (2008). Selection of outgroup taxa was supported by previous studies (Hafner, 1982, 1993; Hafner & Hafner, 1983; Rogers, 1990; Mantooth *et al.*, 2000; Alexander & Riddle, 2005; Hafner *et al.*, 2006, 2007, 2008). Sequence data for *D. microps* were taken from Hafner *et al.* (2006): GenBank accession numbers for 16S and cyt *b* are DQ422887

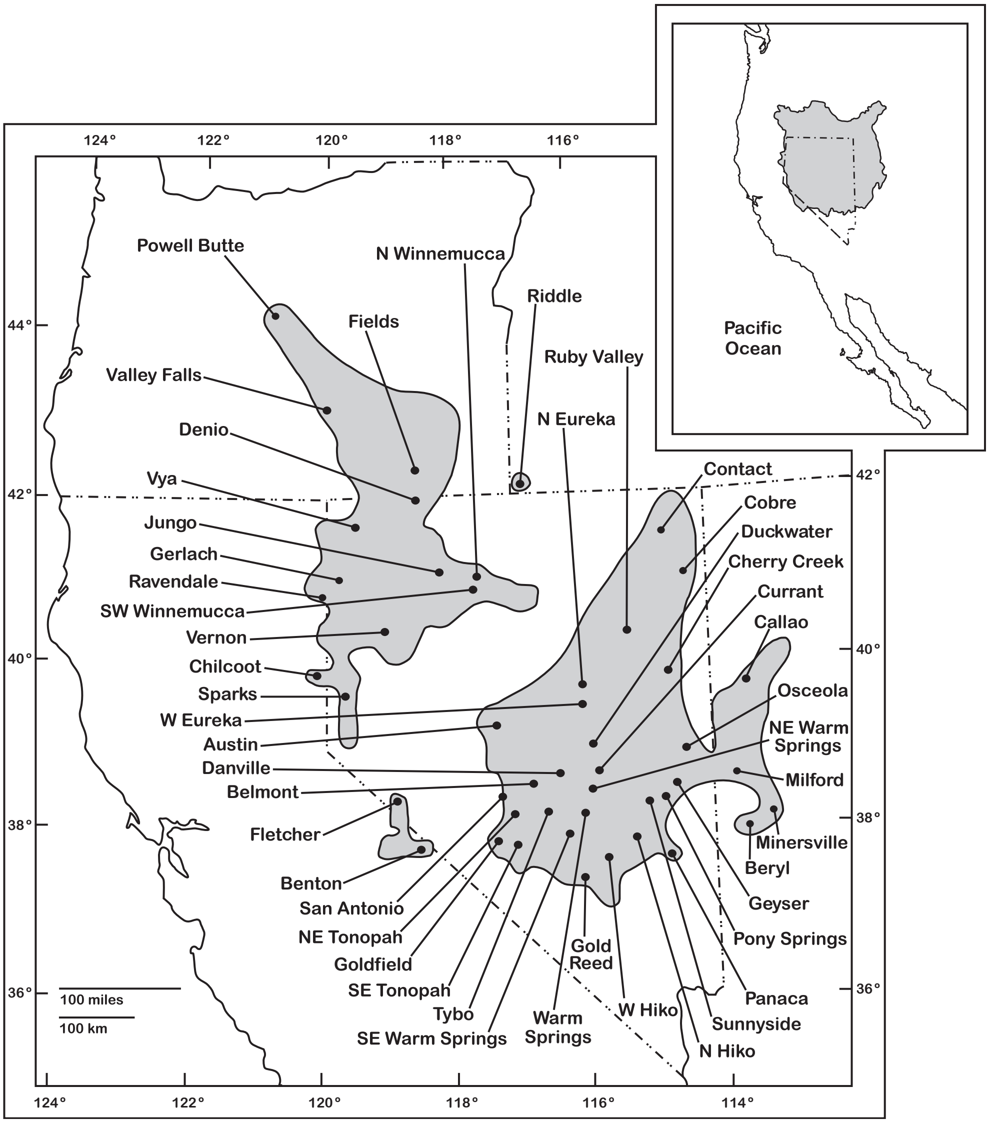

Figure 1 Map showing the distribution of the dark kangaroo mouse, *Microdipodops megacephalus*, and the 47 general localities sampled in this study. The inset map of western North America depicts the Great Basin Desert (shaded area) as defined on floristic data from Cronquist *et al.* (1972). In both maps, the outline of the state of Nevada is shown for orientation.

and DQ422914, respectively. Sequence data for the other three outgroup specimens were taken from Hafner *et al.* (2008): GenBank accession numbers for 16S and cyt *b* for *D. deserti* are DQ870428 and DQ870429, respectively; GenBank numbers for the two individuals of *M. pallidus* are DQ534261 and DQ534357 for 16S, and DQ534255 and DQ534351 for cyt *b*, respectively. Animals collected in this study were treated in a humane manner following guidelines of the American Society of Mammalogists (Gannon *et al.*, 2007) and Occidental College's Institutional Animal Care and Use Committee.

Analyses of mtDNA

All laboratory procedures related to DNA extraction from freshly frozen tissues, including mtDNA amplification using polymerase chain reaction (PCR), purification and sequencing, were conducted as described in Hafner *et al.* (2008). Following Hafner *et al.* (2008), two principal mitochondrial genes, 16S and cyt *b*, were analysed because they have contrasting nucleotide substitution rates (16S evolves more slowly than cyt *b*; Ferris *et al.*, 1983; Springer *et al.*, 2001; Hafner *et al.*, 2006, 2007). It should be noted that sequencing of the cyt *b* gene yielded a continuous section of a small (40 base pairs, bp) portion of $tRNA^{Glu}$, five non-coding bases, and 403 bp of the protein-coding cyt *b* gene (Hafner *et al.*, 2008). As in Hafner *et al.* (2008), the continuous section of $tRNA^{Glu}$ and cyt *b* was not involved in separate cyt *b* analyses but used only in the phylogenetic analysis of the combined data set (16S + cyt *b* + $tRNA^{Glu}$).

Ancient mtDNA analyses were used to obtain genomic DNA from three museum specimens: SDNHM 16431, IMNH 259 and IMNH 693 (collected in 1920, 1968 and 1977, respectively). The lateral digit of the right manus was removed from each specimen and cut into small pieces so that a combination of dried tissue, bone, hair and nail (*c.* 2 mm^2) was the starting material for DNA extraction. DNA was extracted using the DNeasy Blood & Tissue Kit (QIAGEN Inc., Valencia, CA, USA) following the modifications of Iudica *et al.* (2001) to the manufacturer's protocol. Several steps were altered to improve DNA yield: tissue samples were soaked in phosphate-buffered saline for 24 h prior to digestion (with three to five solution changes), digested for 48–72 h at 55 °C until fully homogenized, and carrier nucleotides were added prior to the final elution to facilitate DNA precipitation (3 μg of yeast tRNA; Hafner *et al.*, 2005; J.W. Demastes, University of Northern Iowa, Cedar Falls, IA, USA, pers. comm.). The fragmented nature of the extracted DNA necessitated the use of internal primers to obtain the full length of the targeted 16S and cyt *b* gene fragments (542 bp and 448 bp, respectively). Internal primers were designed specifically for *M. megacephalus* to amplify short (300 bp or less), overlapping segments of each gene that could then be assembled to reach the desired total length. Primers designed for this study are listed in Appendix S2, along with the primer pair combinations used for PCR amplification and sequencing. PCR amplifications were performed in 25 μL reaction volumes using 12.5 μL (0.75 U) of JumpStart REDTaq Ready Mix (Sigma, St. Louis, MO, USA), 10.5 μL of sterile water, 0.5 μL of each primer (10 μm), and 1.0 μL of template DNA. The thermal profile for amplifications of ancient mtDNA included one initial cycle at 95 °C (2 min), followed by 35 cycles of denaturation at 95 °C (30 s), annealing at 55 °C (30 s), extension at 72 °C (30 s), and a final extension at 72 °C (10 min). Purification of PCR products and direct sequencing were performed as described by Hafner *et al.* (2006).

Precautions were taken to address contamination concerns associated with analyses of ancient DNA. Prior to laboratory work, bench surfaces and equipment were washed with a DNase solution (DNA Away, Molecular Bio-Products, San Diego, CA, USA) to remove DNA. Procedures pertaining to DNA extraction and amplification were performed in a separate area of the laboratory using dedicated pipettors with Aerosol Resistant Tips (ART; Molecular Bio-Products). All PCRs were run with two negative controls to detect contamination. Since many of the primers were designed in *Microdipodops*-specific or *M. megacephalus*-specific regions, the chance of amplifying an incorrect gene target was reduced. Nonetheless, the identity of all mtDNA gene sequences was verified using BLAST (Basic Local Alignment Search Tool, National Center for Biotechnology Information, Bethesda, MD, USA). All ancient mtDNA sequences were compared to sequences from unrelated laboratory activity to ensure that each sequence was the product of amplification from the target template. Following Pääbo *et al.* (2004), results were verified by obtaining multiple DNA extractions from each specimen and performing multiple independent amplifications on each DNA extract.

Phylogenetic analyses

Sequences pertaining to the light and heavy strands for each individual were edited and assembled following the methods of Hafner *et al.* (2008). New sequences pertaining to individuals of *M. megacephalus* (n = 163) were submitted to GenBank (GenBank accession numbers DQ870226–DQ870280, DQ870282–DQ870312, DQ870314–DQ870326, and EU861064–EU861127 for 16S; DQ870327–DQ870361, DQ870363–DQ870404, DQ870406–DQ870427, and EU861128–EU861191 for cyt *b*). Alignment of multiple sequences and examination and editing of alignments to verify gap placement were performed as described in Hafner *et al.* (2008). Although the alignment of 16S sequences was unambiguous between *M. megacephalus* individuals and the *M. pallidus* outgroup taxa, secondary structural models were consulted to resolve ambiguous gap regions in the 16S alignment of *M. megacephalus* with the two *Dipodomys* outgroups. Note that the 16S and combined data sets in this study are 1 bp shorter than in Hafner *et al.* (2008) due to the correction in the 16S alignment pertaining to a false gap (correction of a false autapomorphy in the *D. deserti* outgroup sequence). Unresolved ambiguous sites in the complete 16S alignment were treated independently in the subsequent phylogenetic analyses; their inclusion or exclusion caused only minor changes in the extreme terminal tree branches, so ambiguous sites were retained to improve the phylogenetic resolution in the analyses of the 16S and combined data sets. Unique haplotypes were identified using MacClade 4.0 (Maddison & Maddison, 2000) and all phylogenetic analyses were based on unique haplotypes. Methods for determining transition/transversion ratios, estimating base composition, and testing for saturation followed Hafner *et al.* (2008).

Sequence variation in the protein-coding cyt *b* gene was tested for the influence of natural selection and possible deviations from selective neutrality using the McDonald–Kreitman test (McDonald & Kreitman, 1991) performed in DnaSP 5.00.07 (Librado & Rozas, 2009). For this test, unique haplotypes of *M. megacephalus* were identified as the focal group and all unique haplotypes of *M. pallidus* (Hafner *et al.*, 2008) as the outgroup. Data from the non-coding 16S gene were presumed to meet the assumption of selective neutrality.

To investigate possible incongruence between the gene fragments (Wiens, 1998; Leaché & Reeder, 2002), phylogenetic analyses were first performed separately on the 16S (542 bp) and cyt *b* (403 bp) data sets, then on the combined (16S + cyt *b* + $tRNA^{Glu}$) alignment of 990 bp. The partition homogeneity test (PHT; Farris *et al.*, 1994) was conducted as in Hafner *et al.* (2008) using paup* 4.0b10 (Swofford, 2003) to further evaluate phylogenetic congruence. A non-significant PHT result (P = 0.98) permitted combination of the three mtDNA gene fragments. Phylogenetic analyses of the three mtDNA data sets (16S, cyt *b* and combined) using maximum-parsimony and neighbour-joining methods (paup* 4.0b10) determined that all trees were virtually identical topologically except for minor changes within the terminal branches. The combined data set was also analysed using Bayesian (MrBayes

2.01; Huelsenbeck & Ronquist, 2001) and maximum-likelihood (RAxML 7.0.4; Stamatakis, 2006) methods.

Maximum-parsimony analyses followed the methods of Hafner *et al.* (2008). Nodal support for the consensus tree was evaluated using 1000 bootstrap pseudoreplicates (Felsenstein, 1985) and Bremer support values (Bremer, 1994) were obtained by using PAUP* 4.0b10 and TreeRot 2 (Sorenson, 1999). Tests for presence of phylogenetic signal (Hillis & Huelsenbeck, 1992) and calculations of the consistency index (CI) and retention index (RI) were conducted using PAUP* 4.0b10.

Measures of genetic distances were calculated to facilitate direct comparison with results from Hafner *et al.* (2008). MEGA 3.1 (Kumar *et al.*, 2004) was used to estimate percentage nucleotide sequence divergence using both uncorrected pairwise (p) distance and Kimura's two-parameter model (Kimura, 1980). Following the methods of Hafner *et al.* (2008), neighbour-joining distance trees (Nei & Kumar, 2000) were constructed using uncorrected p distance.

Determination of the most suitable model of nucleotide evolution for the combined data set was made using Modeltest 3.7 (Posada & Crandall, 1998) under the Akaike information criterion (AIC) (Posada & Buckley, 2004). The transversional model with invariant sites and among-site rate variation (TVM + I + Γ) was identified as the most appropriate model. Bayesian phylogenetic analyses were performed as in Hafner *et al.* (2008) with MrBayes 2.01 but with two modifications. First, the program was executed using the GTR + I + Γ model (TVM not available) with parameters estimated under uniform priors by each Bayesian analysis (Leaché & Reeder, 2002). Second, incrementally heated chains (Metropolis-coupled Markov chain Monte Carlo; Huelsenbeck & Ronquist, 2001) were run and sampled following Hafner *et al.* (2008) but the first 2000 trees prior to stationarity were conservatively eliminated for each of two runs as burn-in values. The remaining 16,000 equilibrium trees combined from both analyses were used to calculate nodal posterior probabilities and to create a 50% majority-rule consensus tree.

Maximum-likelihood analyses were conducted using RAxML due to the large number of taxa in the combined data set and extended computational times. The rapid algorithms of RAxML are optimized using the general time-reversible (GTR+ Γ) model of rate heterogeneity (Stamatakis, 2006). Thus maximum-likelihood and bootstrap searches were performed under this model, partitioning by gene fragment (the GTR model differs from the TVM model by estimating six rate parameters rather than five). The run was repeated several times with random starting trees to verify topology, and clade support was assessed using 1000 bootstrap replicates. Due to difficulties resolving outgroup placement, and the presumed reciprocal monophyly of the ingroup and outgroups, subsequent runs used the −g option in RAxML to constrain the monophyly of *M. pallidus* relative to *M. megacephalus*. The resulting best-scoring maximum-likelihood tree was annotated with support values from bootstrap replicate trees.

Divergence-time analyses

Adherence to a global molecular clock model was evaluated using a log-likelihood ratio test between clock-constrained and non-constrained trees, as implemented in PAUP* 4.0b10 under the TVM + I + Γ model with fixed parameters. Clock-like rates of evolution were not rejected across the combined data set ($P > 0.05$ for *Dipodomys* outgroups + *Microdipodops* taxa, *Microdipodops* taxa only, and *M. megacephalus* only); thus, the use of strict clock and relaxed clock models was compared in the subsequent analyses. Rates either conformed to a strict molecular clock (CLOC) or were set to uncorrelated lognormal (UCLN), where rates for each branch are independently drawn from a lognormal distribution (Drummond *et al.*, 2006).

Divergence times of major clades were estimated using BEAST 1.5.4 (Drummond & Rambaut, 2007). Calibration priors used two independent strategies. First, the root divergence between *Dipodomys* and *Microdipodops* was calibrated to correspond with the minimum age of the oldest fossil *Dipodomys* (Reeder, 1956) that dates from the Barstovian North American Land Mammal 'Age' (15.9–12.5 Ma; Prothero, 1998); the root height was set to a lognormal prior distribution with an offset of 12.5 Ma, mean of 0, and standard deviation of 1. Second, two dates (and credibility intervals) were used from the Hafner *et al.* (2007) parametric Bayesian analysis of the Heteromyidae: 15.35 Ma (14.10, 15.88) for the root divergence, and 8.06 Ma (6.34, 10.01) for the divergence between *M. pallidus* and the *M. megacephalus* ingroups. These calibrations were set using normal prior distributions with mean of 15.35 Ma (standard deviation of 0.75) and mean of 8.06 (standard deviation of 1.2), respectively. The two calibration strategies using CLOC and UCLN yielded four sets of divergence-time estimates.

BEAST analyses were run under the TVM + I + Γ model by initially selecting GTR and altering the xml file to include equal transition rates. Yule priors were selected due to the species-level scale of analysis, and reciprocal monophyly of the ingroup and outgroup was assumed a priori in accord with results from the MrBayes and PAUP* 4.0b10 analyses. Chain lengths were set to 10,000,000 generations with parameters sampled every 1000 generations. Two independent runs of the UCLN analyses were combined in order to converge upon stable posterior parameter distributions, as determined by Tracer 1.5 (Rambaut & Drummond, 2007); otherwise, single runs were sufficient for the CLOC analyses. Trees were summarized as maximum clade credibility trees after discarding the first 20% of each run as burn-in using the TreeAnnotator program in BEAST. The resulting trees contained mean divergence times and error bars for each node reporting 95% highest posterior density (HPD) intervals.

Orientation analyses of haplotype sharing patterns

Historical trends in gene exchange of kangaroo mice were assessed using directional analyses of phylogeographical patterns, DAPP (Hafner *et al.*, 2008). DAPP relies on compass orientations between pairs of localities whose individuals share haplotypes. Axial data (angular measurements of undirected lines) were measured between all combinations of pairwise localities involved in haplotype sharing and a mean vector (μ) was calculated for each major geographical unit of *M. megacephalus*. Rayleigh's uniformity test, Rao's spacing test and Kuiper's test (Batschelet, 1981; Fisher, 1993; Kovach, 2006) were used to determine if each sample of orientations between pairwise localities was distributed isotropically. The Mardia–Watson–Wheeler test and the Watson U^2 test were used to test the equality of two angular distributions. Circular statistics involved in DAPP used Oriana 2 software (Kovach, 2006).

Haplotype sampling, diversity and distributional islands

The genetically defined, geographical units of *Microdipodops* identified in this study and in Hafner *et al.* (2008) represent mainland islands and were examined biogeographically in the context of haplotypic diversity and island size. This novel approach was inspired by empirical observations regarding population size and genetic variation (Soulé, 1976; Frankham, 1996) and the theory of island biogeography (MacArthur & Wilson, 1967; MacArthur, 1972). Areas (km^2) of distributional islands of kangaroo mice were obtained using VistaMetrix 1.35 software (SkillCrest, LLC, Tucson, AZ, USA) that provided a transparent overlay for recording areas from underlying distribution maps; following convention (e.g. MacArthur, 1972; Frankham, 1996), distributional island areas were converted to log values before analysis. Correlation and regression analyses were used to evaluate hypothesized relationships between the number of unique composite haplotypes, *h*, and the log of the distributional island area. Haplotype–area curves were evaluated separately for the species of kangaroo mice and across all distributional islands for the genus. Estimation of the completeness of haplotype sampling was made following Dixon (2006); for each distributional island, the probability of completeness, *P* (the probability that all haplotypes were sampled), and the predicted number of haplotypes, $\hat{h}$, were calculated. Statistical routines were performed using systat 11 (SYSTAT Software, Inc., 2004).

RESULTS

Fieldwork and geographical distribution

Fieldwork, involving the capture of 199 individuals of *M. megacephalus* from 27,014 trapnights, yielded an overall trapping success of 0.74% for *M. megacephalus*. Although traps were set at known localities (Hall, 1941; Hafner, 1981) or at new sites in habitats judged (by J.C.H.) to be appropriate for this species, trapping success was only 2.67% when considering only those localities where individuals of *M. megacephalus* were captured. The range in trapping success was 0.25% (one capture from 400 trapnights) to 18.0% (9 captures from 50 trapnights) at localities that yielded *M. megacephalus*.

Our understanding of the present geographical distribution of *M. megacephalus* (Fig. 1) is similar to Hall's (1941) description but with several notable differences. Field collection since Hall's (1941) study has yielded two main distributional adjustments: (1) the presence of a distributional isolate in Idaho (Hafner, 1985); and (2) a range extension into the Escalante Desert of south-western Utah (i.e. the localities of Minersville and Beryl reported in this paper). Each of these distributional adjustments extends the known range of *M. megacephalus* more than 100 km from other known populations of the species. In addition, fieldwork and examination of museum specimens revealed that the kangaroo mice around the southern end of Pyramid Lake (western Nevada) are not *M. megacephalus* (cf. Hall, 1941, 1946; Mantooth *et al.*, 2000) but are *M. pallidus* (see Hafner *et al.*, 2008). The distribution of *M. megacephalus* in this region is therefore restricted (generally to the north and to the west of Pyramid Lake) relative to that described in Hall (1941).

Sequence characteristics

Analysis of the combined (16S + cyt *b* + $tRNA^{Glu}$) sequence shows 242 variable characters (99, 136 and 7 variable characters, respectively) across all unique haplotypes of *M. megacephalus* and outgroup taxa. Mean base frequencies for A, C, G and T across all samples are 0.313, 0.245, 0.166 and 0.277, respectively (0.330, 0.209, 0.193 and 0.268, respectively, for 16S; and 0.279, 0.294, 0.138 and 0.288, respectively, for cyt *b*; data for $tRNA^{Glu}$ available on request from J.C.H.). Chi-square tests for possible heterogeneity of base frequencies across all samples are not significant for the combined data set ($\chi^2 = 11.602$, $P = 1.000$) or for each gene ($\chi^2 = 8.272$, $P = 1.000$ for 16S; $\chi^2 = 14.940$, $P = 1.000$ for cyt *b*); hence, it is unlikely that base compositional heterogeneity causes phylogenetic bias. Mean base frequencies for A, C, G and T for unique *M. megacephalus* haplotypes only are 0.330, 0.209, 0.192 and 0.269, respectively, for 16S and 0.279, 0.294, 0.138 and 0.289, respectively, for cyt *b*.

Investigation of the possible role of natural selection in sculpting sequence variation in protein-coding cyt *b* reveals selective neutrality. All fixed substitutions between *M. megacephalus* and *M. pallidus* are due to synonymous substitutions (the analysis includes 64 unique haplotypes for *M. megacephalus* from this study and 26 unique haplotypes for *M. pallidus* from Hafner *et al.*, 2008). The results of the McDonald–Kreitman test (McDonald & Kreitman, 1991) for selective neutrality of sequence variation in cyt *b* show that the ratio of the number of non-synonymous (0) to synonymous (9) fixed substitutions between *M. megacephalus* and *M. pallidus* is not significantly different from the ratio of non-synonymous (11) to synonymous (110) polymorphisms within the species (Fisher's exact test, $P = 0.608$).

Plots of the number of transitions versus uncorrected *p* distance (following the methods of Barker & Lanyon, 2000), show no evidence for saturation for 16S or for cyt *b* for the unique haplotypes of *Microdipodops* studied. Saturation is seen in third-position transitions for cyt *b* when *D. deserti* and *D. microps* are included in the analyses. Transition/transversion ratios for 16S, cyt *b* and the combined data set are 1.865, 8.447 and 4.256, respectively, for samples of *M. megacephalus* only (over all positions and using uncorrected *p*). Tests for phylogenetic signal in our data (involving all unique haplotypes and species of *Dipodomys* designated as outgroups) show significance for 16S (99 variable characters, 50 haplotypes, skewness, g_1, = −0.478, $P < 0.01$) and for cyt *b* (136 variable characters, 68 haplotypes, $g_1 = -0.370$, $P < 0.01$).

Mitochondrial DNA variation in *Microdipodops megacephalus*

Analysis of the combined mtDNA data set for *M. megacephalus* (including 186 individuals from 47 general localities) reveals 88 unique composite haplotypes and 141 polymorphic sites. Examining 16S and cyt *b* separately, there are 46 and 64 unique haplotypes and 50 and 91 polymorphic sites for these genes, respectively.

An assessment of intrapopulational mitochondrial sequence variation may be made by examining the 38 general localities represented by multiple individuals. There is a mean of 4.66 (range 2–21) individuals sampled per locality for these 38 localities. There are significant functional relationships between the number of haplotypes and sample size seen at a locality for 16S ($b = 0.085$, $P = 0.034$), cyt *b* ($b = 0.230$, $P = 0.000$), and for composite haplotypes ($b = 0.257$, $P < 0.001$). In all comparisons, measures of within-population variation are lower for 16S than for cyt *b*. For example, the mean number of haplotypes per locality is 2.05 and 2.50 for 16S and cyt *b*, respectively. Additionally, the mean number of polymorphic sites per population is 2.05 and 3.89 for 16S and cyt *b*, respectively.

Phylogenetic patterns

Phylogenetic analysis of the combined (990 bp) mtDNA data for the 88 ingroup haplotypes of *M. megacephalus* and the four outgroup species yields 174 characters that are potentially parsimony informative (70, 98 and three parsimony-informative characters for the separate 16S, cyt *b* and $tRNA^{Glu}$, respectively). Maximum-parsimony analysis of the data set shows over 10,000 most-parsimonious trees (topologies are the same for 500 of 10,000 trees; CI = 0.732; RI = 0.910). Analyses using maximum-parsimony, neighbour-joining, maximum-likelihood and Bayesian approaches yield trees having virtually identical topology and differing only in the placement of *M. megacephalus* haplotypes at extreme terminal branches. As was seen in Hafner *et al.* (2008), monophyly of the genus *Microdipodops* is strongly supported in all analyses. All analyses except the unconstrained maximum-likelihood approach show that the 88 unique haplotypes of *M. megacephalus* form a highly resolved sister clade relative to the samples of *M. pallidus* (Fig. 2). It appears that without the ingroup monophyly constraint, the maximum-likelihood method suffers from the taxon-number imbalance between ingroup and outgroup, and becomes trapped too early in a local optimum.

