APPENDIX A

BEST MANAGEMENT PRACTICES AND RECLAMATION PERFORMANCE STANDARDS

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BEST MANAGEMENT PRACTICES, MITIGATION MEASURES, AND RECLAMATION PERFORMANCE STANDARDS

A 1.0 Overview of Best Management Practices (BMPs)

Geothermal resource leases are subject to the standard stipulations and lease terms. The current lease terms, dated September 2008 and subject to changes, are found on Form 3200-24a (included at the end of Appendix K). The right to explore, develop and utilize leased geothermal resources is inherent in the lease, subject to stipulations, legal requirements, and terms and conditions on permits. Specific conditions of approval and other mitigation measures would be required during subsequent authorizations. These include timing and location of activities during the development phase (see Section 2.4 and Appendix B of this Final Environmental Impact Statement (FSEIS), Reasonably Foreseeable Development scenario). In addition, the Bureau of Land Management (BLM) and other governmental agencies may require specific permits.

In addition to the standard stipulations and lease terms, the BLM may require a number of best management practices (BMPs) and mitigation measures as conditions of any lease under the action alternatives. BMPs and mitigation measures are generally applied or applied on a site-specific basis to avoid, minimize, reduce, rectify, or compensate for adverse environmental or social impacts. They are applied to management actions to aid in achieving desired outcomes for safe, environmentally responsible resource development, by preventing, minimizing, or mitigating adverse impacts and reducing conflicts.

This section provides a list of sample BMPs that have been collected from various BLM, and other applicable agency documents addressing geothermal and fluid mineral leasing and development, including resource management plans, forest plans, and environmental reports for geothermal leasing and development. The purpose of this section is to provide a list of potential BMPs that could be incorporated as appropriate into the permit application by the lessee or could be included in the approved use authorization by the BLM as conditions of approval. When implementing new BMPs, the BLM will work with an affected lessee early in the process, to explain how BMPs may fit into their development proposals and how BMPs can be implemented in a cost effective and design appropriate manner. The BLM will discuss potential resource impacts with the lessee and seek the operator's recommended solutions. The BLM would encourage the lessee to incorporate necessary and effective BMPs into their project proposal. BMPs not incorporated into the permit application by the lessee may be considered and evaluated through the environmental review process and incorporated into the use authorization as conditions of approval or rights-of-way stipulations.

The Renewable Energy Action Team (REAT) agencies (California Energy Commission (CEC), California Department of Fish and Wildlife (CDFW), BLM, and United States Fish and Wildlife Service (USFWS)) jointly prepared the *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, September 2010. The manual fulfills agency commitments in the State of California's Executive Order (EO) S-14-08, Secretary of the Interior Secretarial Order (SO) No. 3285, and related memoranda between California and the United States Department of Interior (DOI), and between the REAT agencies (signed in 2008 and 2009). The mitigation measures and BMPs proposed in the manual have been adopted for this EIS. Best Management Standards and Reclamation Performance Standards that are relevant to the Haiwee Geothermal Leasing Area (HGLA), and may apply to all action alternatives that authorize geothermal leasing, are listed in this Appendix.

The BLM has published environmental BMPs on its website and in *The Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* (BLM 2007; commonly referred to as the Gold Book). Although these references were published as guidance and standards for the oil and gas industry, the mitigation measures for roads, transmission lines, pipelines, buildings, and screening are applicable guidance for developing and implementing BMPs for geothermal resource power plants. This document has been adopted for this FSEIS and will be applied to geothermal exploration and development within the HGLA.

The CEC approved the Salton Sea Unit #6 Power Project (CEC Publication No. 800-03-021, 2003) with conditions of certification and published a geothermal resources permitting guide (Blaydes & Associates 2007). Both documents provide examples of and explain in detail the requirements for developing geothermal wells and power plants in California. This document has been adopted for this SDEIS.

BMPs for geothermal energy are also incorporated into this SDEIS as detailed below from the Final Programmatic Environmental Impact Statement for Geothermal Leasing in the Western United States (PEIS). The Record of Decision for the Geothermal PEIS was signed on December 17, 2008. Where the BMPs identified in the PEIS are inconsistent or incompatible with those developed under the HGLA Final EIS, the staff will determine the appropriate practices during the site-specific environmental review. Only those individual mitigation measures reasonably necessary to ensure environmentally responsible geothermal development should be selected. BMPs and mitigation measures should be dependent on factors such as the project size, location, site-specific characteristics, and potential resource impacts. Prior to inclusion into a permit, the measures may be further modified to meet site-specific situations and agency requirements.