Four major phylogroups are recognized with high resolution within *M. megacephalus* (Fig. 2): central clade, eastern clade, western clade and the peripheral isolate from Idaho (the Riddle locality). These four clades comprise two sister lineages that assort into a basal south-eastern unit (including the central and the eastern clades) and a basal north-western unit (including the western clade and the Idaho isolate that is known from only one general locality). The four phylogroups appear to be distributed entirely in an allopatric fashion.

The central clade (Fig. 2) consists of one well-resolved subclade and a poorly resolved assemblage of unique haplotypes. The subclade consists of 20 unique haplotypes and represents 21 of the 25 localities of the central clade (excluding the localities of W Eureka, San Antonio, Fletcher and Benton; Figs 1 & 2). The remaining assemblage of 19 unique haplotypes shows little structure in the parsimony, maximum-likelihood and Bayesian analyses but is recognized as a sister subclade in the neighbour-joining analysis (bootstrap support of 83). Unlike the well-resolved subclade, this assemblage is distributed narrowly (includes only Fletcher, Benton, San Antonio, NE Tonopah, Belmont, W Eureka and N Eureka) in the western portion of the geographic range of the central clade (Figs 1 & 2). Nearly half (eight of 19) of the unique haplotypes in this assemblage are contributed by kangaroo mice inhabiting the Mono Basin region of California and Nevada (localities of Fletcher and Benton; Figs 1 & 2). Haplotypes belonging to the well-resolved subclade and the assemblage co-occur at three western localities: NE Tonopah, Belmont, and N Eureka.

Haplotypes of the eastern clade assort into two well-resolved phylogeographical subunits: a western subunit (distributed mainly to the west of the Nevada State boundary) and an eastern subunit (distributed primarily east of the Nevada boundary in the State of Utah; Figs 1 & 2). The western subunit consists of 14 unique haplotypes and its distribution includes the localities of Panaca, Pony Springs, Geyser, Osceola, Milford and Minersville. The eastern subunit consists of 11 unique haplotypes and includes the localities of Beryl, Minersville, Milford, Callao and Geyser. Admixing of subunit haplotypes is seen at the central localities of Geyser (eight of 10 individuals have the western haplotype), Milford (six of 10 individuals show the western haplotype), and Minersville (one of 10 individuals shows the western haplotype; Figs 1 & 2).

The western clade includes a rather heterogeneous collection of 23 unique composite haplotypes from 13 localities. Relationships among the haplotypes within the western clade are resolved poorly (Fig. 2). The western clade is best viewed as a complex polytomy and, as such, lacks the structure seen in the central and eastern clades. Lastly, the Idaho isolate (the Riddle locality) is represented by one haplotype and is aligned in a sister-group fashion with the western clade.

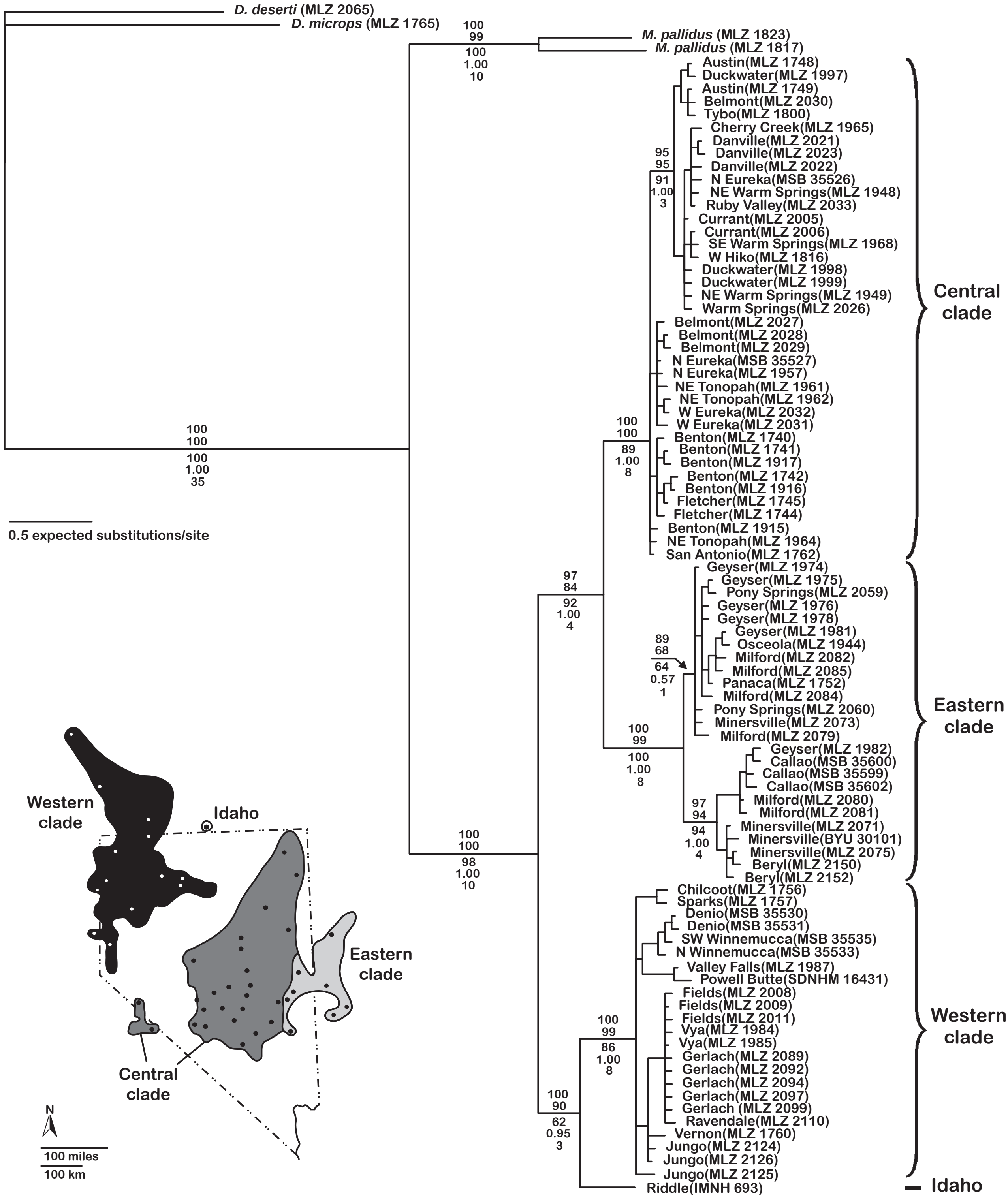

Figure 2 Bayesian phylogenetic tree based on the composite mtDNA sequence data and showing the relationships among the 88 unique haplotypes of *Microdipodops megacephalus* from the Great Basin Desert region of western North America. Distance and parsimony bootstrap support values are indicated above the nodes, with maximum-likelihood support values, Bayesian posterior probabilities and Bremer decay indices below the nodes. The inset map at the lower left shows the geographic range of the four principal clades.

Although levels of sequence divergence within the major clades of *M. megacephalus* are moderate (*c.* 1.5–2.1% for cyt *b*; Table 1), the principal clades are recognized by high levels of sequence divergence (*c.* 5.5–10.2% for cyt *b*; Table 1). Among the inter-clade comparisons, the smallest divergence values are seen in the contrast between the western clade and the Idaho isolate. The largest divergence values are recorded between the western and the eastern clades (Table 1). Due to the known higher rate of nucleotide substitution of cyt *b*, sequence divergence values both within and between *Microdipodops* clades are consistently greater for cyt *b* than corresponding values for 16S (Table 1).

Estimates of divergence dates

Results of the BEAST analyses conforming to the molecular clock and using a relaxed clock are similar but with the latter estimates being generally older (Table 2). Of the two calibration strategies employed (i.e. the use of the single fossil date or the two dates from Hafner *et al.*, 2007), the use of the single fossil calibration yields nodal dates that are younger for the strict clock analyses but sometimes older for the relaxed clock analyses (Table 2). Across all BEAST analyses, estimated dates of basal divergence within *M. megacephalus* vary from *c.* 4 to 9 Ma and divergence-time estimates for the principal clades range from *c.* 2 to 7 Ma (Table 2).

Private haplotypes, haplotype sharing and directional analyses

Private haplotypes (restricted to only one locality) commonly occur in *M. megacephalus*. Of the 88 unique composite haplotypes identified in Fig. 2, 76 (86.4%) are private haplotypes and the remaining 12 (13.6%) are shared between and among two or more localities (Fig. 3; Table 3). The number of private haplotypes per locality varies greatly over geography (range is 0–6; Fig. 3a). In general, it appears that higher numbers of private haplotypes are recorded in the middle latitudes of the distributional ranges of the major clades and this pattern is independent of sample size. Considering those general localities with multiple individuals, there is no functional relationship between the number of private haplotypes and sample size in the central clade ($b = 0.431$, $P = 0.088$) and in the eastern clade ($b = 0.318$, $P = 0.062$). There is, however, a significant functional trend between number of private haplotypes and sample size in the western clade ($b = 0.204$, $P = 0.005$) but this significance is due to a single locality with

Table 1 Mean pairwise sequence-divergence values within and among selected clades of *Microdipodops* from the Great Basin Desert region of western North America examined in this study. Mean percentage divergence estimates for both uncorrected pairwise (*p*) distance and Kimura's two-parameter model (in parentheses) are given for individual genes and the combined data set (All).

	% divergence		
Comparison	16S	cyt *b*	All
Microdipodops megacephalus contrasts			
Within western clade	0.59 (0.59)	2.08 (2.12)	1.00 (1.01)
Within central clade	0.60 (0.60)	1.49 (1.51)	0.78 (0.78)
Within eastern clade	1.00 (1.01)	1.56 (1.59)	1.09 (1.10)
Western clade versus central clade	3.61 (3.71)	8.45 (9.15)	5.33 (5.57)
Western clade versus eastern clade	4.34 (4.49)	9.32 (10.23)	6.10 (6.43)
Western clade versus Idaho isolate	1.98 (2.02)	5.28 (5.52)	3.28 (3.37)
Idaho isolate versus central clade	3.02 (3.09)	8.72 (9.47)	5.15 (5.37)
Idaho isolate versus eastern clade	3.52 (3.61)	8.75 (9.55)	5.54 (5.81)
Central clade versus eastern clade	2.68 (2.73)	6.84 (7.31)	4.16 (4.31)
M. megacephalus versus *M. pallidus*	6.21 (6.50)	13.39 (15.08)	9.03 (9.69)

Table 2 Estimates of divergence time for major nodes of the *Microdipodops megacephalus* phylogeny obtained from BEAST analyses using rates of evolution that either conformed to a strict molecular clock, CLOC, or a relaxed clock with uncorrelated lognormal rates, UCLN. Calibration priors relied on two strategies (see text): Fossil (a single fossil date at the root) and two dates estimated by Hafner *et al.* (2007). Values shown are the mean and 95% highest posterior density (HPD) interval from the maximum clade credibility tree in millions of years ago (Ma). Specimens are from the Great Basin Desert region of western North America.

	Divergence time (Ma)			
	CLOC		UCLN	
Node	Fossil	Hafner *et al.* (2007)	Fossil	Hafner *et al.* (2007)
Dipodomys/*Microdipodops*	13.69 (12.52, 16.00)	15.26 (13.81, 16.65)	13.68 (12.53, 15.93)	14.95 (13.50, 16.44)
M. pallidus/*M. megacephalus*	7.05 (5.23, 8.89)	7.85 (6.50, 9.34)	11.38 (6.97, 14.71)	9.12 (7.16, 11.10)
Within *M. megacephalus*				
Central + Eastern/Western + Idaho	3.88 (2.79, 5.08)	4.31 (3.27, 5.39)	9.20 (5.64, 12.86)	7.78 (5.54, 10.10)
Central/Eastern	2.54 (1.74, 3.39)	2.83 (2.01, 3.64)	6.85 (3.91, 9.88)	5.99 (3.89, 8.15)
Western/Idaho	2.18 (1.42, 2.98)	2.41 (1.68, 3.24)	6.51 (3.26, 9.82)	5.64 (3.37, 8.06)

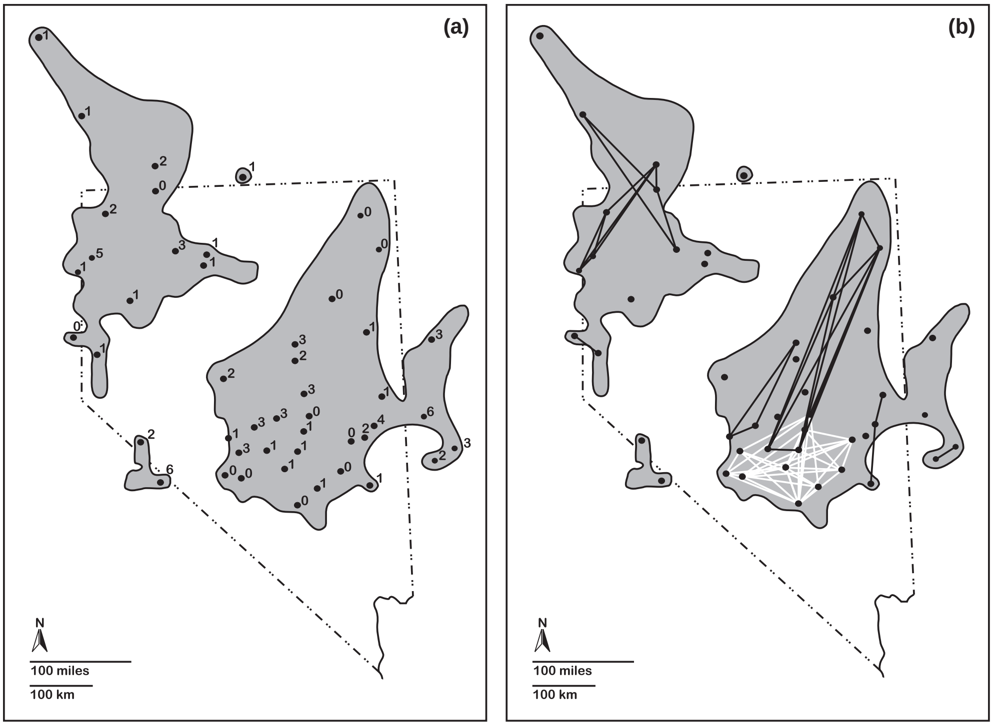

Figure 3 Distribution and abundance of private haplotypes (a) and pairwise haplotype sharing patterns (b) for localities of *Microdipodops megacephalus* from the Great Basin Desert region of western North America. Seventy-six of 88 unique composite haplotypes identified in this study are private haplotypes with 0–6 private haplotypes per locality (a). The remaining 12 unique composite haplotypes are present at two or more localities and yield 66 pairwise combinations of axial data of haplotype sharing (b). Two significantly different angular patterns, a north–south bi-directional trend (black lines) and a complex web pattern (white lines), are evident (b). Note that lower numbers (i.e. 0 or 1) of private haplotypes are found generally in the northern and southern portions of the distribution (a). Data pertaining to private haplotypes and haplotype sharing suggest evidence of source–sink metapopulation dynamics (see text).

large leverage, Gerlach (5 private haplotypes recorded from 21 individuals); the functional trend disappears entirely ($b = 0.120$, $P = 0.320$) with the removal of this one locality.

The 12 composite haplotypes shared between and among localities yield a total of 66 pairwise combinations of axial data that are available for DAPP analysis (Table 3; Fig. 3b). Most of the haplotype sharing occurs in the central clade (52 pairwise combinations), with fewer instances of sharing in the other major clades (11 and 3 pairwise combinations in the western and eastern clades, respectively). There is no sharing of haplotypes among the major clades of *M. megacephalus* and there is no sharing of haplotypes between the Mono peripheral isolate and the main body of the central phylogroup. Visual representation of the orientation data from the DAPP (Fig. 3b) shows two distinct patterns among the *M. megacephalus* distributional bodies. One orientation pattern, involving 10 haplotypes (individual haplotype sharing from two to five localities each and a total of 30 pairwise combinations of axial data; Table 3), shows a distinct north–south directional pattern (black lines in Fig. 3b). The mean vector of the north–south pattern is $\mu = 23.077°$ [and also 203.077° because of the bi-directional (axial) nature of the data] and this pattern is found to be significantly different from a uniform distribution (Rayleigh's $Z = 10.538$, $P < 0.001$; Rao's $U = 160$, $P < 0.05$; Kuiper's $V = 2.712$, $P < 0.01$). The other orientation pattern is derived from the remaining two haplotypes (involving sharing among six and seven localities each and includes 36 pairwise combinations of orientation data; Table 3) and appears like a giant web in the southern portion of the distribution (white lines in Fig. 3b). These data show no departure from a uniform distribution (Rayleigh's $Z = 1.366$, $P = 0.257$; Rao's $U = 112$, $P > 0.90$; Kuiper's $V = 1.239$, $P > 0.15$). Moreover, the north–south orientation trend and the web pattern (Fig. 3b) have significantly different angular distributions (Mardia–Watson–Wheeler $W = 14.72$, $P < 0.001$, Watson $U^2 = 0.402$, $P < 0.001$).

Genetic variation and distributional island size: haplotype–area curves

Five distributional islands are evident in *M. megacephalus*: western clade, Idaho isolate, main central unit, Mono isolate, and eastern clade (Table 4; Fig. 2). In addition to being geographically distinct from one another, these five distributional islands are genetically distinct (no haplotype sharing). Distributional islands vary in size from the tiny Idaho isolate (2.585 $\log_{10}$ km^2) to the main central unit (4.937 $\log_{10}$ km^2; Table 4). Comparing the number of unique composite

Table 3 Sharing of unique composite haplotypes of *Microdipodops megacephalus* from the Great Basin Desert region of western North America over geography. Twelve unique haplotypes, identified in Fig. 2, are present at two or more general localities and are available for directional analyses of phylogeographical patterns (see text). In total, there are 66 pairwise combinations of shared haplotypes (11 in the western clade, 52 in the central clade, and three in the eastern clade) that provide the basis for directional data.

Unique haplotype	Number of localities	Distribution
NE Warm Springs MLZ 1949	7	Central clade: NE Warm Springs (MLZ 1949), Sunnyside (MLZ 1966), Warm Springs (MLZ 2024), SE Warm Springs (MLZ 1972), N Hiko (MLZ 1960), SE Tonopah (MLZ 1831) and Gold Reed (MLZ 2055-2058)
Currant MLZ 2006	6	Central clade: Currant (MLZ 2006), NE Tonopah MLZ (1963), SE Warm Springs (MLZ 1969-1971), Goldfield (MLZ 1747), W Hiko (MLZ 1815) and Gold Reed (MLZ 2053 and MLZ 2054)
Ruby Valley MLZ 2033	5	Central clade: Ruby Valley (MLZ 2033), Contact (MLZ 2069 and MLZ 2070), Cobre (MLZ 2067), Tybo (MLZ 1799) and Warm Springs (MLZ 2025)
Fields MLZ 2009	4	Western clade: Fields (MLZ 2009), Vya (MLZ 1986), Gerlach (MLZ 2091, MLZ 2093, MLZ 2096, MLZ 2098, MLZ 2101, MLZ 2105, MLZ 2108, and MLZ 2109) and Ravendale (MLZ 2111, MLZ 2113 and MLZ 2114)
Belmont MLZ 2028	3	Central clade: Belmont (MLZ 2028), N Eureka (MLZ 1956) and San Antonio (MLZ 1761)
Currant MLZ 2005	3	Central clade: Currant (MLZ 2005), Cobre (MLZ 2068) and NE Warm Springs (MLZ 1905 and MLZ 1950)
Denio MSB 35530	3	Western clade: Denio (MSB 35530), Valley Falls (MLZ 1993) and Jungo (MLZ 2128)
Geyser MLZ 1974	2	Eastern clade: Geyser (MLZ 1974) and Osceola (MLZ 1942 and MLZ 1943)
Geyser MLZ 1976	2	Eastern clade: Geyser (MLZ 1976 and MLZ 1979) and Panaca (MLZ 1755)
Chilcoot MLZ 1756	2	Western clade: Chilcoot (MLZ 1756 and MVZ 158930) and Sparks (MLZ 1759)
Denio MSB 35531	2	Western clade: Denio (MSB 35531) and Fields (MLZ 2007, MLZ 2010 and MLZ 2015)
Minersville MLZ 2075	2	Eastern clade: Minersville (MLZ 2075, MLZ 2077 and MLZ 2078) and Beryl (MLZ 2145-2149 and MLZ 2151)

Table 4 Distributional island area (Area in $\log_{10}$ km^2), sample size (n), observed number of unique composite haplotypes (h), predicted number of haplotypes ($\hat{h}$), and probability of completeness (P) for the distributional islands of *Microdipodops* in the Great Basin Desert region of western North America. Names of distributional islands, n, and h for *M. pallidus* are taken from Hafner *et al.* (2008).

Distributional island	Area	n	h	$\hat{h}$	P
Microdipodops megacephalus					
Western clade	4.846	65	23	24	0.173
Idaho isolate	2.585	2	1	1	0.134
Central clade					
Main central unit	4.937	61	31	38	0.002
Mono isolate	3.449	8	8	Na*	Na*
Eastern clade	4.300	50	25	31	0.007
Microdipodops pallidus					
Western clade					
Main western unit	4.397	44	19	21	0.070
Deep Springs isolate	2.837	10	1	1	0.998
Eastern clade					
Main Eastern unit	4.125	41	21	26	0.011
Alamo isolate	3.090	3	1	1	0.609

*Analysis of completeness of haplotype sampling requires that n must be greater than h.

haplotypes, h, with distributional island size for *M. megacephalus* (Table 4) yields a significant functional relationship ($b = 12.071$, $P = 0.010$; $r^2 = 0.920$); genetic variation, as measured by the number of distinct haplotypes and area are directly related. When the analysis is expanded to include the four distributional islands of *M. pallidus* identified previously (see Hafner *et al.*, 2008; Table 4), we find a highly significant haplotype–area curve for *Microdipodops* ($b = 12.918$, $P < 0.001$; $r^2 = 0.922$; Fig. 4).

Comparison between the actual number of haplotypes recorded on a distributional island, h, and the predicted number, $\hat{h}$, reveals that sampling was generally thorough and sufficient to produce reliable assessments of genetic variation (Table 4). For most distributional islands there is remarkable agreement between observed and predicted number of haplotypes (Table 4). The three instances where the probability of completeness is significant (the main central unit and the eastern clade of *M. megacephalus* and the main eastern unit of *M. pallidus*) pertain to large distributional islands having the three highest numbers of predicted haplotypes (i.e. 38, 31 and 26, respectively; Table 4).

DISCUSSION

Phylogenetic patterns and historical biogeography

The four principal clades identified in this study are distributed in an allopatric fashion with no known areas of sympatry (Fig. 2). Whereas most of the phylogroups are separated from one another by more than 100 km of unsuitable habitat, the central and eastern clades approach each other in a

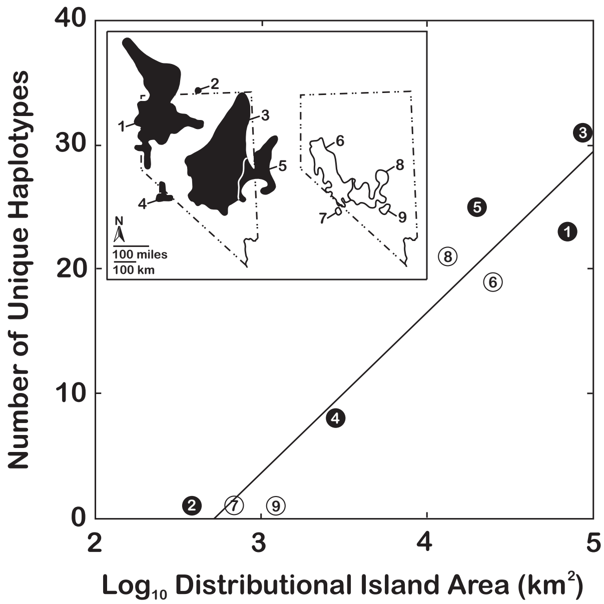

Figure 4 Haplotype–area curve for the distributional islands of *Microdipodops* from the Great Basin Desert region of western North America. Distributional islands for *M. megacephalus* (closed circles; shaded inset map on left): (1) western clade; (2) Idaho isolate; (3) main central unit; (4) Mono isolate; and, (5) eastern clade. Distributional islands for *M. pallidus* (open circles; unshaded inset map on right): (6) main western unit; (7) Deep Springs isolate; (8) main eastern unit; and, (9) Alamo isolate. Highly significant functional relationships exist between the number of observed unique composite haplotypes and area for the distributional islands of kangaroo mice, regardless of whether the curves are evaluated separately for the taxa or combined for the nine distributional islands (as shown, $b = 12.918$, $P < 0.001$; $r^2 = 0.922$). The significant haplotype–area curves suggest that the populations of kangaroo mice represented by the distributional islands are now in approximate genetic equilibrium (see text and Table 4).

near-parapatric (contiguously allopatric) manner. Kangaroo mice belonging to the central and eastern clades are found nearest (*c.* 25 km) each other in White River Valley and Cave Valley (localities Sunnyside and Pony Springs, respectively; Figs 1 & 2). Preliminary fieldwork in this region shows that the intervening habitat is inappropriate for kangaroo mice. The only known area of sympatry involving *M. megacephalus* and other clades of kangaroo mice observed in this study occurs in the southern portion of the distribution of the central clade. Here, *M. megacephalus* is found sympatric with the eastern clade of *M. pallidus* (Hafner *et al.*, 2008).

Cladogenesis within *M. megacephalus* may be placed in a temporal framework of evolutionary divergence within the family Heteromyidae (Hafner *et al.*, 2007) and compared with diversification in *M. pallidus* (Hafner *et al.*, 2008). In general, the estimated divergence times from the BEAST analyses using the relaxed clock (UCLN) model appear older and have larger error intervals than do dates estimated using a strict clock (CLOC; Table 2). Since the UCLN model does not require molecular evolutionary rates to be inherited from node to node throughout the phylogeny, lineage-specific rate heterogeneity is allowed. It appears that decoupling rates among lineages in the UCLN model allows fast-evolving lineages to be older but with less certainty in their temporal placement. However, we interpret the CLOC model divergence-time estimates with higher confidence for several reasons, including the initial failure of the log-likelihood ratio test to reject the molecular clock, the greater specificity of CLOC error estimates, and the greater congruence between CLOC age estimates and Hafner *et al.*'s (2007) independent assessment of divergence times. Accordingly, our results suggest a middle Miocene (*c.* 14–15 Ma) split between *Dipodomys* and *Microdipodops*, a late Miocene (*c.* 7–8 Ma) divergence of the *M. pallidus* and *M. megacephalus* lineages, and a middle Pliocene divergence (*c.* 2–4 Ma) of the principal clades within *M. megacephalus*. The timing of major branching events within *M. megacephalus* is generally synchronous with the divergence (4.38 Ma) of the eastern and western phylogroups of *M. pallidus* reported by Hafner *et al.* (2008).

Accumulating evidence from both molecular (Hafner *et al.*, 2006, 2007, 2008; this paper) and palaeontological (Remeika *et al.*, 1995; Cassiliano, 1999; Jefferson & Lindsay, 2006) studies suggest that kangaroo mice are a relatively old group that diverged during the Miocene and Pliocene and south of the Great Basin. Being sand-obligate mammals, kangaroo mice probably invaded the Great Basin following the formation of extensive sandy habitats during the Pleistocene pluvial–interpluvial cycles (Morrison, 1964; Smith, 1982; Mehringer, 1986; Eissmann, 1990). At this time, however, we cannot rule out the existence of sandy habitats suitable for kangaroo mice in the Great Basin during the Pliocene, owing to an ongoing dispute over the age of the Sierra Nevada uplift and the formation of the eastern rain shadow (dates range from Eocene to late Miocene or early Pliocene; for a review see Molnar, 2010). Although it appears likely that kangaroo mice are relatively recent invaders of the Great Basin (i.e. allochthonous endemics), this designation ultimately awaits more conclusive evidence of regional climatic and tectonic history. These inferences are in sharp contrast to previous interpretations of a relatively young genus that diverged recently and *in situ* in the Great Basin (Hall, 1941; Hafner, 1978).

Comparisons with previous assessments

With a much smaller data set relative to this study, Hafner's (1981) isozymic data recognized three assemblages (the Idaho isolate, and main western and eastern units) that are generally consistent with the present findings based on mtDNA data. Specifically, Hafner's (1981) western and eastern units are consistent with the western and the central plus eastern clades, respectively, that are identified in this study. As in this study, Hafner (1981) and Hafner *et al.* (2006) showed that the kangaroo mice from the Mono peripheral isolate share ancestry with kangaroo mice from central Nevada.

Chromosomal data from Hafner (1981) provide additional nuclear corroboration of the general mtDNA patterns described here. Two karyotypes occur in *M. megacephalus* (Hafner, 1981): the 40-α karyotype ($2n = 40$, one pair of tiny acrocentric autosomes) and the 40-β karyotype ($2n = 40$, all bi-armed autosomes). The distributions of the 40-α and 40-β karyotypes from Hafner's (1981) eastern unit agree with the distributions of the central and the eastern clades, respectively. The Idaho isolate is characterised by the 40-β karyotype (Hafner, 1981, 1985) and, although this is not a unique karyotype, the distributional pattern of this karyotype is distinctive in that the nearest surrounding populations of kangaroo mice show the 40-α karyotype (Hafner, 1981). Hafner's (1981) western unit (=western clade from this study) shows both karyotypes; unfortunately, lack of phylogenetic resolution within the western clade prevents a comparison with the distribution of the karyotypes reported by Hafner (1981).

Hall (1941) recognized 12 subspecies of *M. megacephalus* based on his examination of cranial and external morphological characters. There appears to be no correspondence between the phylogenetic patterns outlined here and the patterns of phenetic variation summarized for *M. megacephalus* by Hall (1941). This discordance is somewhat surprising when compared with the general agreement found between phylogeographical patterns (Hafner *et al.*, 2008) and subspecies distributions (Hall, 1941) in *M. pallidus*. Given that the distribution of *M. megacephalus* is *c.* 4.5 times larger and encounters a wider range of environmental conditions than that of *M. pallidus*, the phenetic patterns identified by Hall (1941) for *M. megacephalus* most likely reflect mainly adaptive modifications rather than components of shared ancestry.

Cryptic speciation

Sequence divergence in cytochrome *b* is now recognized as the 'industry standard' for assessing molecular divergence in phylogenetic studies (Meyer, 1994, p. 278). Mean pairwise sequence-divergence values for cyt *b* between the four principal phylogroups of *M. megacephalus* are 7.89% and 8.54% for uncorrected *p* and Kimura's two-parameter model, respectively (Table 1). As mentioned by Hafner *et al.* (2008), these values of cyt *b* sequence-divergence should be regarded as conservative estimates because they are based on examination of the first portion of the gene, which is known to contain a functioning redox centre in the electron transport chain (Howell, 1989; Irwin *et al.*, 1991) and evolves at a slower rate than the second portion of the gene in rodents and other mammals (Irwin *et al.*, 1991; Lara *et al.*, 1996; Spotorno *et al.*, 2004). Despite the conservative nature of these sequence-divergence values, the level of differentiation of the phylogroups of *M. megacephalus* is consistent with mean percentage sequence-divergence values (> 5%) often reported for sister species of mammals (Baker & Bradley, 2006). Hence, the four major phylogroups identified here are likely to be genetically isolated species.

The four main phylogroups appear to represent morphologically cryptic species embedded within the taxon, *M. megacephalus*. Given that the two basal clades of kangaroo mice, *M. megacephalus* and *M. pallidus*, are regarded morphologically as sibling species (e.g. Hafner *et al.*, 1979), it is not surprising that we know of no morphological characters at this time that will permit discrimination among the major clades of *M. megacephalus*. Before these four major phylogroups are recognized taxonomically, additional research is warranted. Specifically, it would be useful to incorporate additional nuclear markers (e.g. further karyological analyses and especially the use of nuclear sequence data) to evaluate our phylogenetic patterns based on mtDNA data. Although the four clades appear to be distributed strictly in an allopatric fashion, additional reconnaissance in central Nevada (the area where the distributions of the central and eastern clades approach one another) would be valuable in determining whether the forms come into contact and, if so, the nature of the genetic interactions between them.

Many authors have noted that the dramatic climatic events of the Pleistocene were critical to the formation of the Great Basin's flora and fauna (e.g. Grayson, 1993). When considering the evolution and historical biogeography of a sand-obligate endemic such as kangaroo mice, it is especially attractive to focus on the Pleistocene's pluvial history and the formation of sandy habitats as key elements facilitating adaptive divergence. However, evidence from this study and Hafner *et al.* (2008) indicates that major lineage divergence within *Microdipodops* pre-dated the tumultuous climatic events of the Pleistocene. It is unknown exactly how the pluvial events affected the distribution, abundance and divergence of kangaroo mice. We do note, however, that two of the four lineages in *M. megacephalus*, the western clade and the eastern clade, are distributed in the general vicinity of the two largest pluvial lakes of the Pleistocene (Lahontan and Bonneville, respectively) and seem to occur primarily in fine sands in lower elevational habitats. The other two clades of *M. megacephalus*, the central clade and the Idaho isolate, occur in the central and northern Great Basin and are typically found on sandy soils with a gravel overlay, in middle-to-upper elevational habitats. From a historical–biogeographical perspective, it appears that multiple lineages of kangaroo mice invaded the Great Basin perhaps in the early Pleistocene; two major lineages of *M. pallidus* (Hafner *et al.*, 2008) and four major lineages of *M. megacephalus* survive today as products of cryptic speciation.

Intrapopulational haplotypic variation in kangaroo mice

Direct comparisons of sequence data for *M. megacephalus* (this study) and *M. pallidus* (Hafner *et al.*, 2008) are possible because both studies relied on the same gene fragments. Inferences concerning intrapopulational haplotypic variation may be made by examining those general localities where multiple individuals were examined (38 and 20 localities for *M. megacephalus* and *M. pallidus*, respectively); there is no significant difference between the mean number of individuals sampled per locality for the taxa (means are 4.66 and 4.45 for *M. megacephalus* and *M. pallidus*, respectively; $U = 348.500$, $P = 0.598$). Comparisons between *M. megacephalus* and *M. pallidus* regarding 16S show no significant difference for mean number of haplotypes (2.05 and 1.95, respectively; $U = 416.5$, $P = 0.523$) nor for mean number of polymorphic sites per locality (2.05 and 1.40, respectively; $U = 432.0$, $P = 0.380$). However, comparisons between *M. megacephalus* and *M. pallidus* for cyt *b* show a marginally significant difference between the mean number of haplotypes (2.50 and 1.90, respectively; $U = 490.5$, $P = 0.054$) and a strongly significant difference between mean number of polymorphic sites per locality (3.89 and 1.20, respectively; $U = 543.0$, $P = 0.007$).

Intrapopulational genetic differences between *M. megacephalus* and *M. pallidus* should be more pronounced and more easily detected statistically in cyt *b* than in 16S owing to the higher rate of substitution in cyt *b*. Higher levels of population genetic variability in *M. megacephalus* relative to *M. pallidus* may relate to the fact that this species has a larger distribution, a morphology that appears to be more generalized and variable, and inhabits a wider variety of edaphic and floral conditions than *M. pallidus* (Hall, 1941; Hafner, 1981; Hafner *et al.*, 2008). Although it may be tempting to invoke natural selection and Van Valen's (1965) niche-variation hypothesis to explain the observed higher levels of within-populational haplotypic variability in cyt *b* for *M. megacephalus*, it is more parsimonious to conclude that the mechanisms responsible for the observed differences are mainly mutation and genetic drift (and not selection). As noted earlier, cyt *b* for kangaroo mice evolves largely in a neutral fashion (the McDonald–Kreitman test for selective neutrality was not significant).

Given their differences in geographical distributions and habitat preferences, it is likely that *M. megacephalus* and *M. pallidus* experienced dissimilar histories of genetic bottlenecks. Without doubt, the sizes and numbers of populations of kangaroo mice have fluctuated through time in response to environmental changes and populations have lost haplotypic variation due to genetic drift. Greater mean haplotypic variation in cyt *b* for populations of *M. megacephalus* suggests that *M. megacephalus* may have realized larger average population sizes over time than *M. pallidus* (although we found no significant difference between the mean number of individuals sampled per locality between the taxa) and/or *M. megacephalus* may have endured less recent and less severe bottlenecks than *M. pallidus*. Hopefully, future work on the population genetics of kangaroo mice and more detailed information regarding past climatic changes in the Great Basin will enable an evaluation of the demographical histories of these forms.

Directional analyses and source–sink dynamics

Analyses of axial data pertaining to haplotype sharing patterns over geography reveal signatures of historical routes of gene exchange when evaluated by DAPP (Hafner *et al.*, 2008). The two statistically significant orientation patterns uncovered in this study (a north–south directional trend and the web pattern; Fig. 3b) suggest that populations of kangaroo mice adjusted their distributions in response to past climatic changes such as those during the Pleistocene. Specifically, the north–south angular trends are indicative of climate-induced northward and southward distributional adjustments and the web pattern suggests that there was a refugium in the southern Great Basin during cooler climatic periods. Additionally, these angular trends may provide evidence for source–sink population structure (e.g. Pulliam, 1988; Dias, 1996) in kangaroo mice. Hence, there are two explanations for the angular trends that are not mutually exclusive. The age of these haplotype-sharing patterns is not known at this time but would be useful in evaluating these explanations. The web pattern shown here for *M. megacephalus* was not observed in the companion study of *M. pallidus* (Hafner *et al.*, 2008).

The majority (52 of 66 total pairwise combinations) of the axial data available for DAPP pertain to haplotype sharing in the central clade. The co-occurrence of the north–south and web angular trends in the central clade (Figs 2 & 3b) provides telltale signs of source–sink population dynamics. The central clade may be envisioned as a source–sink metapopulation composed of subpopulations of kangaroo mice inhabiting patches of suitable habitat. The northern-most subpopulations here (i.e. Contact, Cobre, Ruby Valley; Figs 1 & 3) contain kangaroo mice in low densities (mean number of animals collected per locality = 1.67) and exist in tiny, isolated patches; these may be regarded as sink subpopulations. Although systematic assessment of habitat quality was not made, these northern patches were judged by us to be low-quality habitats relative to more southern sites (Contact and Cobre had much gravel overlay and Ruby Valley had unusually tall vegetation). In contrast, the 11 southern subpopulations involved in the web pattern (formed by sharing of two haplotypes among six and seven localities each; Table 3) may be viewed as source subpopulations; kangaroo mice occur at slightly higher densities in these subpopulations (mean number of animals collected = 2.82) and in larger patches than the extreme northern subpopulations. In addition, these southern subpopulations are genetically more variable than the northern subpopulations (mean number of haplotypes is 2.09 and 1.33 in the southern and northern subpopulations, respectively), suggesting more long-term stability in the southern, source region. Given these characteristics, it is likely that these northern subpopulations are more prone to extinction and may be maintained by immigration from kangaroo mice in the southern source patches. It is noteworthy that the numbers of private haplotypes in the northern (sink) and southern (source) subpopulations are similarly low (zero or one private haplotype per locality; Fig. 3a) but this is likely to be for different reasons. The dearth of private haplotypes in the northern subpopulations is probably due to local extinction followed by recent colonization from the southern subpopulations, whereas the low number of private haplotypes in the southern subpopulations suggests high levels of gene exchange and a relatively stable demography over long periods of time.

Source–sink dynamics and metapopulation theory may provide a useful framework for future studies examining population regulation, demography, and conservation biology of kangaroo mice. We encourage future workers to incorporate source–sink theory and to gather data regarding the size and quality of a habitat patches. As Figueira & Crowder (2006) noted, source–sink theory has provided much assistance to conservation biologists and wildlife managers in identifying source and sink patches, population size, patch contribution, dispersal corridors, and metapopulation persistence.

Distributional islands of kangaroo mice

As pointed out by MacArthur (1972, p. 105), 'Some mainland habitats are obviously islands'. This perspective is especially relevant when considering the distribution of a stenotopic, mainland taxon such as *Microdipodops*. Given their sand-obligate ecology, local populations of kangaroo mice are distributed in a patchy manner across the Great Basin and are aggregated into distinct island populations that are defined genetically and geographically (Fig. 2; Hafner *et al.*, 2008).

Kangaroo mice inhabiting a distributional island may be viewed as an isolated population surrounded by an ecological vacuum or 'sea'. Although the larger distributional islands are likely to represent metapopulations, the size of a distributional island serves as a correlate of overall population size (see also Frankham, 1996). As predicted by population genetics theory, there is a high positive correlation between genetic diversity and the size of distributional islands in kangaroo mice (Fig. 4). Population genetics theory predicts that genetic variation is a balance between mutation, drift, and natural selection in a population of finite size. There is now a growing body of empirical evidence that demonstrates the positive correlation between genetic variation and population size (and island size) both across populations of a species and across species of plants and animals (for review see, Soulé, 1976; Frankham, 1996).

The haplotype–area curve (Fig. 4) for the distributional islands of *Microdipodops* is analogous to the familiar species–area curves from the theory of island biogeography (MacArthur & Wilson, 1967; MacArthur, 1972), and it may be tempting to apply this theory to our data. However, here we are examining genetic diversity (number of unique haplotypes) at the populational level rather than species diversity (i.e. species richness) at the community level. Given that there is no sharing of composite haplotypes among any of the nine distributional islands, it is unnecessary to invoke a possible balance between immigration and extinction from island equilibrium theory. Instead, population genetics theory alone is sufficient to explain the haplotype–area curve (Fig. 4) for the distributional islands of *Microdipodops*.

Iguchi & Nishida (2000) performed a similar analysis of haplotypic diversity and island size in their study of an osmeroid fish in the Japanese Archipelago, yet we believe that application of this approach to a mainland taxon is both novel and useful in phylogeographical studies and we encourage its application in future studies. Understanding haplotypic variation in space and time is important in the context of conservation biology of kangaroo mice. The high correlation of the haplotype–area curve (Fig. 4) suggests that the populations of kangaroo mice represented by the distributional islands are now in approximate genetic equilibrium. As such, it appears that there have not been recent genetic bottlenecks for any of the larger distributional islands (i.e. for distributional islands equal to or larger than the Mono isolate; Table 4) that were sufficiently egregious to disrupt the formation of a functional trend. Given the great climatic fluctuations during the Pleistocene and the patchy distribution of the subpopulations, this finding was rather surprising to us. The highly significant trend implies that either population sizes for the larger distributional islands did not fluctuate wildly during the pluvial history of the Pleistocene or that genetic equilibrium formed since the end of the Pleistocene. It is noted, however, that these results from maternally inherited mtDNA are most accurately interpreted as dynamics of effective female population size through time. Nonetheless, the high number of unique composite haplotypes from the larger distributional islands indicates that source subpopulations probably persisted throughout the turbulent history of the Pleistocene and were sufficiently large to preserve and accumulate nucleotide substitutions over time; it is not known how long it took for equilibrium to be achieved. The high diversity of haplotypes recorded from the larger distributional islands appears promising for future conservation efforts but the lack of mtDNA variation on the three smallest distributional islets (Idaho, Deep Springs, and Alamo isolates; Fig. 4 & Table 4) is discouraging, albeit entirely predictable from traditional population genetics theory (e.g. Wright, 1931). All distributional islands of kangaroo mice show unique mtDNA properties, so the loss of any distributional island (small or large) would affect adversely overall kangaroo mouse genetic diversity. Future conservation efforts for *Microdipodops* should focus on ensuring the welfare of the smaller and more vulnerable distributional islets while simultaneously working to maintain the genetic diversity represented in the metapopulations inhabiting the larger distributional islands.

Kangaroo mouse abundance and changing abundance

As noted by Hafner *et al.* (2008), the routine reporting of measures of relative abundance (e.g. percentage trap success or capture rate) in phylogeographical studies is useful to field biologists, conservationists and wildlife managers. Such data are invaluable in monitoring the viabilities of populations, especially for organisms such as kangaroo mice, which are considered rare in nature (Hall, 1941, 1946; Hafner *et al.*, 2008). *M. megacephalus* is legally protected in California and Nevada but not in Idaho, Oregon, and Utah. Based on fieldwork from the 1970s, Hafner & Hafner (1998, p. 79) reported that the conservation status (IUCN Red List Category) of *M. megacephalus* was 'Lower Risk, least concern' (updated category is now ‘Least Concern’; Linzey & Hammerson, 2008).

Assessing the conservation status of kangaroo mice using the criteria of Mace & Lande (1991) requires information pertaining to abundance and changing abundance over time. Our trapping results show that *M. megacephalus*, like *M. pallidus* (Hafner *et al.*, 2008), is among the least abundant of the nocturnal desert rodents in sandy habitats of the Great Basin. Considering only those localities where kangaroo mice were captured, the overall trapping success reported here for *M. megacephalus* (2.67%) is similar to the trapping success reported for *M. pallidus* (2.88%; Hafner *et al.*, 2008). When these trapping data for fieldwork conducted during 1999–2007 are combined, the overall *Microdipodops* trapping success is 3.03% (327 kangaroo mice captured/10,808 trapnights), mean percentage trap success is 3.43%, and mean number of kangaroo mice per site is 3.85 for 85 sites that yielded *Microdipodops*. These data may be compared directly with kangaroo mouse trapping data and fieldwork performed three decades ago (Hafner, 1981). Hafner’s fieldwork during 1972–1979 showed overall *Microdipodops* trapping success was 4.32% (442 kangaroo mice captured/10,233 trapnights), mean percentage trap success was 5.24%, and mean number of kangaroo mice per site was 6.70 for 66 sites that yielded *Microdipodops* (Hafner, 1981; data available on request). Comparison of trapping data between the time periods shows statistical significance for both mean percentage trap success ($U = 3377.5$, $P = 0.031$) and for mean number of kangaroo mice per site ($U = 3355.5$, $P = 0.037$). Kangaroo mice, long considered as rare by naturalists, now appear to be even less abundant.

Habitat affinity

Fieldwork shows that *M. megacephalus* occurs in the upper portion of the Upper Sonoran Life-Zone and is found in habitats that are characterized by sandy soils (with or without a gravel overlay) and dominated by sagebrush, *Artemisia* Linnaeus and/or rabbit brush, *Chrysothamnus* Nuttall. Aside from an anomalous high-elevational record of 2455 m (8050 ft; Egoscue, 1981; see below), all capture records of *M. megacephalus* occur from 1189 m (3900 ft; Smoke Creek, Nevada; Hall, 1941) to 2164 m (7100 ft; 2.5 miles NW Powell Mountain, Nevada; Hafner *et al.*, 2006). Hall’s (1941) report of two specimens taken at 2316 m (7600 ft) in Monitor Valley near our Belmont locality is erroneous; Monitor Valley does not exceed 2134 m (7000 ft) in this region. Elevationally, *M. megacephalus* occurs typically in sandy habitats below the singleleaf pinyon, *Pinus monophylla* Torrey & Frémont, and juniper, *Juniperus* Linnaeus, association and above those habitats where greasewood, *Sarcobatus* Nees von Esenbeck, and saltbush, *Atriplex* Linnaeus, predominate. At its lowest elevational and floral limits (e.g. Smoke Creek, Valley Falls, Fields and Panaca), *M. megacephalus* is found in very sandy habitats dominated by greasewood and/or saltbush and often with rabbit brush present. The habitats harbouring *M. megacephalus* at its upper elevational and floral limits (e.g. Powell Mountain, Belmont and Cobre) are dominated by sagebrush and in sandy soils with a gravel overlay immediately below the pinyon–juniper belt. Egoscue’s (1981) unusual high-elevational record pertains to kangaroo mice caught in pinyon–juniper habitat near the summit of a mountain pass during the post-reproductive period and probably represents the fortuitous capture of dispersing individuals.

Throughout its distribution, *M. megacephalus* occurs in a variety of floral associations and, although restricted to sand, displays a rather broad tolerance for soils with varying amounts of gravel overlay. In contrast to *M. megacephalus*, *M. pallidus* is usually found in habitats above those that support the creosote bush, *Larrea* Cavanilles, and below those that support sagebrush (Hafner *et al.*, 1996, 2008). *M. pallidus* is found most frequently in deep, fine, sandy soils and in floral communities where greasewood and saltbush predominate; such habitats occur in the lower portion of the Upper Sonoran Life-Zone. Future studies examining the ecology and habitat specificity of kangaroo mice may find it fruitful to examine possible differences among the principal clades of *M. megacephalus* recognized in this study (Fig. 2). Specifically, it would be interesting to know if the genetic divergence detailed here is accompanied by ecological specialization.

Distribution and conservation biology

Our portrayal of the geographical range of *M. megacephalus* (Fig. 1) is similar to Hall’s (1941) distribution map, excepting for the range extensions in Idaho and Utah and alterations of the distribution around the southern end of Pyramid Lake. It is important to bear in mind that the distribution depicted in Fig. 1 reflects all populations of *M. megacephalus* sampled from the wild in the course of this study and augmented by older specimens from key localities where trapping efforts during this study were unsuccessful. Localities of particular relevance here are Powell Butte, Riddle and Callao (Fig. 1); these localities are positioned on the northern periphery of the distribution and are represented by specimens collected more than 30 years ago. More information is needed on the status and conservation biology of these northern populations before definitive statements regarding temporal distributional adjustments can be made.

Despite recent concerns regarding global warming and documented changes in species distributions (e.g. Parmesan *et al.*, 1999; Beever *et al.*, 2003; Parmesan & Yohe, 2003; Wagner *et al.*, 2003; Perry *et al.*, 2005), we note no overall pattern of northward or elevationally upward distributional changes for *M. megacephalus* when comparing our capture data with those obtained three-quarters of a century ago by Hall (1941). These findings agree with those for *M. pallidus* (Hafner *et al.*, 2008) and are consistent with those reported for xeric-adapted species of mammals (including *M. megacephalus*) from north-eastern Nevada (Rowe *et al.*, 2010). A general pattern that emerged from our fieldwork, however, was the surprising and rather consistent difficulty of collecting specimens across the northern portions of the distribution. Many northern localities (e.g. Powell Butte, Narrows, Riddle, Quinn River Crossing, Sulphur, Winnemucca, Golconda, Izenhood, Halleck, and Callao) that were sampled successfully by Hall (1941) and/or by Hafner (1981) yielded no kangaroo mice in the course of our fieldwork. Other northern localities often yielded kangaroo mice in low abundance (only one or two specimens; e.g. Ruby Valley, Contact, Cobre, Cherry Creek). An exception to this pattern is Valley Falls: one kangaroo mouse was captured from 340 trapnights in 1978 but 13 kangaroo mice were taken from 400 trapnights in 2004.

Relative to the southern portions of their distribution, populations of kangaroo mice from the northern portion of the geographical range seem to show low abundance, occur in tiny habitat patches, and are more widely separated from each other. It is also evident from fieldwork over the past 30 years that many populations in the northern portion of the distribution of *M. megacephalus* have suffered severe habitat alteration and loss. Of the possible 'big four' threat factors discussed by Hafner *et al.* (2008), wild fires and invasive plants, especially over the past two decades, have devastated the low-elevational habitats across the northern portions of the Great Basin. Wild fires followed by the immediate invasion of introduced annual grasses and weed species (especially cheat grass, *Bromus tectorum* Linnaeus, and Russian thistle, *Salsola tragus* Linnaeus; Whisenant, 1990; Knapp, 1996) appear directly responsible for our inability to collect kangaroo mice at localities such as Winnemucca, Izenhood and Halleck (type locality for both the genus and species, *Microdipodops megacephalus*). Other kangaroo-mouse localities of Hall (1941) and Hafner (1981) not ravaged by fire are now modified to varying degrees by the presence of introduced annual grasses. Although it remains to be determined to what extent kangaroo mice can tolerate invasive plants, places that yielded kangaroo mice in the 1970s (e.g. Narrows, Quinn River Crossing and Sulphur) are now covered by invasive grasses and our collecting efforts yielded no kangaroo mice.

The most northern record for the genus is Powell Butte (Hall, 1941; Fig. 1, Appendix S1) and is based on a single specimen collected in 1920. This locality is over 150 km north of the closest known locality of kangaroo mice (Valley Falls; Fig. 1) and, because of its unique location, may provide insights into the conservation biology of kangaroo mice occurring at their upper ecological limits. Although our trapping efforts yielded no additional kangaroo mice, this locality appeared to represent satisfactory *Microdipodops* habitat except for the presence of juniper woodland. Because kangaroo mice occur below the limits of the juniper woodland elsewhere in their distribution, we conclude that woodland expansion, commonplace across the northern Great Basin since post settlement times due largely to fire suppression (Tausch *et al.*, 1981; Miller & Rose, 1999; Miller & Tausch, 2001), has resulted in the dissection and loss of sagebrush habitat and the extinction of this isolated population of kangaroo mice.

More so than in any other area across the distribution of *Microdipodops*, many populations of *M. megacephalus* in the northern portion of the Great Basin are either locally extinct or facing serious threats due to loss of habitat. Although some of the northern-most localities still seem to remain in a near-pristine ecological state (e.g. Valley Falls, Riddle, Fields, Contact, Cobre and Callao), their preservation is only due to happenstance of their extreme remote locations away from human settlements and activities. It should also be kept in mind that these populations are typically small and isolated (owing to the vagaries of the distribution of appropriate sandy habitats) and, hence, are highly susceptible to habitat alteration due to anthropogenic factors and the vicissitudes of climate change. From a conservation perspective, the picture that is emerging for *M. megacephalus* is one that parallels closely the environmental threats facing the sage grouse, *Centrocercus urophasianus* Bonaparte, in the Great Basin (e.g. Connelly *et al.*, 2004). Specifically, populations in the basins and valleys (towards their lower ecological range) are facing ever-increasing environmental threats and habitat loss due to wild fires, invasive plants, agriculture and livestock grazing, whereas populations of kangaroo mice occurring at higher elevations and in more northern latitudes (towards their upper ecological range) seem to be facing increasing loss of sagebrush habitat associated with expansion of juniper and pinyon woodland. Further fieldwork in these northern areas would be especially useful for monitoring the status and understanding the temporal stability of these small and isolated populations.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Localities and numbers of specimens examined in this study.

Appendix S2 Primers used for the amplification and sequencing of mitochondrial genes from *Microdipodops megacephalus* for ancient DNA analyses.

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Appendix G

Draft Groundwater Monitoring ~~Plan~~ Goals and Objectives

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Appendix G. Draft Groundwater Monitoring Goals and Objectives for the North Valley Geothermal Development Project

G.1 Goals and Objectives

In addition to the required monitoring, avoidance, minimization, and mitigation measures outlined in **Section 2.1.3** of the environmental assessment (DOI-BLM-NV-W030-2020-0003-EA), the Bureau of Land Management (BLM) would also require progress toward meeting associated goals and objectives created for the Proposed Action. Achievement of goals and objectives would be required to ensure project activities would not significantly affect hydrologic resources (groundwater, springs, and seeps). Adaptive and flexible management approaches aimed at achieving outlined goals and objectives are necessary for successful project management. Outlining clear, specific objectives—and the timing of monitoring and management responses—for the associated water resources monitoring and mitigation plan is imperative to determine whether project actions are meeting acceptable standards and, if not, modifying project activities and management approaches to ensure objectives are met.

The BLM formulated draft goals and objectives using multiple resources, including National Environmental Policy Act documents, established monitoring protocols and guides, manuals and technical references, interdisciplinary team review, and professional input and expertise with partner agencies. Objectives outlined for this Proposed Action may consist of a specific threshold or range; however, flexibility to adaptively change thresholds would be maintained as new information is collected throughout project operations (exploration and development activities). The need for changes to project operations may stem from the results of the ongoing monitoring data collection or from changes in climatic conditions, resource conditions, or other events (such as flooding and wildfire). Adaptive management within the monitoring plan would be used to allow for changes, additions, and/or modifications of objectives, thresholds, and triggers to suit the goals of the project and ensure compliance with the environmental assessment.

Data collected for all objectives would occur on a quarterly basis for the life of the project. In addition to the voluntary monitoring described, the BLM will require Ormat to drill three monitoring wells on BLM-administered public land between the Pyramid Lake Paiute Tribe Reservation boundary and the southern area of interest (see **Figure 1**); the BLM will also require Ormat to monitor five springs on the Pyramid Lake Paiute Tribe Reservation (see **Table 1**). Initial goals would be evaluated concurrently with the collection of the monitoring data and reporting of results.

Figure 1 Potential Monitoring Well Locations

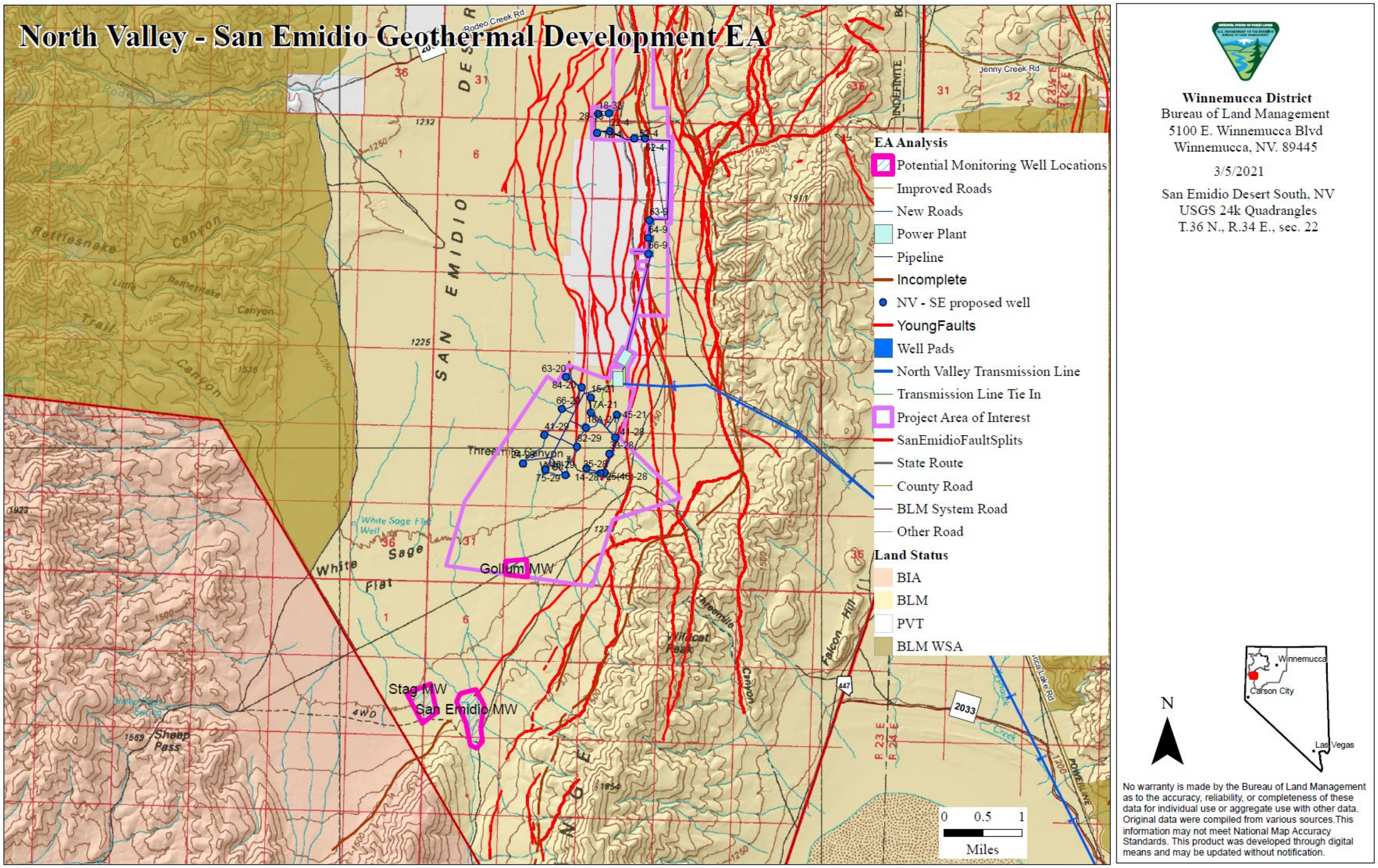

Table 1
Proposed Surface Water Monitoring Parameters

Site ID	Coordinates									
	Name	Easting (m)	Northing (m)	Elevation (ft)	Land Status	Feature	Monitoring Frequency	Field Parameters	Chemistry	Flow
27/23-13d1*	Moses Rock Spring	290,990	4,453,755	6,200	PLPT	Spring	Quarterly	X	X	X
28/23-31a1*	San Emidio Spring	292692	4459066	5,040	PLPT	Spring	Quarterly	X	X	X
28/23-26d1*	Stag Springs	289489	4459659	5,500	PLPT	Spring	Quarterly	X	X	X
28/22-9d1*	Sheep Pass Spring	286372	4464784	4,748	PLPT	Spring	Quarterly	X	X	X
29/22-19c1*	Summit Springs	282662	4471407	5,860	PLPT/BLM	Spring	Quarterly	X	X	X
29/22-3a1	Jackass Spring	288558	4476686	4,500	BLM	Spring	Quarterly	X	X	X
30/22-19d1	Bull Basin Spring	283596	4481051	6,040	BLM	Spring	Quarterly	X	X	X

*Monitoring contingent on access authorization from PLPT.

The frequency, duration, and timing of monitoring and reporting may increase or decrease dependent on the results of meeting or not meeting monitoring objectives, as determined by the BLM. Monitoring objectives, indicators, and other aspects of data collection, as well as management actions and mitigation measures, may be subject to modifications at any time during project operations, including the exploration, utilization, decommissioning, and reclamation phases. Any changes to monitoring objectives or the water resources monitoring and mitigation plan would require prior approval from the BLM Authorized Officer.

What are monitoring objectives?

Monitoring objectives are quantitative statements that provide a means of evaluating whether management goals are achieved. Monitoring objectives should be specific, quantifiable, and attainable based on ecosystem potential, as well as resource availability and the sensitivity of the methods.

At a minimum, monitoring objectives should include:

1. the focal indicator(s) that will be monitored,
2. quantitative benchmarks or thresholds for each indicator, and
3. the proportion of the resource that is required to meet a given benchmark.

The most robust monitoring objectives also clearly identify the reporting units, a time frame for evaluating the indicator(s), and the desired confidence level (e.g., 90 percent confidence) in the objective.

What are benchmarks?

These statements establish quantitative guidelines to help determine if the management goals are achieved.

Benchmarks are indicator values, or ranges of values, that establish desired conditions and are meaningful for management. Benchmarks are used to determine if observed indicator values at assessed points (i.e., monitoring sites) are within the range of desired conditions; benchmarks are also synonymous with triggers.

Development of the monitoring plan

Once quantitative monitoring objectives have been established, monitoring needs can be determined. The BLM must determine the values to be measured, how the values will be measured, and the frequency and duration of data collection for each indicator.

Hydrology (Groundwater and Surface Water) Monitoring Data Collection

Develop measurable objectives:

- Establish indicators.
  - Water quantity: volume
  - Water quality: temperature, field parameters (potential of hydrogen [pH], electric conductivity, salinity, dissolved oxygen, and turbidity), and geothermal indicators (silicon dioxide and magnesium)
- Define baseline/reference conditions for indicators.

- Develop objectives based off of goals. These objectives are thresholds that trigger management actions.
- Develop appropriate management actions and mitigation measures.

<u>Key water quantity indicators:</u>

- Flow/stage (surface water) and hydraulic head (groundwater)
  - Compile flow and hydraulic head data at key monitoring sites.
  - What is the highest and lowest value currently recorded at each site?
  - What would be an acceptable range of values, considering water use trends and changes in the season, climate, and other natural variations?

<u>Key water quality (and geothermal) indicators:</u>

- Temperature:
  - Compile temperature data at key monitoring sites.
    - What is the highest and lowest value currently recorded at each site?
    - What would be an acceptable range of temperatures (e.g., temperatures would not exceed ± 5 percent of the associated temperature range)?
      - Hot water (greater than 122 degrees Fahrenheit [°F])
      - Warm water (68°F–122°F)
      - Cold water (less than 68°F)
- Field parameter indicators:
  - What other parameters could be influenced by geothermal activities?
    - Boron, mercury, lithium, and rubidium
  - Other than temperature, are there any field parameters that could be used as indicators (e.g., pH, electric conductivity, dissolved oxygen, and turbidity)?
  - Geothermal waters are typically higher in many dissolved constituents; an increase in electric conductivity could be a warning signal that there is more mixing occurring.
    - Geothermal indicators: high concentrations of silicon dioxide or low concentrations of magnesium
      - Compile silicon and magnesium concentrations at key monitoring sites.
      - What are the highest and lowest values currently recorded at each site?
      - What are the median values and what is an acceptable range of values for each site (e.g., concentrations would not exceed ±2 standard deviations from average or within a specific percentage)?

Ongoing Hydrologic (Groundwater and Surface Water) Conditions[1]

Goal—Gain a clear understanding of the local hydrogeology, including areas of groundwater discharge and recharge, to ensure water quantity is not unduly influenced by geothermal development.

[1] Values and percentages for hydrology objectives and benchmarks are only placeholders for discussion. These values will be redefined once actual data are evaluated.

Objective—Maintain the surface water flow and stage within ±10 percent from baseline conditions for 90 percent of key monitoring sites.

Objective—The surface water flow or stage would not decrease by ±15 percent consecutively for 6 months from baseline conditions for 90 percent of key monitoring sites.

Objective—Maintain hydraulic head within ±15 percent from baseline conditions for 90 percent of key groundwater monitoring wells.

Goal—Maintain current groundwater and surface water quality conditions at the San Emidio Desert basin.

Objective—Maintain water temperatures within ±10°F from baseline conditions, considering natural and seasonal variations, at all key monitoring sites.

Objective—Water temperature would not decrease more than ±10°F relative to baseline conditions at 95 percent of thermal springs during winter months (if there are thermal springs located).

Objective—Water temperatures would not exceed ±20°F consecutively for 3 months from baseline conditions at 90 percent of key monitoring sites.

Objective—Maintain field parameters (pH, electric conductivity, salinity, dissolved oxygen, and turbidity) within ±10 percent of baseline conditions at 85 percent of key monitoring sites.

Objective—At 80 percent of key surface monitoring sites, silicon dioxide and magnesium would not exceed ±5 percent of reference concentrations for 6 months consecutively.

Objective—Maintain key geothermal indicator values[2] within ±10 percent from baseline concentrations at all key monitoring sites.

G.2 MANAGEMENT ACTIONS AND MITIGATION MEASURES

A management action or mitigation measure may be triggered if a key indicator has reached a target threshold. The following is a general list of potential management actions and mitigation measures that may be implemented during, or following, project operations. This is not a complete list; the BLM, Ormat, contractor, and/or partner agencies may develop additional management actions or mitigation, as needed, to ensure goals and objectives are being achieved.

G.2.1 Mitigation Measures Outlined in the Proposed Action

See the mitigation section in North Valley Geothermal Development Project at the San Emidio Geothermal Field Utilization Plan (Ormat 2020).

[2] Key geothermal indicators: silicon dioxide, magnesium, boron, mercury, lithium, and rubidium (subject to change after further correspondence with a subject matter expert at the University of Nevada, Reno)

Additional proposed management actions and mitigation measures in the event an established monitoring threshold has been exceeded:

1. Increase the frequency, duration, and/or timing of monitoring specific parameters at defined monitoring locations, to determine if other applicable management actions or mitigation measures need to be enforced.
2. Increase or decrease the amount of pumping or injection rates, or both, of geothermal fluid until maintenance of pre-operation conditions is achieved.
3. Alter the location(s) of pumping or injection, or both, of geothermal fluid until maintenance of pre-operation conditions is achieved.
4. Temporarily cease pumping or injection, or both, at site-specific well locations until maintenance of pre-operation conditions is achieved.

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Appendix H

~~Draft~~ EA Comment Response Matrix

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Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Air Quality	In the FEA, include information on the ambient air conditions, NAAQS, criteria pollutant nonattainment zones in the project area, and potential air quality impacts of proposed Project activities, including indirect and cumulative impacts. Demonstrate compliance with state and federal air quality regulations and disclose the potential impacts from temporary or cumulative degradation of air quality. In addition to incorporating the Geothermal PEIS best management practices and mitigation measures, EPA recommends an evaluation of the following to reduce emissions of criteria air pollutants and hazardous air pollutants: · Quantify Emissions - Estimate emissions of criteria pollutants from the proposed Project activities and discuss the timeframe for release of these emissions over the lifespan of the Project. Describe and estimate emissions from potential construction activities, as well as proposed mitigation measures to minimize these emissions. · Specify Emissions Sources - Specify the emission sources by pollutant from mobile sources, stationary sources, and ground disturbance. Use this source-specific information to identify appropriate mitigation measures and areas in need of the greatest attention. · Construction Emissions Mitigation Plan - EPA recommends including commitments to air quality mitigation measures during construction and operational activities. In addition to measures necessary to meet all applicable local, state, and federal requirements, the EPA recommends that the following measures be included: Fugitive Dust Source Controls · Stabilize open storage piles and disturbed areas by covering and/or applying water or chemical/organic dust palliative where appropriate. This applies to both inactive and active sites, during workdays, weekends, holidays, and windy conditions. · Install wind fencing and phase grading operations where appropriate and operate water trucks for stabilization of surfaces under windy conditions. · When hauling material and operating non-earthmoving equipment, prevent spillage and limit speeds to 15 miles per hour. Limit speed of earth-moving equipment to 10 miles per hour.	Revised EA Table 3-2 to include additional clarification on proposed mitigation related to air quality.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Air Quality	Discuss in the FEA whether NSR program permits will be required for the proposed Project in the leased areas. If so, describe the permitting process and the information that must be addressed in the permits.	The project would be required to comply with new source review permitting and any other applicable local, state, and federal permit requirements as stated in Section 1.6 of the EA. No changes made to the EA.
Cultural and Tribal Resources	Lastly, the Tribe is concerned of impacts to cultural sites in the area of the Project, both within and outside of the Reservation boundary. The Bureau should provide the Tribe with an inventory of known cultural sites so that both the Tribe and Bureau can assess the Project's impacts to these important sites.	The BLM provided the proposed action to the Nevada SHPO for review. The SHPO determined that all known cultural sites would be avoided by the project. No changes made to the EA.
Cultural and Tribal Resources	Describe in the FEA how the BLM is addressing the Pyramid Lake Paiute Tribe's concerns and include mitigation measures that were developed as a result.	The EA and Hydrogeological Evaluation have been revised to address the PLPT's concerns related to water and cultural resources.
Cultural and Tribal Resources	The Nevada SHPO has reviewed this document and supports the document as written. The SHPO also supports the inclusion of public reminders that the Bureau of Land Management intends to use the NEPA process to meet the requirements for consultation under Section 106 of NHPA and the Protocol (2014). If this notification and draft EA result in the identification of additional cultural resources or effects not previously considered by the agency, additional consultation with the SHPO may be necessary under the terms of the Protocol.	Comment noted
Cumulative impacts	Maps showing the cumulative effect study area(s) are emphasized in the National Environmental Policy Act (NEPA), particularly in section 5 of "cumulative effects" https://ceq.doe.gov/publications/cumulative_effects.html and are totally missing from the EA or Hydrogeologic Evaluation.	The EA has been revised to include a new map showing the cumulative effect study area used for the cumulative effects analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Cumulative impacts	(EA, page 3-53) The following comment is made in the EA in regard to cumulative effects: "Because there is a lack of connectivity between the geothermal resource in the San Emidio Desert Basin and undeveloped geothermal resources in adjacent hydrologic basins, Alternative A is not anticipated to prevent development of these resources in the future. Similarly, there is no direct connection between the geothermal resources in the San Emidio Desert and groundwater and surface water resources in the Pyramid Lake Valley basin; thus, there would be no contributions to cumulative effects on water quality or quantity in Pyramid Lake, including habit for listed fish species." There is no conclusive scientific bases or analyses in either the EA or the Hydro Report to support these statements. The capacity and extent of the geothermal resource from which the proposed Project will withdraw from are not stated, quantified, or otherwise illustrated in either the EA or the Hydro Report. The analyses and information that are provided in the Hydro Report conflict with the statements that are made regarding no effects.	The EA and Hydrogeological Evaluation have been revised to address the PLPT's concerns related to water and geothermal resources.
Direct/indirect impacts	Figure 1 of the Hydrogeologic Evaluation shows a 5 miles buffer area around the Area of Interest (AOI) which is arbitrary and misses several areas that might be affected by the project.	The EA and Hydrogeological Evaluation have been revised to address the PLPT's concerns related to water and geothermal resources. The scope of the hydrogeological evaluation generally includes an area within 5 miles of the area of interest; however, some sections evaluated a larger area to provide a broader hydrogeologic context, including the potential interactions between geologic, hydrologic, and geothermal systems in the San Emidio Desert with those in surrounding basins and ranges.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
General wildlife	In addition to the decline and receding of the water table, there would be impacts to springs on the Reservation within the San Emidio Basin. The area is inhabited by wildlife, including sage grouse, and tribally-protected Big Horn Sheep. Tribal members utilize the rangelands in the Lake Range for cattle grazing, for many of whom this is their sole source of income. These springs are essential to maintain the vegetation on the rangeland habitat as well as streams and wetlands. Any disruption of the water flow in these areas will have a devastating effect on the wildlife and cattle in the area.	The revised Draft EA includes a stipulation to monitor groundwater and a groundwater monitoring plan prepared by Ormat in included as an appendix to the EA. The EA analysis has been revised to reflect the monitoring plan and changes made in the hydrogeologic evaluation.
Geology	Geologic mapping clearly links the Lake Range Fault on the east side of Pyramid Lake with the production faults at the San Emidio geothermal project (Crafford 2007, Faulds et al 2013, Anderson and Faulds 2013, Moore 1979) as indicated on the attached map by Ehni (Figure 1). San Emidio geothermal production wells are located adjacent to the north end of the Lake Range (Mackelprang and More 1979) which extends south where the Lake Range forms the eastern side of Pyramid Lake. The fault system associated with the San Emidio geothermal system is the northern extension of accommodation faults related to the Lake Range Fault. The Lake Range Fault is a right lateral, right stepping west dipping normal fault. The producing faults at San Emidio are a northern extension of this fault. The Lake Range Fault splays off to the north on the Sweetwater and Hell's Kitchen faults which are most likely extensional accommodation (tensional) faults and are probably the primary fault system that is being produced at the San Emidio geothermal project.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.
Geology	Figure 1 (SEE ATTACHMENT): Fault system showing expansion of San Emido geothermal project Area of Interest (AOI) along the Sweetwater fault connecting the Northern Extension of the Lake Range Fault with the Lake Range fault on Pyramid Lake. The AOI appears to be "chopped" off on the southwest end even though supporting documents for the EA and Hydrogeologic report indicated that the geothermal anomaly is open-ended to the southwest as indicated on this map. (note: some fault names used on this map are colloquial and used as reference only)	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geology	The EA discusses the link between faults and geothermal systems however fails to present maps that show the location of these faults.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.
Geology	On Page 2-2 the Hydrogeologic Evaluation states that "The San Emidio and Empire faults are in and most closely associated with the Project" and as depicted on the Figure 3 of the Hydrogeologic Evaluation, the Empire fault is actually the northern extension of the Sweetwater fault (Faulds et al 2013, Anderson and Faulds 2013, Crafford 2007). It should be noted that The Faulting on Figure 3 of the Hydrogeologic Evaluation is not consistent with other published maps (Faulds et al 2013, Anderson and Faulds 2013, Crafford 2007). The Lake Range Fault on Figure 3 splits at Hells Kitchen and on figure 3 the Hells Kitchen fault is called the Lake Range fault. If this is correct, then the Lake Range fault that appears to supply the hot water for the Pyramid Hot Springs is the same fault that San Emidio is on. On Page 4-6 of the Hydrogeologic Evaluation states that "The Lake Range fault extends from the southeastern shore of Pyramid Lake, branches off into an east-northeast-striking oblique fault, and terminates southeast of Wind Mountain Mine" which basically says that the Lake Range fault connects Pyramid Lake with San Emidio. However, it is most likely that the Lake Range Fault and the Northern Extension of the Lake Range Fault are components of a "right stepping, right lateral" fault system and the Sweetwater-Hell's Kitchen faults are dilational or transitional pull apart geothermal zones as noted on figure 6 of the Hydrogeologic Evaluation. The fact that there are no maps of the fault system in the EA, and that the fault system is poorly described with conflicting statements, supports the recommendation that the proposed development, if approved, will need a robust monitoring program, directed by the PLPT, in order to protect the resources of the PLPT.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geology	The EA does not provide a map showing the fault systems in the vicinity of the proposed Project. Figure 3 of the Hydro Report does show the location of some faults in relation to the proposed Project, including references to Lake Range, San Emidio, and Empire Faults. As generally illustrated on Figure 3 of the Hydro Report, the Lake Range fault extends from the Pyramid Lake into the San Emidio Desert Basin and the proposed Project area. However, Figure 3 of the Hydro Report does not correctly represent the full extent of the fault identified as the San Emidio Fault. The full extent of the faults extending from the Pyramid Lake into the San Emidio Desert Basin are provided on Figure 2 attached to this Technical Memorandum (faults in Figure 2 are based on USGS, 2007). As shown on the attached Figure 2, there are two faults that extend from the Pyramid Lake into the San Emidio Desert Basin. The southernmost fault extends from the Pyramid Lake through the San Emidio Canyon and a second fault to the north extends from the Pyramid Lake through the Sweetwater Canyon/Stag Canyon. Both faults extend from Pyramid Lake into the San Emidio Desert and the geothermal production area associated with the proposed Project. Figure 3 in the Hydro Report should be corrected to accurately show both faults extending from the Pyramid Lake into San Emidio Desert Basin.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	**Comment Text**	**Response**
Geology	The report emphasizes that the geothermal system is fault controlled but then states that "These north-northeast striking structures appear to be geologically independent of the Lake Range, Fox Range, and Pyramid Lake faults, which appear south of the Project area". There are no temperature gradient or isotherm maps in the hydrogeologic evaluation that support this conclusion. Folsom (2020, Figure 1) presents an isotherm map at 30m below ground level; however, as Warren(2018) points out, the San Emidio geothermal resource is hotter to the south (towards the PLPT reservation) and the anomaly is open-ended to the south. In Figure 1 of the attached map Ehni outlines the areal extent of the hypothetical "Sweetwater geothermal system". The proposed North Valley Geothermal Development project is on the northeast end of the Sweetwater geothermal system. The right stepping right lateral Lake Range fault on the shores of the Pyramid Lake, and the Northern Extension of the Lake Range Fault adjacent to the existing San Emidio project, are connected by the dilational Sweetwater and Hell's Kitchen faults. The hydrogeologic evaluation completely misses this correlation. The San Emidio geothermal resource is located on the north end of the dilational Sweetwater extensional (NW-SE tension) fault zone which connects the northern extension of the Lake Range Fault in the San Emidio basin with the Lake Range fault in the Pyramid Lake basin. As pointed out by Warren (2018), the San Emido geothermal anomaly extends to the south, which is where the Sweetwater fault is located. The hydrogeologic evaluation failed to show the relationship of the hottest portion of the San Emidio geothermal system and the Sweetwater fault.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.
Geology	Wood (1990) recognized the Lake Range Fault as separating Wind Mountain from the Lake Range just north of the San Emidio geothermal project. The Fault zone that produces geothermal fluids at San Emidio is just west of the Lake Range fault, in a similar structural setting to the Wind Mountain Fault as described by Wood in 1990. The Sweetwater Fault zone appears to be a southern extension of the Wind Mountain / San Emidio fault zone, connecting Pyramid Lake with San Emidio.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geology	The Hydrologic Evaluation also states that "There is also no evidence that geothermal water or groundwater is connected with geothermal or groundwater resources outside the San Emidio basin" (page ES2). However, the faulting that controls the San Emidio geothermal system is permeable and connects to Pyramid Lake. In addition, the water table in San Emidio is at a higher elevation than the surface elevation of Pyramid Lake (NDWR well file records) and you would have to assume that the faulting that connects the two basins is not permeable; and this is contradictory to the data, since the hottest portion of the San Emidio geothermal system is along the Sweetwater fault. Therefore the Sweetwater fault must have good permeability which is good evidence that the San Emidio basin could be connected to the Pyramid Lake basin.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).
Geothermal Resources	On Page 3-36; the EA makes a similar statement; "The groundwater systems in the San Emidio Desert are not interconnected to those in the Pyramid Lake Valley groundwater basin (Basin 81)." The connection between San Emidio and Pyramid Lake has not been fully evaluated. Faulting connects the two basins and how much permeability there is along these faults has not been determined. On Page Page 3-37; the EA states "The currently producing geothermal reservoir at the SEGU and the geothermal reservoirs south of the unit on the PLPT Reservation do not interconnect (BLM 2020b). This indicates that proposed geothermal utilization would not affect the PLPT's ability to develop the geothermal resource on the reservation in the future." Although BLM 2020b (Hydrogeologic Evaluation) implies that the geothermal systems are separate, the evidence is indirect and inferred from geophysical interpretations. Communication between the two basins might occur along the Sweetwater fault and Hell's Kitchen fault. Both of these fault systems are dilational "transitional pull apart" zones similar to example G on Figure 6 of in the Hydrologic Evaluation report (BLM 2020b). Unknown geothermal resources probably exist in the area, especially within the PLPT reservation in the San Emido Basin. Sacred hot springs at the "Pyramid" in Pyramid Lake are on the Lake Range Fault, which extends all of the way up to San Emidio, and the hydrology of this system in not very well understood.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geothermal Resources	The Hydrogeologic Evaluation states that "Geochemistry data from wells in the Project area also indicate the San Emidio geothermal system is hydrologically distinct from geothermal systems at Pyramid Lake and the Smoke Creek Desert." However data supporting this conclusion has been blanked out (Table 4) or just summarily summarized. How was this decided. In the big picture, the San Emidio fluids are very similar to most Basin and Range fault controlled systems which are characterized by relatively low TDS and low SO4/Cl ratios. On page 3-3 the Hydrogeologic Evaluation states "These concentrations (at San Emido) are higher than those measured at geothermal systems near Pyramid Lake" but does not present data that supports this conclusion. However, available data on water analyses from the geothermal fluid at the Needles well on the shores of Pyramid Lake and at San Emidio are relatively similar (SEE TABLE IN ATTACHMENT).	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).
Geothermal Resources	The pumping and injection of the geothermal waters will be conducted by a series of 25 wells. The productions wells will extract the geothermal waters from the shallow aquifer forming a cone of depression. This will result in reduction and disturbance of the geothermal aquifer, as well as mixing the thermal waters with the groundwater. The injection of the spent water back into the geothermal aquifer could also have a negative impact on the Tribal trust resources by cooling the geothermal reservoir in the Reservation. The impact of how the injection fluid from this proposed expansion could impact the freshwater and geothermal resource located on the Reservation need to be fully evaluated. The depth and location of proposed injection and production wells need to be examined to determine whether the proposed expansion at San Emidio could have an adverse impact on the resources located on the Reservation. The Tribe would like to see monitoring wells installed along the border of the Reservation in advance of any expansion in order to establish baseline data for this proposed expansion. In addition, the location, depth, schedule and monitoring program of these monitoring wells should be provided to the Tribe for review to ensure the Tribal trust resources are not diminished.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geothermal Resources	on page 4-4 where it states that at Emerson Pass "In 2013, the Nevada Bureau of Mines and Geology drilled four shallow wells, from 140 to 250 feet deep. The bottom hole temperatures ranged from approximately 205 to 298°". These are false and erroneous statements, the Nevada Bureau of Mines and Geology did not drill these holes, the Pyramid Lake Paiute Tribe did, and there are no wells with temperature as high as 298F.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic and hydrologic conditions in the San Emidio Desert and surrounding basins.
Geothermal Resources	(EA, page 3-35) The EA erroneously states: "…connectivity between the geothermal resources in the San Emidio Desert and adjacent undeveloped geothermal resources is unlikely. Proposed geothermal utilization, including reinjecting cooled geothermal fluids, is not anticipated to affect adjacent geothermal resources or the possibility of developing these resources in the future." Referring to Figure 2 attached to this Technical Memorandum, clearly the use of well water, geothermal well water production, and reinjection of geothermal well water at the proposed Project site will likely have impacts on the Tribe's undeveloped geothermal resources in the San Emidio Desert Basin. The resources underlying the portion of the Reservation that extends into the San Emidio Desert Basin are part of the same resources associated with the proposed Project.	The EA and Hydrogeological Evaluation have been revised to clarify existing geologic and hydrologic conditions in the San Emidio Desert and surrounding basins.
Geothermal Resources	The areal extent of the geothermal resource is poorly defined and open ended to the southwest, and most likely extends onto the PLPT reservation. The EA erroneously discounts the affect that the proposed development will have on the PLPT resources by making numerous references stating that the "The groundwater systems in the San Emidio Desert are not interconnected to those in the Pyramid Lake Valley groundwater basin" while nearly 23,500 acres (over 36 square miles) of the PLPT reservation lies within the San Emidio Desert ground water basin. Freshwater resources belonging to the PLPT could be adversely affected if the proposed development is mismanaged. Based on the above, and as well as the impact of other geothermal developments that were mismanaged and adversely impacted the freshwater and or geothermal resources, the proposed development will need a robust monitoring program coordinated by the PLPT.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geothermal Resources	On page 2-3, the EA states: "Ormat is proposing 25 production and injection wells,…..During normal well field operations, total geothermal fluid production rates are expected to be approximately 8,400 gallons per minute (gpm) at 320 degrees Fahrenheit. Individual production well flow rates are expected to be approximately 4,200 gpm…. Individual injection wells are expected to receive approximately 2,600 gpm". This math doesn't add up, total field production for 48 mega watts will be closer to 34,000 gpm, not 8,400 gpm. At 320F it will take about 17,000 gpm to produce 24 Mega Watts (gross) for each plant, which will only require 4 production wells at 4,200 gpm. And in order to reinject all 17,000 gpm at 2,600 gpm per well only 6 wells or so would be required. In order to fully assess the environmental impact, PLPT needs to have a better understanding of how much fluid is being produced and injected. In addition it is not clear if the old plant be decommissioned?	The information included in the EA is based on Ormat's proposed action as stated in the Utilization Plan (Ormat 2020) available on ePlanning. The AMOR II plant has been decommissioned. Decommissioning of the existing San Emidio geothermal power plant is outside the scope of this EA

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geothermal Resources	(EA, Section 3.3.6 Cumulative Effects, page 3-53) The Hydro Report states that the current San Emidio geothermal plant and northern production wells are associated with the San Emidio fault (Hydro Report, page 4-5). The Hydro Report also states that the geothermal system is likely produced by conductive faults that provide pathways for fluid convection (Hydro Report, "Proposed Project" page 4-11). As shown in Figure 2 attached to this Technical Memorandum, there are two (2) faults that extend from the Pyramid Lake into the San Emidio Desert Basin and into the area proposed for geothermal well production. Based on the fault connectivity that exists between the Pyramid Lake and the proposed geothermal production area in the San Emidio Desert Basin, the following conclusion as stated in the EA is unsupported and contradicted by the facts: "Because there is a lack of connectivity between the geothermal resource in the San Emidio Desert Basin and undeveloped geothermal resources in adjacent hydrologic basins, Alternative A [the proposed Alternate] is not anticipated to prevent development of these resources in the future. Similarly, there is no direct connection between the geothermal resource in the San Emidio Desert and groundwater and surface water resources in the Pyramid Lake Valley basin; thus there would be no contributions to cumulative effects on water quality or quantity in Pyramid Lake, including habitat for listed fish. (EA, page 3-53).	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).
Geothermal Resources	The Tribe has spent considerable resources exploring and delineating the geothermal resources with the boundary of the Reservation. The system within the Reservation's boundary is part of the same system found in San Emidio with a shallow thermal aquifer and extensive faulting that intersects the groundwater. The most promising area for geothermal development for the Tribe has been located on the northeast sections of the Reservation contiguous to San Emidio. This is illustrated in the major system fault along the Lake Range East Pyramid Lake Fault that displays down-to- the-west motions, and then splays into a series of dextral dip slip faults on the northwest end of the lake. Evidence of faults in this system can be seen on geologic mapping performed by the Tribe during exploration activities.	Comment noted

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Geothermal Resources	The EA fails to identify where the San Emidio Geothermal unit is located. On page 1-1 in Chapter 1, the EA states: "The Project proposes geothermal development in the San Emidio Geothermal Unit (SEGU; NVN-85820X), which encompasses approximately 20,400 acres." However, on figure A-2, the outline of the San Emidio Geothermal Unit barely encompasses 13,440 acres. The BLM serial page agrees with the unit size of being 20,400 acres, so Figure A-2 must be wrong and a map showing where the unit is needs to be included in the EA. And there is no mention of the Unit geology supporting this geothermal unit.	Map A-2 has been revised to include NVN-98636 in the SEGU. The extent of the SEGU is as depicted in Figure A-2.
Government entities	Provide an update in the FEA on the status of consultation with the USACE regarding jurisdictional determination and CWA 404 permitting responsibilities for the Project.	The revised Draft EA includes a stipulation to obtain a USACE permit, if applicable.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Government-to-Government consultation	As shown in Figure A-1 of the Draft EA, the Project is located approximately 3 miles to the northeast of the boundary of the Pyramid Lake Paiute Reservation ("Reservation"). The Project proposes to withdraw groundwater from the San Emidio Basin, which basin extends into the Reservation boundaries. Because of its proximity to the Reservation and its proposal to withdraw water from the San Emidio Basin, the Project will impact Tribal trust resources. As previously stated, the BLM has unique obligations to consider and protect all Tribal trust resources. See e.g. Presidential Memorandum on Government-to-Government Relations with Native American Tribal Governments (April 29, 1994); Executive Order No. 13007 (May 24, 1996) (implementing policy to protect and preserve Indian religious practices and sacred sites on federal lands); Secretarial Order No. 3206 (June 5, 1997) (outlining Department of the Interior principles regarding American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act); Executive Order No. 13175 (November 6, 2000) (Consultation and Coordination with Indian Tribal Governments); Secretarial order No. 3342 (October 21, 2016) (Identifying Opportunities for Cooperative and Collaborative Partnerships with Federally Recognized Indian Tribes in the Management of Federal Lands and Resources). Pursuant to these and other authorities, the Tribe will by separate correspondence request formal government-to-government consultation with the Bureau with respect to the Project, and its impacts on Tribal trust resources.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Groundwater	The report failed to include historical data showing how much draw down in the water table has occurred during the production of the existing power plant. In addition, water table data in Table 3 is blacked out. To make a complete Environmental Assessment, the current water table elevations need to be included for baseline data for all existing wells (production, injection, and freshwater wells) within the cumulative effects study area (CESA). Historical data on all wells (water table when first drilled and subsequent measurements) should be included to evaluate how much draw down in the water table has occurred with the current facility.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	Page 3-3 of the Hydrogeologic Evaluation states that "The highest recorded TDS concentration at any Ormat well in the San Emidio Desert is 4,400 mg/L (ORMAT Nevada, Inc. 2020b; see Table 4), whereas TDS concentrations in Pyramid Lake typically exceed 5,500 mg/L (see Section 3.3.3)." Comparing geothermal water with lake water that is derived primarily from the Truckee River drainage system is meaningless, and there is no section 3.3.3 in this report. The Hydrogeologic Evaluation falsely states on Page 3-7 that "There are no known groundwater inflows to Pyramid Lake from outside the basin." The data should be summarized in Piper Diagrams in order to make the conclusions that the Hydrogeologic Evaluation has arrived at, but there is no mention of this type of analysis, and therefore is deficient.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including the addition of Piper Diagrams.
Groundwater	First, the Tribe is concerned with impacts to its federal reserved groundwater rights within the Reservation boundary. A portion of the Reservation overlies the groundwater and geothermal resources in the San Emidio Desert Basin. The Tribe has federal reserved rights to the resources, including geothermal and underground water, within the San Emidio Basin. The groundwater reservoir in the area is at shallow depths with relatively poor quality. The groundwater quality would deteriorate further with the additional pumping for the Project. Any additional exploitation of groundwater under the proposed Project would lower the water table, and possibly recede, underneath the Reservation lands within the San Emidio Desert Basin. This would result in the loss of an irretrievable resource to the Reservation and the Tribe.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	The proposed 25 geothermal and injection wells for the Project are a significant increase compared to the existing 3.6 MW San Emidio I facility. Most of the proposed new wells would be located near the Reservation. In addition to pumping, the cone of depressions from these proposed new wells would directly impact the Tribe's groundwater and geothermal resources within the Reservation. Most likely, the spent geothermal water would be injected in places that would not offset the cones of depression. The Bureau should require Ormat to conduct an investigation, including pump tests, hydrological modeling, temperature analysis, among other research, to quantify the Project's impacts--both from withdrawal and reinjection--on the Tribe's federal reserved groundwater rights within the San Emidio Basin, and within other adjacent areas. This investigation should include an analysis of impacts to both the Tribe's geothermal resources and impacts to groundwater in the alluvium.	The revised EA includes a stipulation for Ormat to conduct groundwater monitoring, which will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). The revised EA includes a draft monitoring plan as an appendix.
Groundwater	In the FEA, clarify the extent of groundwater resources in the project area and discuss what the primary water source will be for construction and operations. Include a discussion of the potential impacts of alternative water sources and potential mitigation measures to offset these impacts.	The EA, in Section 2.1.1.7, describes the water sources for construction and operation. Additionally, the EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert, which resulted in revised analysis in the EA.

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Comment Code Name	Comment Text	Response
Minerals	Pyramid Associates, L.P. owns 1,084 acres of patented mining claims ,tax parcel numbers 071-070-01, 071-070-02, 071-070-03, 071-070-04, 071-070-05, 071-070-15, 071-070-17, and 10 unpatented mining claims BLM serial numbers; NMC 728347, 728348, 728350, 728351, 728353, 728354, 728356, 728357, 728359, 728360, equaling 200 acres. All this property is located within the project area of interest Located within sections 3, 4, 5, 8, 9, 10 in township 29N range 23EWM. The project is proposed to either be located on or adjacent to these patented and unpatented mining claims. The project will likely impact the known mineral resources, ground water resources, geothermal resources, subsurface geology, and seismic activity. The Draft EIS does not appear to address the impacts of injection of geothermal fluids on or adjacent to these mining claims.	The EA has been revised to clarify that approximately 200 acres of the Pyramid Associates, LP unpatented mining claims overlap the SEGU, but they are outside the AOI. In accordance with the Multiple Minerals and Development Act, undeveloped claims outside a plan of operations do not reserve a specific right to surface use. Locatable minerals could still be developed under the Multiple Minerals and Development Act, but could be limited by approved development in the AOI. Similarly, pursuant to the Geothermal Steam Act, non-unitized geothermal development is not party to the agreements or royalties of a geothermal unit. Any geothermal development outside the unit would be subject to the potential adverse effects of competing for the same geothermal reservoir.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	(Hydro Report, Section 3.3.1 Water Budget, page 3-2) The EA relies on the Hydro Report for most of the conclusions that the proposed Project will not affect the environment, water resources, vegetation, wildlife, and cultural resources. Section 3.3.1 of the Hydro Report is entitled "Water Budget" and it, like the Water Budget section of the EA, does not provide an actual water budget analysis or a discussion of how the proposed Project will impact the existing water budget for the San Emidio Desert Basin. Section 3.3.1 of the Hydro Report correctly notes that the perennial yield of the San Emidio Desert Basin is 4,600 acre-feet annually, and correctly notes that the Nevada State Engineer has permitted 7,296 acre-feet of groundwater to be pumped from the basin annually (not including 1,303 acre-feet of additional permitted pumping from geothermal groundwater). The Hydro Report also correctly notes that the San Emidio Desert Basin is a "designated basin," meaning it is over depleted and in need of additional administration by the State Engineer. However, the Hydro Report fails to explain/justify/reconcile how the proposed Project could not adversely affect the already overcommitted groundwater resources of the San Emidio Desert Basin.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the basin's status as a designated basin.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	(Hydro Report, Section 3.4 Existing Water Rights, page 3-7) Section 3.4 of the Hydro Report makes reference to a table of existing water rights and a figure showing existing points of diversion within the San Emidio Desert Basin, presumably derived from data/information published by the Nevada Department of Water Resources. However, the Hydro Report fails to recognize or mention the Tribe's federal reserved rights to the resources of the San Emidio Desert Basin, including geothermal and shallow groundwater, underlying the portion of the Reservation that is within the San Emidio Basin.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Groundwater	Any drillholes (water or monitor wells or boreholes) that may be located on either acquired or transferred lands are ultimately the responsibility of the owner of the property and must be plugged and abandoned as required in Chapter 534 of the Nevada Administrative Code. A waiver for the use of groundwater from a new or existing water well may be allowed for the exploration phase, which may include drill pad construction, dust control/road work, oil and gas well and test well construction, and miscellaneous uses associated with this phase; however, a water right permit is required for any subsequent use of water beyond the exploration phase including, but not limited to, water used for the hydraulic fracturing process during the oil and gas well development stage.	Comment noted

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	The water table in the San Emidio basin is at a higher elevation than the surface of Pyramid Lake and if producing the geothermal resource at San Emidio resulted in lowering the water table below the surface elevation of Pyramid Lake, water in Pyramid Lake might be affected. In 1988, one year after the San Emidio power plant went on production, the water table in the San Emido basin was at an elevation of about 4044 feet above sea level, 6 feet below ground level (AMOR II, 1988). By 1994 it had dropped to an elevation of 3923 feet above sea level, 142 feet below ground level (Pruett 1994). The elevation of pyramid lake is 3792 feet above sea level and therefore the hydrologic gradient is from San Emidio into Pyramid lake. Isothermal intervals in geothermal wells in San Emidio and on the PLPT reservation, are convective zones with relatively high fracture connectivity and permeability (Reeves et al., PLPT). Permeable Vocaniclastic rocks at San Emidio (Mesquite 1994, pg 28) could also provide communication between Pyramid Lake and San Emidio.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	In the Final EA, summarize groundwater quantity and flow as it relates to production and injection wells and discuss the complexity of the hydrographic basins and water rights issues.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Groundwater	Define the baseline the Project will be using for water quality and what threshold would need to be exceeded to determine a water quality effect. If available, include monitoring baselines for the region or any additional monitoring data beyond the deep geothermal wells. Include proposed measures to mitigate water quality effects on the shallow groundwater aquifer.	The EA and Hydrogeological Evaluation have been revised to clarify baseline hydrology and geologic conditions in the San Emidio Desert and surrounding basins. Required groundwater monitoring will provide additional data to inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	Figure 10 (Existing Production and Injection Wells) in the Hydrogeologic Evaluation depicts all wells in the Project vicinity (BLM 2020c). The existing San Emidio geothermal facility currently operates on just seven wells (four production and three injection). This figure is misleading in that the vast majority of the wells depicted are temperature gradient, observation, idle, and even abandoned wells. Further, some of the wells depicted are old water wells associated with the Wind Mountain Mine and were not drilled with the intention of geothermal exploration or development. Ormat recommends to the BLM that either a summary of the wells depicted in Figure 10, or identifying the types of wells in a legend, rather than depicting that all these wells as simply production or injection, is required.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert. This included several revisions to figures and tables in the Hydrogeological Evaluation.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	On Page 3-35; the EA states "As described in the Hydrogeologic Evaluation (2020b), connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unlikely. Proposed geothermal utilization, including reinjecting cooled geothermal fluids, is not anticipated to affect adjacent geothermal resources or the possibility of developing these resources in the future. Similarly, there is no direct connection between the geothermal resource in the San Emidio Desert and groundwater and surface water resources in adjacent hydrographic basins such as the Pyramid Lake Valley groundwater basin (Basin 81); thus, Alternative A is not anticipated to have effects on groundwater or surface water quality or quantity in adjacent hydrographic basins or on Pyramid Lake." It has not been demonstrated or proven that there is no connection between the San Emidio groundwater basin and Pyramid Lake. The EA infers that there is no "direct" communication between San Emidio and the Pyramid Lake, but there is no data on how is this measured except for indirect conclusions made from geophysical data. Although communication between San Emidio and Pyramid Lake might not be "direct" with obvious surface drainage from San Emido to Pyramid Lake, there is most likely some communication because Pyramid Lake is the low point and fault communication between San Emidio and Pyramid Lake is obvious. In 1988, one year after the San Emidio power plant went on production, the water table was at an elevation of about 4044 feet above sea level, 6 feet below ground level (AMOR II, 1988). By 1994 it had dropped to an elevation of 3923 feet above sea level, 142 feet below ground level (Pruett 1994). The elevation of pyramid lake is 3792 feet above sea level and therefore there is probably a significant amount of recharge and communication of water from San Emidio into Pyramid lake. If the water table in San Emidio is dropeed below 3792 feet, the hydrologic gradient would be from Pyramid Lake to San Emidio.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	A complete evaluation of the well construction, groundwater and thermal water movement, and impact to the Tribe's Trust resources must be evaluated. The increased pumping could also result in reversing the groundwater gradients from the playa and older alluvial deposits into fresh water zones. In addition to the loss in groundwater storage, there could be land subsidence in connection with the proposed Project.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Groundwater	In the Final EA, clarify which of the proposed wells will be used for production and which will be used for injection. Include a discussion of the groundwater flow analysis and how other water rights holders may be affected by the proposed Project. This may include maps of groundwater drawdown throughout the life of the Project or graphical depictions of the cones of depression from the production wells.	Proposed well locations are shown on Map A-3. Additionally, the EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including potential hydrologic impacts.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Groundwater	In the FEA, provide further detail in terms of the water quality within the Pyramid Lake, Smoke Creek Desert, and San Emidio Desert hydrographic basins. Summarize this information in tabular form making comparisons between the areas. Provide additional information to support the lack of hydraulic connectivity between hydrographic basins and if pumping tests were performed discuss the results in terms of permeability and connectivity to other hydrographic basins or saturated units.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Groundwater	Figure 7 (Observed and Modeled Velocities of Hydrothermal Flow at San Emidio Geothermal Field) in the Hydrogeologic Evaluation is a gross misrepresentation of the geophysical figures provided in Folsom et al. (2020). In the figure pulled from this research, Folsom et al. (2020) are showing "induction arrows," which point towards more electrically conductive portions of the earth. As used in the Hydrogeologic Evaluation, the BLM is instead suggesting that these vectors are "hydrothermal flow velocities" (BLM 2020c). In no way do Folsom et al. (2020) indicate these arrows indicate the direction of fluid travel as suggested by the BLM. Therefore, Ormat requests clarification within the Hydrogeologic Evaluation of what this figure actually depicts, and changing the name of the figure to San Emidio Observed and Modeled Conductive Features.	The EA and Hydrogeological Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert. This included several revisions to figures and tables in the Hydrogeological Evaluation.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Level of NEPA analysis (EA vs. EIS)	The Tribe requested that the Bureau bypass an Environmental Assessment and instead proceed directly to the development of an Environmental Impact Statement under the National Environmental Policy Act.	The BLM prepared the draft Environmental Assessment in accordance with Title 40 Code of Federal Regulations Chapter V - Council on Environmental Quality, Subchapter A - National Environmental Policy Act Implementing Regulations, specifically Part 1501.5, environmental assessments. Preparation of an EA is based on the baseline documentation prepared for the EA, including the revised Hydrogeologic Evaluation, which indicate that the proposed action is not likely to have a significant effect.
Mailing list or nothing to code	We request to be notified by mail of any actions and determinations concerning this proposed project. Mailing address Pyramid Associates 800 Shale Pit Road, Ellensburg WA, 98926.	Added to mailing list
Mitigation measures	Include in the FEA mitigation and monitoring measures to protect sensitive biological resources that result from discussions with wildlife agencies. Include the status of the Eagle Act Compliance Plan and whether an Eagle Take Permit is warranted.	The Eagle Act Compliance document has been revised and included as an appendix to the revised EA. Additionally, the EA includes the following stipulation: "The BLM would not issue a notice to proceed for any project that is likely to result in take of bald eagles and/or golden eagles until the applicant completes its obligation and demonstrates compliance with the Bald and Golden Eagle Protection Act, including coordination with the USFWS on agreed-upon measures to avoid take, or to obtain an eagle take permit should take be unavoidable."

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Mitigation measures	While Ormat is aware of 2018 Instruction Memorandum No. 2019-018, issued by the Department of Interior Deputy Directory for Policy and Programs (BLM, 2018) in regards to compensatory mitigation, we believe off-site mitigation has the best chance for success given the presence of an existing geothermal power plant and ancillary facilities within the San Emidio Geothermal Field and an existing 500 kV DC transmission line paralleling the proposed North Valley gen-tie route. Further, because the North Valley Project is expected to be in commercial operation a minimum of 30 years, final restoration of the Project-impacted lands could not happen until decommissioning and removal. Given this 30-year (minimum) project lifetime, and the 5-year monitoring and mitigation requirement in the EA, it is currently unknown how reporting and final determination to influence management decisions could even be made prior to final restoration of the Project. Therefore, at this stage, Ormat firmly believes that offsite voluntary compensatory mitigation would be the most beneficial for the Project.	The EA has been revised to include a monitoring and mitigation plan for pale and dark kangaroo mice. The plan does not include offsite compensatory mitigation.
Mitigation measures	In the FEA, provide a link to the Design Features document or include it as an Appendix. Include a summary of which design features will be used to inform the development of the applicable measures.	NDOW's Design Features and Tools to Reduce Wildlife Mortalities Associated with Geothermal Sumps has been included as a reference in the EA. Applicable design features to be implemented would be determine in coordination with the BLM and NDOW.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Mitigation measures	In regards to Pale Kangaroo Mouse (PKM)/Dark Kangaroo Mouse (DKM) mitigation as required in the Draft EA, there are several instances within Table 3-9 (BLM-Required Stipulations) that highlight the unknown effectiveness of the BLM-required mitigation measures (BLM 2020a). The Draft EA further states that information regarding PKM/DKM's local and geographic distribution, habitat use, population genetics, and dietary needs is limited (BLM 2020a). The Microdipodops Survey Protocol, developed by both BLM and Nevada Department of Wildlife (NDOW) and utilized to acquire baseline data for the species in relation to the project, has a stated objective to "Determine DKM/PKM distribution within the project area, especially in relation to proposed disturbance features or habitat removal actions. Where needed, determine habitat associations in order to allow inference to other potentially impacted areas within the project area or in future or other projects" (BLM 2020a, Appendix D). Given the undetermined and dynamic nature of the final disturbance totals for the project (Ormat is proposing up to 189.9 acres of temporary disturbance and 129.5 acres of permanent disturbance in the geothermal AOI however, final disturbance could be much less as the project advances in development/drilling), Ormat proposes the same solution implemented for the Crescent Dunes Solar Energy Project (BLM 2010) - voluntary compensatory mitigation. To mitigate for the loss of known habitat, Ormat would commit to the establishment of a fund to further the data needs for supporting management decisions regarding PKM/DKM, to be administered through a joint effort by NDOW and BLM.	The EA has been revised to include a monitoring and mitigation plan for pale and dark kangaroo mice prepared by Ormat in collaboration with BLM and NDOW.
Monitoring and adaptive management	Define the baseline the Project will be using for water quality and what threshold would need to be exceeded to determine a water quality effect. If available, include monitoring baselines for the region or any additional monitoring data beyond the deep geothermal wells. Include proposed measures to mitigate water quality effects on the shallow groundwater aquifer.	The EA and Hydrogeological Evaluation have been revised to clarify baseline hydrology and geologic conditions in the San Emidio Desert and surrounding basins. Required groundwater monitoring will provide additional data to inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable).

Comments on Public Draft EA 1

Comment Code Name	**Comment Text**	**Response**
Monitoring and adaptive management	Include in the FEA, safety procedures and protocols for assessing natural seismic hazards. Describe monitoring protocols that will address the risk of induced seismicity and implement procedures for evaluating resulting impacts.	There is no EGS and no seismic hazard associated with the proposed action. See Geology analysis under Section 3.3.3 of the Draft EA
Monitoring and adaptive management	Underground Injection Control (UIC) Program, which prescribes to Nevada Administrative Code (NAC) 445A.810 et seq., and in particular outlines the surface of the land lying over the zone of endangering influence for review and monitoring. Under the UIC program, administered by NDEP - Bureau of Water Pollution Control (BWPC), monitoring for groundwater degradation can include any combination of water levels and chemistry of springs, existing area wells, or new monitoring wells. With this NDEP UIC program in mind, Ormat would like to point to three springs with water rights permits identified in Table 5 (Points of Diversion within 5 Miles of the Project), for which the BLM is requiring monitoring on via the Table 3-9 (BLM Required Stipulations) in the EA. Permit 88484 (Rodeo Creek) is a perched water source (spring) located on the opposite (west) side of the valley from the proposed action, and is up-gradient in elevation from the proposed action. The perched nature of this water source indicates water flows expressed at the surface originate in the Fox Range and flow downslope until reaching an impermeable layer, where the water is then expressed at the surface. Water rights permits 17994 and V03065, both springs, are located on the other (east) side of the Lake Range from the proposed action, and are in a different hydrologic basin entirely. Given that the Hydrogeologic Evaluation prepared by BLM clearly states "There is also no evidence that geothermal water or groundwater is connected with geothermal or groundwater resources outside the San Emidio basin" (p. 4-10). Further, as the Hydrogeologic Evaluation prepared by BLM generally indicates that the San Emidio geothermal system is isolated and distinct from nearby geothermal systems and shallow groundwater (BLM 2020c). Therefore, proposing monitoring of these springs outside the hydrologic basin is not warranted to the Project.	Comment noted. Additionally, the revised EA includes a stipulation for Ormat to conduct groundwater monitoring, which will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). The revised EA includes a draft monitoring plan as an appendix.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Monitoring and adaptive management	As mentioned in the EA, the proposed Project would also fall under UIC Program, where the permit would require the geothermal injection program be designed and monitored to prevent degradation of underground drinking water sources from geothermal injection fluid (BLM 2020a; 3-34). The proposed Project's new injection wells would also be regulated by the UIC Program, and if it NDEP-BWPC determines there is a potential for groundwater impacts, new monitoring location may be required to allow detection of possible impacts before they occur. As such, Ormat recommends that any BLM concerns regarding potential impacts to resources or water rights be presented to the NDEP-BWPC so that appropriate monitoring locations can be included in the UIC monitoring program so as to not duplicate monitoring efforts that have the same goal.	Comment noted. Additionally, the revised EA includes a stipulation for Ormat to conduct groundwater monitoring, which will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). The revised EA includes a draft monitoring plan as an appendix.
Surface water	The EA fails to identify all surface waters that might be affected the proposed action. On page 3-7, the EA states "Three springs are present within 5 miles of the AOI. These include Rodeo Creek, Chimney Spring, and Painted Rock Spring". This statement is wrong. Sheep Pass Spring is 3.6 miles from the project area and not included in this inventory. Stag Spring is 5 miles from the project area and San Emido Spring is about 5.2 miles from the project area. All three of these springs are on the PLPT Reservation. In addition there are other springs in the area that are within 5 miles of the project area that are not included in this inventory. On Page 3-33; the EA states "Effects on surface water quality are unlikely because there are no perennial streams or other surface waters in the project area." This statement is erroneous; there are perennial springs within the project area.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins. Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Surface water	The EA failed to adequately discuss the potential impact on wetland and riparian areas. In Table 3-2, the EA makes a false statement that wetlands and riparian zones are "Not Present A project area habitat inventory (BLM 2020a) determined that wetlands and riparian areas are not present". The biological baseline resource document (BLM 2020a) does not mention wetlands and the discussion of riparian areas is inadequate. Section 3.5 of the Hyrdrogeologic Evaluation refers to the wetlands that exist just west of the existing facility and riparian areas exist around perennial springs in the area.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins. Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Surface water	(Hydro Report, Section 3.3.3 Surface Water, San Emidio Desert, page 3-7) The Hydro Report states that there are three perennial springs within 5 miles of the Project area with a reference to Hydro Report Table 4. Table 4 in the Hydro Report does not appear to list any springs. Furthermore, there are several other springs within the portion of the Reservation that extends into the San Emidio Desert Basin that are not mentioned in the Hydro Report. Figure 2 attached to this Technical Memorandum shows springs in the San Emidio Basin (on the Reservation) that should be included in the Hydro Report.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins. Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Surface water	All Nevada water laws must receive full compliance. All water used on a project must be permitted by the State Engineer's Office. All waters of the State belong to the public and may be appropriated for beneficial use pursuant to the provisions of Nevada Revised Statutes (NRS) Chapters 533 and 534 and not otherwise. The State Engineer must permit all water used on the described project.	Comment noted
Surface water	Ensure that any water used on a project for any use shall be provided by an established utility or under permit or temporary change application or waiver issued by the State Engineer's Office with a manner of use acceptable for suggested projects water needs.	Comment noted
Surface water	Include in the FEA safety plans and measures for unanticipated flooding events, especially as it pertains to the Project's infrastructure components. Discuss potential mitigation for any impacts to desert washes, playas, and vegetative communities.	Mitigation measures are included in Section 3.3.1 of the Revised Draft EA. Additional analysis has been included in the Draft EA and Hydrogeologic Evaluation regarding precipitation patterns and associated runoff.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Surface water	(Hydro Report, Section 3.3.3 Surface Water, Pyramid Lake, page 3-7) The Hydro Report states that the waters of the Pyramid Lake are hydrologically distinct from the surface and groundwater resources north of the Pyramid Lake basin, including the San Emidio Desert, based on TDS, salinity, and pH levels of the Pyramid Lake water. This statement is made without scientific bases and does not recognize the various sources of water that contribute to TDS, salinity, and pH in the Pyramid Lake that are not present as contributing sources to the San Emidio surface and groundwater resources.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Additionally, the BLM and PLPT have engaged in subsequent government-to-government consultation and entered into a data sharing agreement through which the PLPT has provide relevant hydrology data to the BLM for inclusion in the EA analysis.
Surface water	(Hydro Report, Section 3.5 Jurisdictional Water, page 3-7) Section 3.5 of the Hydro Report refers to "…approximately 115 acres of freshwater emergent wetlands that may be present on the floor of the San Emidio Desert…[that] may be considered jurisdictional Wetlands and Other Waters of the US by the US Army Corps of Engineers" and concludes that coordination with the USACE would be necessary to determine the jurisdictional status of the wetlands. However, Table 3-2 of the EA shows that "Wetlands - Riparian Zones are Not Present. A project area habitat inventory (BLM 2020a) determined that wetlands and riparian areas are not present." The conflicting statements made in the EA and the Hydro Report concerning the existence and status of wetlands and riparian areas should be reconciled.	The revised Draft EA includes a stipulation to obtain a USACE permit, if applicable.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Surface water	Figure 4 (Points of Diversion), as referenced in Sections 3.3.3 (Surface Water) and 3.4 (Existing Water Rights) of the Hydrogeologic Evaluation depicts water rights permit locations far beyond the locations identified within the five-mile area of investigation for the technical report (BLM 2020c). Sage Hen Springs, which is over 20 miles from the Project location and therefore has no connection to the proposed Project, is also depicted and mentioned, however, it is unknown why this spring received mention in the technical report and in Figure 4 (BLM 2020c). Additionally, there are several other Points of Diversion located outside the 5-mile radius depicted in Figure 4, several Points of Diversion easily identified on the Nevada Division of Water Rights mapping application as outside the 5-mile radius but not depicted in Figure 4, and at least one Point of Diversion listed in Table 5 (Points of Diversion within 5 Miles of the Project) but not depicted in Figure 4 (BLM 2020c). With these points in mind, and in an effort to clarify the relevance of identified Points of Diversion to the proposed Project, Ormat recommends clearly identifying within Figure 4 all Points of Diversion listed in Table 5 (Points of Diversion within 5 Miles of the Project) and labeling by permit number, and denoting within the text of the Hydrogeologic Evaluation the importance of the identified permits with respect to perceived impacts. If there are no perceived impacts to these locations, Ormat recommends removing the references from the figures, tables, and Hydrogeologic Evaluation altogether.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including points of diversions.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Threatened and Endangered Species	The EA erroneously dismisses the possibility for possible adverse impacts to Endangered species. On page 3-6 in Table 3-2, the EA states "No threatened, endangered, candidate, or proposed species or designated critical habitat are present in or near the project area and would therefore not be affected by Alternative A (BLM 2020a)." This statement is not supported by any factual information. And then this section continues with saying "There were concerns raised during scoping regarding the potential connectivity of the San Emidio geothermal reservoir and surface water in Pyramid Lake and that Alternative A could affect Lahontan cutthroat trout and cui-ui in Pyramid Lake. See analysis for Issue 2 (Section 3.3.3) and the Hydrogeologic Evaluation (BLM 2020b), which indicate that geothermal fluid flows northward following fault structures along the eastern boundary of the San Emidio Valley and there is no connectivity between the San Emidio geothermal reservoir and Pyramid Lake. Accordingly, Alternative A would have no potential to affect threatened or endangered species in Pyramid Lake or the Truckee River." Not all of the springs in the area have been inventoried for endangered species and the research presented in BLM 2020a is not conclusive that there is not any hydrologic communication between San Emidio and Pyramid Lake. Especially since the water table in San Emidio is higher than the surface level of pyramid lake, it would seem that the hydrologic gradient would flow toward Pyramid Lake. On Page 4-1 the EA discounts the possibility of any endangered species be affected by the proposed development with this statement: "Current surveys have indicated that ESA-listed species are not found in the project area." Since the EA only recognized 3 springs in the area and in reality there are several more, recognized in this EA, it would appear that the other springs that have not been inventoried in this EA might have endangered species inhabiting them, such as mollusks (snails).	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Monitoring data would inform the need for any potential mitigation related to threatened, endangered, candidate, or proposed species, or designated critical habitat.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Water Resources	There are four hydrologic systems that could be impacted by the proposed geothermal development at San Emidio. (1) Subsurface freshwater ground water aquifers could be damaged by overproduction and or poorly designed wells. (2) Surface water (and springs) could be impacted by over production. (3) Known geothermal systems in the Pyramid lake basin might be affected and (4) undeveloped geothermal resources that might exist along the Sweetwater fault on the PLPT Reservation in the San Emidio basin could be significantly affected by the proposed development.	Comment noted
Water Resources	The Hydrologic baseline data in the report did not include included or characterize all freshwater surface sources and subsurface groundwater well data in the project area. On page 37 the reports states that "Three perennial springs are present within 5 miles of the Project area: Rodeo Creek, Chimney Spring, and Painted Rock Spring (see Table 4)". This statement is erroneous, Sheep Pass Spring on the PLPT reservation is only 3.6 miles from the project area and Jackass spring is only 4 miles west of the AOI. Stag Spring is 5 miles from the project area and San Emido Spring is about 5.2 miles from the project area both of which are within the San Emidio hydrologic basin and located on the PLPT reservation. In addition, Table 4 has nothing to do with Springs. Although Stag and San Emido springs are just outside of the arbitrary 5-mile buffer (Figure 1 of Hydrogeologic Evaluation), they should be included the Hydrogeologic study since they are within the San Emidio hydrologic basin and could be affected by the proposed activity.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Water Resources	(EA, Section 3.2.1 Water Resources, page 3-7) The EA includes two (2) paragraphs under the heading "Water Budget." However, a water budget is missing from this section of the report. The Water Budget section of the report discusses an annual estimate of 4.2 inches of precipitation per year for the San Emidio Basin, cites 7,186 acrefeet of existing groundwater usage in the basin, and states the basin perennial yield is 4,600 acrefeet per year. The second paragraph of the section entitled Water Budget concludes with the statement: "It can be inferred that the excess recharge due to precipitation is counterbalanced by discharge due to groundwater uses and water uptake by vegetation." The EA should provide a proper analysis for a water budget and explain how the proposed Project will affect the existing water budget.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert. The revised Hydrogeologic Evaluation includes a revised water budget analysis.

Comments on Public Draft EA 1

Comment Code Name	Comment Text	Response
Water Resources	The project may be subject to BWPC permitting. Permits are required for discharges to surface waters and groundwaters of the State (Nevada Administrative Code NAC 445A.228). BWPC permits include, but are not limited to, the following: -Stormwater Industrial General Permit -De Minimis Discharge General Permit -Pesticide General Permit -Drainage Well General Permit -Temporary Permit for Discharges to Groundwater's of the State -Working in Waters Permit -Wastewater Discharge Permits -Underground Injection Control Permits -Onsite Sewage Disposal System Permits -Holding Tank Permits Please note that discharge permits must be issued from this Division before construction of any treatment works (Nevada Revised Statute 445A.585). For more information on BWPC Permitting, please visit our website at: http://ndep.nv.gov/bwpc/index.htm. Additionally, the applicant is responsible for all other permits that may be required, which may include, but may not be limited to: -Dam Safety Permits - Division of Water Resources -Well Permits - Division of Water Resources -401 Water Quality Certification - NDEP -404 Permits - U.S. Army Corps of Engineers -Air Permits - NDEP -Health Permits - Local Health or State Health Division -Local Permits - Local Government	Comment noted

Comments on Public Draft EA 1		
Comment Code Name	**Comment Text**	**Response**
Water Resources	On Page 3-7 of the Hydrogeologic Evaluation, it states that "The TDS, salinity, and pH levels at Pyramid Lake indicate it is hydrologically distinct from surface and groundwater resources north of the Pyramid Lake basin, including the San Emidio Desert" but does not present the data to support this. And how do you compare ground water to surface water, especially when Pyramid Lake is sourced primarily from the Truckee river. In 1988, one year after the San Emidio power plant went on production, the water table was at an elevation of about 4044 feet above sea level, 6 feet below ground level (AMOR II, 1988). By 1994 it had dropped to an elevation of 3923 feet above sea level, 142 feet below ground level (Pruett 1994). The elevation of pyramid lake is 3792 feet above sea level and therefore, there is probably a significant amount of recharge of fresh water from San Emidio into Pyramid lake along permeable fault zones and or through permeable geologic units (volcaniclastic rocks), as described in the Hydraulic Evaluation on page 4-10.	The EA and Hydrogeologic Evaluation have been revised to clarify existing hydrology and geologic conditions in the San Emidio Desert and surrounding basins, including clarifications regarding the potential hydrological connectivity (or lack there of) between the San Emidio and Pyramid Lake Basins. Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be coordinated between Ormat and BLM (and PLPT as applicable). Monitoring data would inform the need for any potential mitigation related to threatened, endangered, candidate, or proposed species, or designated critical habitat.
Comments on Public Draft EA 2		
Public Outreach	The Tribe has not had sufficient time since BLM's November 29, 2020 notification of availability of the Revised Draft EA to prepare full and complete comments. The Revised Draft EA grew from 138 pages to 264 pages, and the draft hydrogeologic report grew from 47 to 60 pages. The Tribe requests that the BLM provide an additional period of time for the Tribe to prepare and submit complete comments on the Revised Draft EA. Nonetheless, the Tribe submits this letter, which includes the enclosed additional technical comments prepared on behalf of the Tribe and submitted as part of the Tribe's comments on the Revised Draft EA.	During consultation meetings between BLM and PLPT resource staff in December 2020 and January and March 2021, the BLM offered PLPT additional time to provide further comments on the EA.

Comments on Public Draft EA 2

Comment Code Name	Comment Text	Response
Public Outreach	The Tribe requested DEMD to provide additional feedback on the revised draft EA and Hydrogeologic Evaluation. Due to the short commenting period, DEMD's review was handicapped. DEMD agrees with the comments and listed deficiencies from the two engineering consulting firms, Stetson Engineers Inc. and Ehni Enterprises, Inc., that have been submitted on behalf of Pyramid Lake Paiute Tribe.	Comment noted.
Public Outreach	Substantially all the comments submitted by the Tribe and by Stetson on behalf of the Tribe, in regard to the original EA and the original Hydro Report were given one or both of the following generic responses: "The EA and the Hydrological Evaluation have been revised to clarify existing geological conditions in the San Emidio Desert and surrounding basins" "Required groundwater monitoring will provide additional data regarding potential interconnectivity and inform applicable mitigation measures to be collected between Ormat and BLM (and PLPT as applicable)." The Tribe's comments were very specific and referenced specific pages and sections of the original Draft EA and Draft Hydro Report where BLM statements were made or where BLM Report figures could be found that the Tribe's comments applied to. Conversely, the BLM's responses to the Tribe's comments (see above and Appendix H of the Revised Draft EA) are simple (one-sentence), generic, and repeated statements, made without specifically addressing the original comment, and without any reference to a specific location in the Revised Draft EA and/or Revised Hydro Report where the "clarification" may be found that allegedly addressed the Tribe's original comments.	Comments submitted by the PLPT and other commenters on the original Draft EA resulted in extensive revisions to the hydrogeologic evaluation. Because of the comprehensive nature of the revisions, BLM's comment responses indicated that the evaluation had been substantially revised rather than indicating changes on specific pages. Changes in the EA made from the original EA to the second draft EA were clearly indicated with highlighted text and were predominately in Section 3.3.3 to reflect changes to the hydrogeologic evaluation. Changes from the second public draft EA to the Final EA are similarly highlighted in the EA document.

Comments on Public Draft EA 2

Comment Code Name	Comment Text	Response
Public Outreach	These review comments are prepared on behalf of the Pyramid Lake Paiute Tribe (PLPT) by Wm. J. Ehni, consulting geologist. I would like to mention that there has not been enough time to review and comment on all issues that I believe could impact resources belonging to the PLPT. The revised EA document contains new information and has been expanded form 138 pages to 264 pages. The Hydrogeologic report has a considerable amount of new data and was expanded from 47 pages to 60 pages.The short comment period for reviewing this revised draft EA does not allow enough time to address all of the deficiencies of the draft monitoring program (Appendix G of the revised EA).	During consultation meetings between BLM and PLPT resource staff in December 2020 and January and March 2021, the BLM offered PLPT additional time to provide further comments on the EA.
Government-to-Government consultation	As you are aware, the Bureau of Land Management ("Bureau") has unique obligations to consider and protect all Tribal trust resources. See e.g. Presidential Memorandum on Government-to-Government Relations with Native American Tribal Governments (April 29, 1994); Executive Order No. 13007 (May 24, 1996) (implementing policy to protect and preserve Indian religious practices and sacred sites on federal lands); Secretarial Order No. 3206 (June 5, 1997) (outlining Department of the Interior principles regarding American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act); Executive Order No. 13175 (November 6, 2000) (Consultation and Coordination with Indian Tribal Governments); Secretarial order No. 3342 (October 21, 2016) (Identifying Opportunities for Cooperative and Collaborative Partnerships with Federally Recognized Indian Tribes in the Management of Federal Lands and Resources). Pursuant to these and other authorities, the Tribe requests formal government-to-government consultation with the Bureau with respect to the Project, and its impacts on Tribal trust resources, prior to any final decision by the Bureau.	The BLM takes government-to-government consultation seriously and has engaged in consultation with the PLPT several times on this project, starting in January 2020. The BLM and PLPT participated in a government-to-government consultation in December 2020, January 2021, and March 2021, following the release of the second draft EA. During esach meeting, the BLM committed to ongoing meaningful consultation with PLPT resource specialists and the Tribal Council to address concerns related to the EA, Hydrogeologic Evaluation, and groundwater monitoring plan.

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Government-to-Government consultation	The Tribe provided highly confidential and sensitive proprietary data to the BLM prior to the release of the Revised Draft EA. That information does not appear to have been considered by BLM in the Revised Draft EA. The Tribe hereby offers to discuss that information with the BLM, and to assist in interpreting it as necessary, during our government-to-government consultation meetings.	The BLM appreciates the Tribe providing the data and offering to discuss it. BLM resource specialists reviewed the data when it was received and determined that it was consistent with the data already included in the hydrogeologic evaluation and EA. Because of the proprietary nature of the data, the BLM did not include reference to the data in the EA or supporting documents.
Cumulative impacts	In chapter four, other multiple-use actions are discussed: what are these projects? Has BLM considered the cumulative impacts of this project, geothermal and transmission corridor projects proposed to the north and south, and these additional actions? In addition, improper livestock and wild horse and burro grazing post "restoration activities" may negate any potential benefits to soil structure or vegetation communities.	Table 3-13 in the revised draft EA lists the past, present, and reasonably foreseeable projects the BLM considered in the cumulative effects analysis. Projects listed include existing and proposed geothermal and transmission infrastructure projects in the project vicinity. Rangeland Management was identified in the cumulative effects section of the document under the list of past, present, and reasonably foreseeable future actions" in the comment response. BLM management for WHB and livestock grazing post-restoration is outside the scope of this project.

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Cumulative impacts	The Cumulative Effects section of the Revised Draft EA states: "Geothermal utilization [at the proposed project location] would have the potential to contribute incrementally to effects on resources in the analysis area. Long-term contributions would occur if geothermal fluid utilization changed groundwater aquifer quality or quantity. This could affect water quality or availability in the San Emidio Desert and adjacent groundwater basins for wildlife, livestock, wild horses and burros, and water rights holders." (Revised Draft EA, page 3-56). Additionally, the Revised Hydro Report states that the geothermal system at the proposed project is "likely produced by conductive faults that provide pathways for fluid convection" (Hydro Report, Proposed Project, page 4-10). As shown in Figure 2 attached to this Technical Memorandum, there are two (2) faults that extend from the Pyramid Lake into the San Emidio Desert Basin and into the area proposed for geothermal well production. Based on the admitted potential for the proposed Project to affect water quality or availability in the San Emidio Desert and adjacent groundwater basins, coupled with the fault connectivity that exists between the Pyramid Lake and the proposed geothermal production area in the San Emidio Desert Basin, the proposed Project would very likely effect the Tribe's resources, including undeveloped groundwater and geothermal water resources in the San Emidio Desert Basin, and groundwater and surface water resources in the Pyramid Lake Valley Basin, including the Pyramid Lake. SEE ATTACHED PDF for figure titled: HYDROGRAPHIC BASINS IDENTIFIED BY THE NEVADA DIVISION OF WATER RESOURCES IN THE VICINITY OF PYRAMID LAKE SEE ATTACHED PDF for figure titled: PROPOSED SAN EMIDIO II GEOTHERMAL PROJECT (ORMAT)	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks. Additionally, the pending decision record (DR) will require the proponent to develop a final hydrologic monitoring plan in coordination with the BLM within one year. The purpose of the final monitoring plan would be to monitor potential quantity and quality impacts to the freshwater aquifer in San Emidio Desert basin including water resources on Reservation land as determined through consultation with the Tribe. The BLM will have final approval of the monitoring plan.

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Cumulative impacts	Why is the cumulative effect study area (CESA) map not included in the hydrogeologic report? Figure A-10 in the revised draft environmental assessment, the CESA includes the entire San Emidio hydrologic basin whereas the 5-mile buffer maps in the Hydrogeologic report conveniently misses a large portion of the PLPT reservation. Why does the CESA not extend all the way to Pyramid lake along the Sweetwater fault? The warm spring 27/22-16a1 (Table 4 in the hydrogeologic report) on the southwest end of the Sweetwater fault could be affected by the proposed development and therefore should be included in the CESA. In the Hydrogeologic report, why is the 5-mile buffer around the Area of Interest on Figure 7 not the same as shown in Figures 1 and 9? Geothermal and water resources could be impacted more than 5 miles from the project boundary and as noted above a revised and enlarged CESA should replace this arbitrary 5-mile buffer. The discrepancies of the outline of the 5-mile buffer between Figure 7 and Figures 1 and 9 need to be resolved or the 5-mile buffer replaced with the CESA map.	The CESA for the EA is the viewshed for the AOI and the transmission line. The BLM used a five mile buffer from the AOI in the Hydrogeologic Evaluation; the BLM concluded that a five mile buffer was sufficient for providing a geologic and hydrologic context for the project. In many instances, to provide additional context, the hydrogeologic evaluation discusses geologic and hydrologic conditions beyond the five mile buffer (such as surfance and groundwater and geothermal resources on the PLPT Reservation).
Level of NEPA analysis (EA vs. EIS)	The Tribe requests that BLM proceed to a full environmental impact statement for the Project because of the obvious threat the Project poses to the Tribe's resources.	If the BLM determines that the proposed project, with appropriate mitigations, would not result in significant environmental impacts, the agency would be prepared to sign a FONSI and Decision Record for the EA. If such a conclusion could not be made, then the BLM would evaluate the need for an EIS.

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Monitoring and adaptive management	The draft plan identifies the monitoring locations, frequency, duration, and constituents for the proposed action. Under this plan, monitoring will occur at a quarterly frequency for the first year of construction and operations after which the frequency of monitoring will be re-evaluated. EPA is concerned that the short duration of the initial monitoring period may not capture trends or define a baseline from which potential project impacts could be determined. Additionally, the draft plan does not describe the action levels or mitigation measures that may be used in either case to remedy groundwater quantity or quality concerns. Such action levels are essential to ensure investigation and mitigation occurs prior to exceedance of standards that are protective of water quantity and quality. Recommendations: We continue to recommend that the monitoring plan include action levels or thresholds in order to implement potential mitigation and that the plan detail specific mitigation measures that may be implemented should the project result in impacts to surrounding groundwater resources. During the initial monitoring period (construction and year one of operations), we suggest monitoring at an increased frequency in order to determine an appropriate baseline for groundwater quantity and quality for the project vicinity. If an increased frequency cannot be accomplished, we recommend monitoring at the quarterly frequency for an increased duration.	Since the release of the second Draft EA, the BLM has been coordinating with the PLPT's resource specialists and Ormat top develop a meaningful and enforceable water monitoring plan. The proposed monitoring plan is included as an appendix to the Final EA. The monitoring plan identifies groundwater and surface water monitoring locations and parameters. Monitoring data will identify whether potential impacts occur from the proposed action and will inform potential management responses.

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Monitoring and adaptive management	The following are DEMD's main comments and recommendations on the revised draft EA and Hydrogeological Evaluation. For additional information, please reference the consultant's reports in appendix A. 1. More time should be provided to comment and review the revised documents 2. Implementation of 3 or more monitoring wells near or on PLPT's reservation boundary with Tribal input on location. This program would monitor; a. Water chemistry and quality b. Hydraulic head c. Hydraulic gradients d. Temperatures e. Investigate and implement chemical tracers program from the monitor wells to producers 3. The Revised EA did not adequately determine hydrologic impacts on the PLPT Reservation and does not implement an adequate monitoring program to protect the PLPT water rights	During consultation meetings between BLM and PLPT resource staff in December 2020 and January and March 2021, the BLM offered PLPT additional time to provide further comments on the EA. Since the release of the second Draft EA, the BLM has been coordinating with the PLPT's resource specialists and Ormat top develop a meaningful and enforceable water monitoring plan. The proposed monitoring plan is included as an appendix to the Final EA. The monitoring plan identifies groundwater and surface water monitoring locations and parameters. Monitoring data will identify whether potential impacts occur from the proposed action and will inform potential management responses.
Other laws	All Nevada water laws must receive full compliance. All water used on a project must be permitted by the State Engineer's Office. All waters of the State belong to the public and may be appropriated for beneficial use pursuant to the provisions of Nevada Revised Statutes (NRS) Chapters 533 and 534 and not otherwise. The State Engineer must permit all water used on the described project.	Comment noted. The BLM acknowledges that the project proponent would be required to comply with all applicable Nevada water laws.
Water Resources	Water for Construction Projects Ensure that any water used on a project for any use shall be provided by an established utility or under permit or temporary change application or waiver issued by the State Engineer's Office with a manner of use acceptable for suggested projects water needs.	Comment noted. The BLM acknowledges that the project proponent would be required to comply with all applicable Nevada water laws.

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Groundwater	Wells and Boreholes Any drillholes (water or monitor wells or boreholes) that may be located on either acquired or transferred lands are ultimately the responsibility of the owner of the property and must be plugged and abandoned as required in Chapter 534 of the Nevada Administrative Code. A waiver for the use of groundwater from a new or existing water well may be allowed for the exploration phase, which may include drill pad construction, dust control/road work, oil and gas well and test well construction, and miscellaneous uses associated with this phase; however, a water right permit is required for any subsequent use of water beyond the exploration phase including, but not limited to, water used for the hydraulic fracturing process during the oil and gas well development stage.	Comment noted. The BLM acknowledges that the project proponent would be required to comply with all applicable Nevada water laws.
Groundwater	The Tribe continues to have major concerns with impacts to its federal reserved groundwater rights within the Reservation boundary. More than 23,000 acres of the Reservation overlies groundwater and geothermal resources in the San Emidio Desert Basin. The Tribe has federal reserved rights to the resources in the San Emidio Desert Basin, including several springs, geothermal resources, and underground water. These concerns have not been adequately addressed in the Revised Draft EA, because it focuses on dismissing the Tribe's concern regarding the fault connectivity that exists between the resources in the San Emidio Desert Basin and the Pyramid Lake hydrographic basin. The Revised Draft EA also does not provide adequate data or analyses to justify dismissal of the Tribe's concerns with the impact on the Tribe's federal reserved water rights and other resources within the Pyramid Lake hydrographic basin, which will be adversely affected by the proposed Project.	BLM hydrology and geology specialists have reviewed the best available science, including data provided by the PLPT, and have determined that there is no conclusive evidence that suggests the groundwater and geothermal resources in the project area (in the San Emido Desert) are connected to those in the Pyramid Lake Basin. The Final EA includes a proposed water monitoring plan, which identifies groundwater and surface water monitoring locations and parameters. Monitoring data will identify whether potential impacts occur from the proposed action and will inform potential management responses.

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Groundwater	The groundwater reservoir in the area is at shallow depths with relative poor quality. The groundwater quality would deteriorate further with the additional pumping for the Project. Any additional exploitation of groundwater under the proposed Project would lower the water table, and possibly recede, underneath the Reservation lands within the San Emidio Desert Basin. This would result in the loss of an irretrievable resource to the Reservation and the Tribe. These concerns have not been adequately addressed in the Revised Draft EA.	BLM hydrology and geology specialists have reviewed the best available science, including data provided by the PLPT, and have determined that there is no conclusive evidence that suggests the groundwater and geothermal resources in the project area (in the San Emido Desert) are connected to those in the Pyramid Lake Basin. The Final EA includes a proposed water monitoring plan, which identifies groundwater and surface water monitoring locations and parameters. Monitoring data will identify whether potential impacts occur from the proposed action and will inform potential management responses. No additional water rights would be required for the proposed project, and water from the geothermal aquifer would be used in a closed-loop binary geothermal energy generation process, and injected back into the geothermal reservoir to ensure longevity and renewability of the geothermal resource. Continued monitoring under the State of Nevada Underground Injection Control (UIC) program would ensure water quality impacts from geothermal development do not occur in association with the proposed project. Additionally, the pending decision record (DR) will require the proponent to develop a final hydrologic monitoring plan in coordination with the BLM within one year. The purpose of the final monitoring plan would be to monitor potential quantity and quality impacts to the freshwater aquifer in San Emidio Desert basin including water resources on Reservation land as determined through consultation with the Tribe. The BLM will have final approval of the monitoring plan.

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Groundwater	The Tribe has previously requested a complete evaluation of the well construction, groundwater and thermal water movement, and impact to the Tribe's Trust resources, which have not been completed with the Revised Draft EA. The increased pumping could also result in reversing the groundwater gradients from the playa and older alluvial deposits into fresh water zones. In addition to pumping, the cone of depressions from the proposed new wells would directly impact the Tribe's groundwater and geothermal resources within the Reservation. Most likely, the spent geothermal water would be injected in places that would not offset the cones of depression. This concern has not been addressed in the Revised Draft EA. The Tribe reiterates its request that Bureau require Ormat to conduct an investigation, including pump tests, hydrological modeling, and temperature analysis, among other research, to quantify the Project's impacts--both from withdrawal and reinjection--on the Tribe's federal reserved groundwater rights within the San Emidio Basin and the Pyramid Lake Basin, and within other adjacent areas. This investigation should include an analysis of impacts to both the Tribe's geothermal resources and impacts to groundwater in the alluvium.	Relatively steady groundwater-level declines (approximately 15 feet basin-wide) have occurred in the San Emidio Desert alluvial aquifer since the 1960's. Please refer Figure 6 on Page 3-7 and Page 3-11 of the Hydrogeologic Evaluation regarding declining water levels in San Emidio Desert. Groundwater-level declines in the freshwater alluvial aquifer have been relatively steady both before and after geothermal power generation commenced in the San Emidio Desert in the 1980's. This suggests operational management of the geothermal resource (e.g., pumping and injection within the geothermal reservoir) does not appear to affect water levels in the freshwater aquifer."

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Comment Code Name	Comment Text	Response
Groundwater	Why is there no water table data for the existing geothermal wells? Establishing a baseline map of the potentiometric surface is important and should include more data from the project area where there are production wells. Historical data for the static water table from the production and injection wells should be included in the EA or at least the Hydrogeologic report. Figure 5 of the Hydrogeologic report contains some regional data which is important, but to evaluate how much of an impact there will be to the groundwater it is important to know how the existing production has impacted the water table. The Potentiometric Surface map on Figure 5 of the Hydrogeologic report appears to use data from Table 2 and on first appearance would appear to be data from approximately the same time. However, by comparing the map with the data in Table 2 it appears that some of the data spans a time form 1968 to 1996. One apparent typo in Table 2 is for well 29/23-29a1 with a static water table at 11.93 feet in 1996, which is identical to the water table reported by Glancy an Rush in 1968 for this well.	The geothermal resource is believed to mix with near surface groundwater along the San Emidio fault. Evidence of hydrothermal alteration (see Section 4.1) suggests a geothermal outflow zone occurs at a depth of between approximately 115 and 328 feet below ground surface along the San Emidio fault (Rhodes 2011; Folsom et al. 2020). Hence, the potentiometric surface map and hydrographs for the San Emidio Desert alluvial aquifer presented in the Hydrogeologic Evaluation (e.g., figures 5 and 6) represent static water level conditions near the proposed project over time. The typo in Table 2 of the Hydrogeologic Evaluation regarding the static water level recorded by Glancy and Rush in 1968 at well 29/23-29a1 has been corrected.

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Comment Code Name	Comment Text	Response
Surface water	The EA includes references to various springs noted on topographic maps in the mountain ranges surrounding the San Emidio Basin near the proposed Project area. In regard to the existence of the springs, the EA states: "These springs [named springs], as well as several unnamed springs, occur several hundred feet above the valley floor and are likely derived from local perched water tables." This statement is unsupported by reference to any evidence that there are perched water tables or geologic formations that crate perched water tables, to produce the spring discharges. As shown in Figure 2 attached to this Technical Memorandum, several of the springs in the canyons on the Reservation are aligned with the faults through the canyons (see springs in Sweetwater and Hells Kitchen Canyons). Furthermore, there are springs at lower elevations along the faults through those canyons that are present near the Pyramid Lake and at elevations below the San Emidio Desert Basin where the proposed Project wells will be located. If the springs are fault-controlled, and the faults provide pathways for fluid convection for the geothermal system at the proposed Project (Revised Draft Hydro Report, page 4-10), then the proposed Project has a potential to adversely effect the flow of springs on the Reservation.	The occurrence of springs in drainages along inferred or concealed faults running between San Emidio Desert and Pyramid Lake Valley alone does not prove a connection exists between groundwater and geothermal resources in the two basins. Such a connection should be supported by spring water chemistry being representative of the freshwater aquifer or geothermal resource they are presumably connected to. However, the water type recorded from springs along inferred and/or concealed fault alignments between San Emidio Desert and northern Pyramid Lake Valley (i.e., spring 28/23-31a1 in San Emidio Canyon and spring 27/22-16a1 in Sweetwater Canyon, respectively) are calcium-bicarbonate type, while the San Emidio Desert freshwater aquifer and/or geothermal resource is sodium-sulfate or sodium-chloride type. Additionally, specific conductance recorded from these springs (640 micro-mhos at the unnamed spring in 27/22-16a1 or less at San Emidio Spring in 28/23-31a1) is less than either the freshwater aquifer (685 to 43,500 micro-mhos) or the geothermal resource (5,700 to 7,400 micro-mhos). If these springs represented water from the freshwater aquifer or geothermal resource moving from San Emidio Desert to Pyramid Lake Valley, one would expect higher specific conductance resulting from water-rock interaction along the path of the "connecting" fault. The lower specific conductance exhibited at spring sites on the mountain blocks situated between San Emidio Desert and Pyramid Lake Valley supports these springs are more likely sourced locally by precipitation and/or snowmelt.

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Comment Code Name	**Comment Text**	**Response**
Surface water	What evidence is there for the springs in the mountain ranges to be derived from perched water tables? In the EA on page 3-7 in the section on surface water it states that "These springs, as well as several unnamed springs, occur several hundred feet above the valley floor and are likely derived from local perched water tables." Springs in the mountain ranges above the valley floor are most likely fault controlled and not derived from perched water tables. The recharge for a basin and range geothermal system is typically from the mountain ranges where the precipitation is higher. Therefore, if there is significant drawdown to the water table around the production field(s), it will place a higher demand on the natural recharge to the system reducing flow rates of freshwater springs in the recharge area (the mountains).	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks.

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Comment Code Name	Comment Text	Response
Geology	Of particular concern to the Tribe is the BLM's reference in the Revised Draft EA to a boundary line fault, which BLM alleges creates a barrier to the flow or connection of waters in the shared aquifer between the Project well locations and the Reservation portion of the aquifer(s). This new boundary line fault does not exist on any prior or historic geologic mapping of the area, and BLM relies only on the Project proponent's statement that it exists, but has not verified the data upon which the Project proponent claims to rely for the existence of this new and heretofore undiscovered fault. The Tribe rejects this claim and requests that the BLM take the requisite "hard look" into this matter that NEPA demands. The Tribe also restates its prior request that it receive any and all data with respect to the existence of this previously undiscovered boundary line fault.	It is unclear what statement in the Revised Draft EA this comment refers to. There is reference to faults which "likely form a boundary" included in the Draft Groundwater Monitoring Plan submitted by the proponent and included in Appendix G of the Revised Draft EA. That reference in Section 3.1 of the Draft Groundwater Monitoring Plan pertains to the geothermal resource at depth but concludes the extent of the geothermal system to the southwest is not clearly defined. This remark in the proponent's Draft Groundwater Monitoring Plan included as an appendix to the Revised Draft EA by no means supports an interpretation of a boundary line fault existing which "creates a barrier to the flow or connection of waters in the shared aquifer between the Project well locations and the Reservation portion of the aquifer(s)."

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Comment Code Name	Comment Text	Response
Geology	The Revised Draft EA does not provide a map showing the fault systems in the vicinity of the proposed Project. Figure 4 of the Revised Hydro Report does show the location of some faults in relation to the proposed Project, including references to Lake Range, San Emidio, and Empire Faults. Of note, there is no source cited for the faults depicted on Figure 4 of the Revised Hydro Report. As generally illustrated on Figure 4 of the Revised Hydro Report, the Lake Range fault extends from the proposed Project area to the Pyramid Lake in the Pyramid Lake Basin. Additionally, Figure 4 of the Revised Hydro Report shows both the Empire Fault and San Emidio Faults extending in a NE-SW direction from the proposed Project area, crossing the Pyramid Lake Reservation boundary, and terminating in the southwest portion of the San Emidio Basin that underlies the Reservation. These faults as mapped on Figure 4 of the Revised Hydro Report provide connectivity between the Tribe's resources underlying the Reservation portion of the San Emidio Desert Basin and the resources that the proposed Project will access.	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks.

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Geology	Figure 4 of the Hydro Report does not correctly represent the full extent of the fault identified as the Empire Fault. The full extent of the faults extending from the San Emidio Desert Basin to the Pyramid Lake Basin are provided on Figure 2 attached to this Technical Memorandum (faults in Figure 2 are based on Crafford, 2007). As shown on the attached Figure 2, there are two faults that extend from the San Emidio Desert Basin into the Pyramid Lake Basin. The southernmost fault extends from the proposed Project area through the San Emidio Canyon and a second fault to the north extends from the proposed Project area through the Sweetwater Canyon/Stag Canyon. The Sweetwater Canyon/Stage Canyon fault shown on the attached Figure 2 appears to correspond to the Empire Fault shown on Figure 4 of the Revised Hydro Report. The faults mapped by Crafford (2007) extend from the proposed geothermal Project into the Pyramid Lake Basin. Figure 4 in the Hydro Report should be corrected to accurately show all faults extending from the Pyramid Lake into San Emidio Desert Basin, and the conclusions of the Draft Hydro Report should be modified to acknowledge the faults as mapped by Crafford (2007) that create a connectivity between the San Emidio and Pyramid Lake Basins.	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks.

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Geology	What is the significance of the boundary faults mentioned on Figures 3 and 4 in Appendix G of the EA? Appendix G of the revised draft EA was not in the original draft EA. The San Emidio geothermal system is a typical fault-controlled basin and range geothermal system. Having a comprehensive understanding the geology of the geothermal system, including the faulting, is important for successful projects. These boundary faults are highlighted in two of the figures of Appendix G and it is unclear of their significance. Fluid migration along faults could substantially affect the PLPT geothermal and fresh water resources. The information supplied to the BLM via the data sharing agreement suggests Faulting could provide communication between the San Emidio and Pyramid lake. And that the Sweetwater fault (see Figure 1 and 2 below) and the Hells Kitchen fault could be possible conduits for this communication. The EA and Hydrogeologic report do not completely address the potential communication along these faults onto the PLPT reservation.	It is unclear what statement in the Revised Draft EA this comment refers to. There is reference to faults which "likely form a boundary" included in the Draft Groundwater Monitoring Plan submitted by the proponent and included in Appendix G of the Revised Draft EA. That reference in Section 3.1 of the Draft Groundwater Monitoring Plan pertains to the geothermal resource at depth but concludes the extent of the geothermal system to the southwest is not clearly defined. This remark in the proponent's Draft Groundwater Monitoring Plan included as an appendix to the Revised Draft EA by no means supports an interpretation of a boundary line fault existing which "creates a barrier to the flow or connection of waters in the shared aquifer between the Project well locations and the Reservation portion of the aquifer(s)."

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Comment Code Name	Comment Text	Response
Geology	Detailed geologic Maps by Faulds and Rhodes show faults that connect San Emido with PLPT tribal lands. The following figures have been compiled from published detailed geologic mapping by Faulds and Rhodes and regional geology by Crafford (2007). Figures 1 and 2 clearly demonstrate the concerns that the PLPT has regarding the potential degradation if tribal geothermal and water resources. SEE ATTACHED PDF for Figure 1: Detailed fault mapping by Faulds and Rhodes superimposed over Crafford's regional geologic map clearly shows the potential communication between the proposed San Emido expansion and the PLPT resources. The AOI appears to be "chopped" off on the southwest end even though supporting documents for the EA and Hydrogeologic report indicated that the geothermal anomaly is open-ended to the southwest. SEE ATTACHED PDF Figure 2: Geologic map (Crafford 2007) showing the location of the Sweetwater fault as mapped by Faulds (2013) on the PLPT reservation extending to the fault at San Emido mapped by Rhodes (2011). Table 4 of Hydrogeologic report includes the Sweetwater warm spring (27/22-16a1) which occurs at the southwest end of the Sweetwater fault. The temperature gradient holes shown as purple triangles are from the SMU geothermal data base. Gradient hole SED8 has a gradient of 152.88C/Km (8F/100ft) is in section 1 of T28N R22E. It does not appear that the SMU data was incorporated into the Hydrologic report (Tables 5, 6 and 7) or EA.	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks.

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Comment Code Name	Comment Text	Response
Geothermal Resources	Finally, the Revised Draft EA does not adequately analyze the Project's injection of the spent geothermal water back into the geothermal aquifer, which will have a negative impact on the Tribal trust resources by cooling the geothermal reservoir within the Reservation. The impact of how the injection fluid from this proposed expansion could impact the freshwater and geothermal resource located on the Reservation needs to be fully evaluated. While the Revised Draft EA now includes a nominal groundwater monitoring plan, that plan is sorely lacking.	In accordance with the Geothermal Steam Act as amended and the regulations at 43 CFR 3280, a Participating Area shall be established and royalties apportioned for that portion of the Geothermal Unit reasonably proven to produce geothermal resources or necessary to support production in commercial quantities such as pressure support injection wells. If future drilling and development proves that geothermal resources are being drained from federal or trust mineral lands, the remedy prescribed by regulation would be to review and expand the participating area and reapportion royalties. According to existing laws and regulations at 43 CFR 3210.16 it is the duty of the mineral owner to prevent or prove drainage by diligently drilling, and submit a request to expand the Participating Area.

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Comment Code Name	Comment Text	Response
Geothermal Resources	The Revised Draft EA states: "As described in the Hydrogeologic Evaluation (2020b), the presence or extent of connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unknown." (Revised Draft EA, page 3-37). While this statement is a significant change from the statement made in the original Draft EA "...connectivity between the geothermal resources in the San Emidio Desert and adjacent undeveloped geothermal resources is unlikely," existing evidence, including information provided by BLM indicates the connectivity is very likely. The existing evidence for geothermal resource connectivity between the San Emidio and Pyramid Lake Basins includes the existence of faults connecting the basins as mapped by Crafford (2007) (see Figure 2 attached to this Technical Memorandum), the existence of the Lake Range Fault connecting San Emidio Basin to Pyramid Lake Basin (see Figure 4 in the Revised Draft Hydro Report), and fact that the larger Black Rock Geothermal Belt aligns and extends from the Black Rock Desert Basin, through the San Emidio Desert Basin, and continues to the Pyramid Lake, at which point the geothermal belt terminates at the Pyramid Lake fault (see Figure 2 of the Revised Draft Hydro Report).	The source for fault information in the vicinity of the proposed project shown in Figure 4 is cited in the text on Page 2-3 of the Hydrogeologic Evaluation as Rhodes 2011; Matlick 1995; Warren et al. 2018. The faults identified as Quaternary Faults in Figure 4 include selected Quaternary faults from a number of sources compiled in the QuaternaryFaultWesternUS.shp at: http://www.nbmg.unr.edu/geothermal/Data.html There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks.

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Comment Code Name	Comment Text	Response
Geothermal Resources	Regarding Fish Habitat, Native American Religious Concerns, and Wildlife (Threatened or Endangered Species), to support conclusions of "no potential affect," Table 3-2 of the Revised Draft EA includes statements that "The Hydrogeologic Evaluation (BLM 2020b) indicates that the groundwater systems in the San Emidio Desert and the Pyramid Lake Basin are not interconnected" and "[T]here is no connectivity between the San Emidio geothermal reservoir and Pyramid Lake." These statements conflict with the following statement found on page 3-7 of the Revised Draft EA: "As described in the Hydrogeologic Evaluation (2020b), the presence or extent of connectivity between the geothermal resource in the San Emidio Desert and adjacent undeveloped geothermal resources is unknown."	There is no known direct connection between the geothermal resource in the San Emidio Desert and groundwater resources in adjacent hydrographic basins, such as the Pyramid Lake Valley groundwater basin (Basin 81); thus, Alternative A in the EA is not anticipated to have effects on groundwater or geothermal resources in adjacent hydrographic basins. Table 3-2 in the EA has been revised to reflect conclusions cited in the Hydrogeologic Evaluation as noted by the commentor.

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Comment Code Name	Comment Text	Response
Geothermal Resources	(EA, page 3-53) The original Draft EA included the following statement in regard to cumulative effects: "Because there is a lack of connectivity between the geothermal resource in the San Emidio Desert Basin and undeveloped geothermal resources in adjacent hydrologic basins, Alternative A is not anticipated to prevent development of these resources in the future. Similarly, there is no direct connection between the geothermal resources in the San Emidio Desert and groundwater and surface water resources in the Pyramid Lake Valley basin; thus, there would be no contributions to cumulative effects on water quality or quantity in Pyramid Lake, including habit for listed fish species." The Revised Draft EA removed the portion of the above-referenced statement regarding the "lack of connectivity between the geothermal resource in the San Emidio Desert and undeveloped geothermal resources in adjacent hydrologic basins" and replaced that language with "[T]he best available science indicates there is no direct connection between the geothermal resource in the San Emidio Desert and surface water resources in the Pyramid Lake Valley basin. Developing and implementing a water monitoring and reporting program would confirm the presence or absence of any cumulative effects on water quality or quantity in Pyramid Lake, including habitat for listed fish species." (underline added). This section of the Revised Draft EA leaves open the question of groundwater and geothermal connectivity between the San Emidio Desert Basin and the Pyramid Lake Basin	There is no evidence to suggest a substantial connection exists between the freshwater aquifer or geothermal resources in San Emidio Desert and Pyramid Lake Valley. Surface water in San Emidio Desert basin originates from precipitation and snowmelt on adjacent mountain blocks which eventually accumulates in drainages and flows towards the basin center (Glancy and Rush 1968). Groundwater recharge occurring along this pathway likely reports to the San Emidio Desert freshwater aquifer. Groundwater within the freshwater aquifer then flows north (Glancy and Rush 1968, NDWR 2020b) as does outflow from the geothermal resource (Folsom et al. 2020). Previous investigations (Glancy and Rush [1968] and Van Denburgh et al. 1973) confirm there is no firm evidence sizable quantities of groundwater move between San Emidio Desert and Pyramid Lake Valley through consolidated rocks. Additionally, the pending decision record (DR) will require the proponent to develop a final hydrologic monitoring plan in coordination with the BLM within one year. The purpose of the final monitoring plan would be to monitor potential quantity and quality impacts to the freshwater aquifer in San Emidio Desert basin including water resources on Reservation land as determined through consultation with the Tribe. The BLM will have final approval of the monitoring plan.

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Comment Code Name	Comment Text	Response
Geothermal Resources	When completed, approximately how much production (gpm) will there be from all of the producing wells in San Emidio? On page 2-3, section 2.1.1.3 Well Field, the EA states the Ormat is proposed 25 well and "total geothermal fluid production rates are expected to be approximately 8,400 gallons per minute (gpm) at 320 degrees Fahrenheit. Individual production well flow rates are expected to be approximately 4,200 gpm". This suggests that there will be only two production wells. In other Ormat documents, they predict 6,000 to 12,000 gpm per 12 Mw plant and therefore, the 24 megawatts that is being proposed will take 12,000 to 24,000 gpm.	Based on the North Valley Geothermal Development Project Utilization Plan (Ormat 2020) available on eplanning, Ormat is proposing to construct a 20 MW net (24 MW gross) binary design plant with an air-cooled heat rejection system. Ormat anticipates normal geothermal fluid production rates of approximately 9,620 gallons per minute (gpm) at 320°F but acknowledges production rates could vary between 6,000 and 25,000 gpm depending on need. Individual production well flow rates could be as high as approximately 4,200 gpm with a wellhead pressure of about 100 pounds per square inch gauge (psig). The existing San Emidio water cooled binary-plant has a current design capacity of 11.8 megawatts and a geothermal well production requirement of approximately 4,000 gpm (BLM 2010). Hence the resultant average geothermal production rate would increase to approximately 14,000 gpm.
Wildlife	In addition to the decline and receding of the water table, there would be impacts to springs on the Reservation within the San Emidio Basin. The area is inhabited by wildlife, including sage grouse, and tribally-protected Big Horn Sheep. Tribal members utilize the rangelands in the Lake Range for cattle grazing, for many of whom this is their sole source of income. These springs are essential to maintain the vegetation on the rangeland habitat as well as streams and wetlands. Any disruption of the water flow in these areas will have a devastating effect on the wildlife and cattle in the area.	Comment noted. The proposed groundwater monitoring plan would evaulate changes in springs and other water resources. Based on the monitoring results, the BLM would apply adaptive managmeent strategies to avoid, minimize, and mitigate impacts on water and associated wildlife resources.

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Comment Code Name	Comment Text	Response
General wildlife	It appears here that understanding the relationship between environmental characteristics and disturbance and presence or "absence" of either pale or dark kangaroo mouse is a main objective. However, the methods outlined do not go beyond data collection. Rather, this project seems to focus on collection of a large amount of data that will not be synthesized and potentially cannot be synthesized to allow scientifically defensible relationships between species and habitat conditions. This is the actual result that may help promote conservation of kangaroo mice-yet it is almost completely lacking in this plan. Data needs to be collected in a way that fosters analysis-the risk here is that methods inappropriate for analysis will be used throughout the project life. The utility of this data collection is unclear and may be more so because kangaroo mice can be very rare on the landscape. Failing to account for detectability may obscure relationships between occupancy and habitat suitability.In the introductory chapters, the lack of resources to do a mark-recapture study or to use an experimental approach is noted. However, plans to trap extensively at ten sites over five years are detailed. It is unclear what "lack of resources" entails.	The kangaroo mouse plan should collect data that could be analyzed. Recommend updating k-mice plan to help focus on how to collect scientically - valid data. Unclear how to account for detectability of k-mice and comment does not provide details on how to update plan to achieve this. Recommend incorporating information from this comment and add information in the plan to explain kangaroo mice can be very rare on the landscape and pull information from Hafner et al. 2008 & Hafner and Upham 2011 to support this. Agreed about the plan being unclear regarding the "lack of resources" for a mark-recapture study. If it is for mark-capture-recapture method of sampling k-mice, this is already built into the k-mouse protocol (on page 3 of 6). If a k-mouse is caught it would then be “marked” with a small stripe using a non-toxic sharpie each night in order to keep track of unique captures. If the “marked” k-mouse is caught in a subsequent night (of the 4 night trapping session), the “recapture” would be recorded on the data sheet. No other tissue sample or materials are needed if there is a recapture. So it is really unclear what this section is referring to by saying “resources required are not available”. Recommend updating k-mice plan to include experimental approach so the data can foster analysis, as stated in the comment.

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Comment Code Name	Comment Text	Response
General wildlife	While the word "mitigation" is used throughout Chapter 4, the actual activities described are unlikely to result in significant advances in habitat protection or restoration and, most importantly, yield any significant benefits for these species. Simply adding seed to xeric low-elevation areas or hand-planting may not lead to establishment of native vegetation communities as required by these species. Native species establishment may not even occur within a five-year period. The interim reclamation plans here, used without any pre-existing habitat targets for these two species, is questionable. Simply putting out native seed may not yeild acceptable restoration results for habitat specialists-especially when vegetation preferences of these two species in this region are not now clear and may never be made clear by project activities undertaken here. Some of this seed may not be commercially available and require on-site data collection. Even if "restoration activities" seemed a plausible solution, it must be buffered with an acceptable monitoring plan and timeframe. However, the design, collection, and synthesis of ecological and biological data does not seem robust enough to reveal the success or failure of seeding efforts. While seeding efforts to ameliorate habitat conditions for a poorly-understood habitat specialist may quickly become underwhelming, we urge caution during efforts to ameliorate soil compaction. Further justification for techniques and location for these activities should be described-this has never been used or suggested in kangaroo mouse habitat anywhere across the species' range. Do we have existing knowledge or a platform to acquire that knowledge within the next five years to complete an action in likely-sensitive habitat that would be the first of its kind? To take these activities without local understanding of populations, suitable soil conditions for either species, a robust monitoring plan and analysis method at treatment and control areas seems capricious and may harm these species. Changing soil characteristics where these species are currently found is not supportable.	The kangaroo mice plan identfies a five-year period of monitoring. It is recommended that this time-frame be extended to allow for more time to monitor efforts. It is unclear from the comment what other information or revisions may be needed to include in to the plan to allow for more robust ecological and biological data. Agreed that there is uncertainty with the soil de-compaction portion of the plan and that this technique is not detailed enough in the plan. Recommend removing the proposed soil de-compaction technique from the plan and focus on the effectiveness habitat restoration in disturbed areas within the project footprint.

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Comment Code Name	Comment Text	Response
General wildlife	Interim reclamation is necessitated in almost every EA/EIS and would be done regardless of DKM or PKM presence. Simply re-billing this existing requirement as mitigation seems disingenuous, especially considering the lack of actual knowledge about the species that exists or will be garnered here in this project. In restoration terms, BLM is not asking Ormat to do anything above what would be required for any other project.	Comment noted regarding interim reclamation. The applicant has committed to environmental protection measures within the EA (section 2.1.3), which include reclaiming temporarily disturbed areas as soon as possible.Restoration actions within the project area (including kangaroo mice habitat) would include reseeding. However, the applicant committed measures do not provide details on how the k-mice habitat would be avoided, disturbance minimized, or restored as needed. Therefore, there are required stipulations in the EA to provide for avoidance, minimization, and restoration actions within the project area. The required stipulations also identify the need for a monitoring plan to determine mitigation effectiveness.

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Comment Code Name	Comment Text	Response
General wildlife	In addition to meeting meaningful restoration targets, effective restoration needs to be based on a solid understanding of species' distribution throughout project area. If nearest species are outside the dispersal distance, then changing habitat in an area that is unavailable to kangaroo mice will not benefit local populations. Habitat alteration is extremely delicate and is the culmination of significant scientific understanding. Also, it is important to restate here and throughout that these species distribution models are not to be used at a fine scale and that there is significant bias in the model, simply because there has been no robust statewide collection of data for these species and these models have never been validated. It would be better if less time was spent discussing a foregone conclusion that habitat alterations will not help these species at all-instead effort should be put into derivation of meaningful knowledge and potential restoration targets that could be used across the multiple projects planned in predicted suitable and known occupied kangaroo mouse areas in northwestern Nevada.	Comment noted about the concern of habitat restoration efforts if species are not within the restoration areas. However, during baseline studies, two kangaroo mice were captured within the project area. The nearest species are within the project area and the focus of kangaroo mice plan is within project area. To be in compliance with BLM's Compensatory Mitigation IM-2019-018, the monitoring and mitigation activities for the project would need to be conducted within the power plant and transmission line project area unless the proponent volunteers to conduct monitoring and/or mitigation offsite. At this time, the proponent has not volunteered to conduct monitoring and/or mitigation offiste. Additionally, any proponent volunteered action proposed outside of the project area is non-enforcable by the BLM. Therfore, monitoring and mtigation activities are proposed within the project area footprint. As kangaroo mice were detected within the footprint, habitat restoration activities would be focused on kangaroo mice within the project and not outside.

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Comment Code Name	Comment Text	Response
General wildlife	We support and recommend habitat avoidance wherever possible-the potential for high impacts to these species here and in proposed concurrent regional projects should be underscored. We encourage consultants to ensure proper identification techniques for these species. They are difficult and rare to detect so having an individual in hand and correctly taking measurements and tissue samples is of utmost importance. We encourage biologists to consult with a mammologist and species expert. Project planners should understand the low detectability of these two species and the interference of this dynamic in allowing for a true understanding of species' absence. Trapping during prime environmental conditions at each site multiple times within a year should be implemented whenever possible. Modifications of project activities and goals are discussed on 4-1, "The Plan proposes to integrate and develop findings into appropriate mitigation measures, to offset proposed impacts on the species' habitat." Is there a process by which findings will be integrated? Will this require additional NEPA? Without a stated synthesis and analysis techniques, are plan "findings" defensible enough for incorporation, specifically when long-term and potentially irreversible habitat alterations may be proposed? While a pilot project to understand habitat requirements for species is a laudable goal, a stated objective to understand the ecological niche of kangaroo mice seems compromised by data collection with potentially poor methodology. Further kangaroo mouse pilot projects like this should be viewed with skepticism that they will ever yield species knowledge at the level needed for more precise and technical restoration options and mitigation strategies. Without more-appropriate, scientifically-based projects that yield robust conclusions, the likelihood of further protection requirements for these will likely only increase.	The plan has been updated to include recommendations that biologists consult with mammologist and species experts to assist in handling and correctly taking measurements/tissue samples. Language in the draft monitoring plan section 4-1 has been revised to reference BLM required stipulations rather than proposed mitigation previously found in the monitoring plan.

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Comment Code Name	Comment Text	Response
Land Use and Infrastructure	The Los Angeles Department of Water & Power (LADWP) has reviewed the project plan of development proposed by Ormat and has concluded it will impact LADWP's Transmission Line Right of Way (TLRW) at multiple locations including the use of the existing access roads that are operated and maintained by LADWP. The Right of Way Engineering Group, on behalf of LADWP's Power System, coordinated the review of the request and additional information will be required from Ormat before any developments are authorized within LADWP's TLRW subject to the following comments and conditions.	Comment noted. The EA has also been revised to note that the existing 500kV line is essential to the LADWP infrastructure system.
Land Use and Infrastructure	1) Ormat referenced herein shall pertain to its employees, agents, consultants, contractors, officers, patrons, or invitees of Ormat, or by any other of Ormat's affilliated entities. 2) The information provided, to date, is inadequate to properly review the proposed improvements within sections of LADWP's TLRW. We therefore reserve the right to comment until more detailed information is provided regarding the proposed project. Provide plans illustrating the LADWP TLRW boundaries within the proposed project. Include towers and clearances from the proposed transmission line. Also, provide grading plan and utility plans, including any other plans illustrating the impacts to LADWP's TLRW. If access roads are proposed, provide plans illustrating impacts to LADWP's access roads. The plans should include APNs, state plane coordinates, or use the Public Land Survey System to locate the developments impacting LADWP's TLRW. 3) Ormat is proposing to utilize the existing access roads to construct, operate, and maintain the proposed improvements. LADWP currently operates and maintains these existing access roads. Therefore, a joint agreement needs to be put in place to cover the cost for the future operations and maintenance of the existing access roads.	Comment noted. The EA has also been revised to note that the existing 500kV line is essential to the LADWP infrastructure system.

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Comment Code Name	Comment Text	Response
Land Use and Infrastructure	Conditions: 1) Ormat shall acknowledge the LADWP Transmission Line Rights-of-Way are integral components of the transmission line system, which provides electric power to the City of Los Angeles and other local communities. Their use is under the jurisdiction of the Federal North American Electric Reliability Corporation (NERC), an organization of the Federal Energy Regulatory Commission (FERC). Safety and protection of critical facilities are the primary factors used to evaluate secondary land use proposals. The rights-of-way serve as platforms for access, construction, maintenance, facility expansion and emergency operations. Therefore, the proposed use may, from time to time, be subject to temporary disruption caused by such operations. 2) Ormat shall be responsible for the maintenance of the Project area and shall keep the area in a neat and clean condition within LADWP's TLRW. It is our understanding Ormat will assume responsibility for the maintenance of the project improvements, and for all the risks and liabilities associated with the proposed improvements. LADWP will not be liable for any damage to the proposed project during LADWP's operation and maintenance activities. 3) A permanent, unobstructed 20-foot wide roadway (patrol road), accessible at all times by LADWP maintenance personnel shall be provided and maintained. A wider roadway width may be required on curved segments. The roadway must remain open and unobstructed, excluded from any watering and kept as dry as possible at all times. 4) No excavations are allowed within 50 feet around the base of tower footings. 5) No improvements or construction activities of any kind whatsoever will be allowed within the LADWP TLRW without the prior written approval of the LADWP. 6) Conductor Clearances will be subject to the review and approval of the Transmission Engineering Group. The LADWP will need a copy of the conductor survey illustrating the cross sections showing our existing conductors and proposed developments. See attached LADWP Conductor Survey Instructions. The Transmission Engineering Group will use the data to calculate and confirm that conductor clearances meet the National Electrical Safety Code (NESC). 7) No equipment taller than 14-feet shall be used under the LADWP TLRW. It is Ormat's responsibility to comply with all applicable standards and safety regulations while working near or under high voltage overhead transmission lines. 8) No grading or structures shall be constructed within the LADWP TLRW without prior written approval of the LADWP.	Comment noted. The EA has also been revised to note that the existing 500kV line is essential to the LADWP infrastructure system.

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Comment Code Name	Comment Text	Response
Land Use and Infrastructure (conitnued)	9) Provide the location and elevations (heights) of all above and below ground structures, including the cross sections of existing and proposed project within and adjacent to the LADWP TLRW. All ground elevations are to remain unchanged from existing conditions after construction associated with the Ormat proposed project is completed. Cut & fill slopes inside the LADWP TLRW steeper than 2 horizontal to 1 vertical require retaining structures or geotechnical report approval. Note: Grading activity resulting in a vertical clearance between the ground and the transmission line conductor elevation less than thirty-five (35) feet or as noted in the State of California, PUC, General Order 95 within the LADWP TLRW is unacceptable. 10) Ground cover for all below ground utilities shall not be less than four (4) feet. 11) California Code of Regulations, Title 8, Section 2700 defines "qualified electrical workers" as "a qualified person who by reason of a minimum of two years of training and experience with high-voltage circuits and equipment and who has demonstrated by performance familiarity with the work to be performed and the hazards involved." This definition of "qualified electrical workers" shall be equivalent to OSHA's definition when applicable outside of California. At all times during installation, replacement, and/or maintenance of any improvement authorized within the LADWP TLRW, Ormat shall have at least one qualified electrical worker on site to observe said work and ensure all OSHA required safety protocols are followed. 12) When grading activity affects the transmission line access roads, Ormat shall replace the affected access roads using LADWP's Access Road Design Criteria. See attached. 13) No grading is allowed below the top of tower footings within the LADWP TLRW, located in the immediate vicinity of the towers. 14) All aboveground metal structures including, but not limited to, pipes, drainage devices, fences, and bridge structures located within or adjoining the right of way shall be properly grounded, and shall be insulated from any fencing or other conductive materials located outside of the right of way. For safety of personnel and equipment, all equipment and structures shall be grounded in accordance with the National Electric Code, Article 250, whichever is more restrictive. 15) The right of way contains high-voltage electrical conductors; therefore, Ormat shall utilize only such equipment, material, and construction techniques that are permitted under applicable safety ordinances and statutes, including the following: State of California Code of Regulations, Title 8, Industrial Relations, Chapter 4, Division of Industrial Safety, Subchapter 5, Electrical Safety Orders, California Public Utilities Commission, General Order No. 95, Rules for Overhead Electric Line Construction or the National Electrical Safety Code, whichever is more restrictive.	

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Comment Code Name	Comment Text	Response
Land Use and Infrastructure (conitnued)	16) An area at least 100 feet around the base of each tower must remain open and unobstructed for necessary maintenance, including periodic washing of insulators by high pressure water spray. 17) Additional conditions may be required following review of detailed site plans, grading/drainage plans, etc. 18) Condition Nos. 1-9, 11A, 12-22C, 23A-23B, 25, 27-29, and 31A-32 of the Standard Conditions for Construction shall apply. 19) If any excavations are required, utility agencies within the proposed excavation sites shall be notified of impending work. Ormat shall be responsible for coordinating relocation of utilities, if any, within the project boundaries. Before commencing any excavations, Underground Service Alert (a.k.a. DigAlert) shall be notified. 20) This reply shall in no way be construed as an approval of any project.	
Appendix G Groundwater Monitoring Plan	Figure 3 in the Draft Monitoring Plan generally shows faults ("Geophysical") that are aligned from the San Emidio Desert Basin and the location of the proposed geothermal Project, extending in a southwest direction towards the Pyramid Lake Reservation Boundary. Figure 3 include references to "Boundary Faults to deep zone" with "LiDAR" cited for the source of the "Boundary Faults." The Tribe has requested information regarding the LiDAR-determined faults that conveniently appear on Figure 3 as a potential boundary to fault connectivity between San Emidio and Pyramid Lake Basins. There is no specific citation or reference to a study or mapping that can be evaluated to assess or support the existence of the so-called Boundary Faults that are illustrated on Figure 3.	The reference to faults which "likely form a boundary" included in the Draft Groundwater Monitoring Plan submitted by the proponent (Ormat) and included in Appendix G of the Revised Draft EA pertains to the geothermal resource at depth but concludes the extent of the geothermal system to the southwest is not clearly defined. Ormat reportedly has LiDAR data for a portion of San Emidio Desert valley which is proprietary. Any agreement to provide proprietary data to PLPT and/or BIA would need to be worked out directly with Ormat.

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Comment Code Name	Comment Text	Response
Appendix G Groundwater Monitoring Plan	The Draft Monitoring Plan is proposing the use of one (1) existing, shallow, ranch well ("White Sheep Flat Well" shown on Figure 2 attached to this Technical Memorandum) to monitor potential effects the proposed geothermal Project may have on the Tribe's springs in the San Emidio Basin, springs in the Pyramid Lake Basin, the Tribe's groundwater resources and geothermal resources underlying the San Emidio Basin portion of the Reservation, the Tribe's groundwater and geothermal resources in the Pyramid Lake Basin portion of the Reservation, and the Pyramid Lake. The use of a single, shallow well located more-or-less midway between the proposed geothermal Project and the Pyramid Lake Reservation boundary is severely inadequate to provide a basis for evaluating and monitoring potential impacts to the Tribe's resources.	The objectives and approach to the proponent's Draft Groundwater Monitoring Plan included in Appendix G of the Revised Draft EA were preliminary. The pending decision record (DR) will require the proponent to develop a final hydrologic monitoring plan in coordination with the BLM within one year. The purpose of the final monitoring plan would be to monitor potential quantity and quality impacts to the freshwater aquifer in San Emidio Desert basin including water resources on Reservation land as determined through consultation with the Tribe. The BLM will have final approval of the monitoring plan.
Appendix G Groundwater Monitoring Plan	As proposed, the monitoring program will not provide enough information to ensure that the resources belonging to the PLPT are not being adversely impacted by the proposed geothermal development. Freshwater resources belonging to the PLPT could be adversely affected if the proposed development is mismanaged. The DRAFT proposed ground water monitoring plan is seriously deficient. To protect the resources belonging to the PLPT, the project will need a robust monitoring program coordinated by the PLPT.	The Final EA includes BLM's goals and objctives for groundwater monitoring (see Appendix H in the Final EA), which are based on consultation with the PLPT and communication with Ormat. The purpose of the final monitoring plan would be to monitor potential quantity and quality impacts to the freshwater aquifer in San Emidio Desert basin including water resources on Reservation land as determined through consultation with the Tribe. The BLM will have final approval of the monitoring plan.