The BMPs also include those identified in the Environmental, Health and Safety Guidelines for Geothermal Power Development (International Finance Corporation 2007), recommended controls on hydrogen sulfide gas (H_2S) emissions (Nagl n.d.), examples of waste discharge requirements (Regional Water Quality Control Board [RWQCB], Colorado River Basin Region 2007), and injection well guidance (USEPA 1999).

The BLM will incorporate BMPs as detailed in this appendix into proposed use authorizations after appropriate review. Final BMPs are most suitable for consideration by an administrative unit on a case-by-case basis, (1) depending on their effectiveness, (2) the balancing of increased operating costs vs. the benefit to the public and resource values, (3) the availability of less restrictive mitigation alternatives that accomplish the same objective, and (4) other site specific factors.

Guidelines for applying and selecting project-specific requirements include determining whether the measure would: 1) ensure compliance with relevant statutory or administrative requirements, 2) minimize local impacts associated with siting and design decisions, 3) promote post construction stabilization of impacts, 4) maximize restoration of previous habitat conditions, 5) minimize cumulative impacts, or 6) promote economically feasible development of geothermal energy on BLM-administered lands.

Geothermal project developers are advised to incorporate the general BMPs applicable to their project and project site into their Plan(s) of Development or Plan(s) of Operation submitted to the BLM, which are required for surface-disturbing activities. The BMPs provide guidance for lessees on how to meet Section 6 of the standard lease terms for this project area. Depending on site-specific conditions and individual development plans, the following BMPs and mitigation measures may be required. Others could be identified during site-specific analyses.

The BMPs, mitigation measures, lease stipulations, conditions of approval, and the construction, operation, maintenance, and reclamation of the geothermal developments, will be monitored to ensure their continued effectiveness and compliance through all phases of the project. When compliance is determined to be ineffective, the BLM will take steps to determine the cause and require the operator to take corrective action which may include stopping operations until compliance is restored as determined by the Authorized Officer.

A 2.0 General BMPs

These BMPs would help reduce or eliminate impacts to multiple elements of the human and natural environment. Many BMPs would also minimize operator costs. The following BMP's are applicable across multiple resources, project components, and project phases:

1) Prior to geothermal exploration and development, a focused geotechnical survey should be conducted on potential areas of disturbance such as roads, drill pads, and power plant locations so they will be sited to avoid any hazards from subsidence or liquefaction (i.e., the changing of a saturated soil from a relatively stable solid state to a liquid during earthquakes or nearby blasting). Structures and facilities will be designed and constructed in accordance with seismic safety standards. Initial exploration (geophysics) does not disturb any land subsurface. The survey will evaluate and identify potential geologic hazards and would provide remedial grading recommendations, foundation and slab design criteria, and soil parameters for the design of geothermal power infrastructure. Prior to the initiation of geotechnical surveys (i.e., subsurface work as well as off-road travel), all areas of potential ground disturbance will be submitted to the appropriate environmental compliance activities (e.g., cultural resource survey, biological investigations) as determined by the BLM.
2) The operator will collect available information describing the environmental and socio-cultural conditions in the vicinity of the proposed project and will provide the information to the agency.
3) A monitoring program will be developed by the operator to ensure that environmental conditions are monitored during the exploration and well drilling, testing, construction, and utilization and reclamation phases. The monitoring program requirements, including adaptive management strategies, will be established at the project level to ensure that potential adverse impacts of geothermal development are mitigated. The monitoring program will identify the monitoring requirements for each major environmental resource present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring observations and additional mitigation measures into ongoing activities. The operator will provide results of the monitoring program to the agency in an annual report.
4) Prior to commencing work, project boundaries (including access routes and staging/parking areas) will be staked or flagged, as necessary, to identify the limits of the work area.
5) No work will occur outside defined project limits.
6) Work area footprints will be restricted to existing disturbed areas to the extent feasible.
7) Exploration, construction and operations related traffic would be restricted to routes approved by the agency(ies). Construction of new access roads or cross-country vehicle travel would not be permitted unless prior written approval is given by the authorized officer. Authorized roads used by the proposed action will be rehabilitated when construction activities are complete. The agency(ies) would work with the proponent to develop site-specific standards for route reconstruction. Use of other unimproved roads will be restricted to emergency situations.
8) Neither roads, drilling pads, nor other constructions should divert nor focus rain runoff within the sub-watersheds.

A 3.0 Resource Specific BMPs

A 3.1 Air Quality

The following air quality BMPs include recommendations to reduce emissions of criteria or hazardous air pollutants, CO_2 and H_2S. The United States Environmental Protection Agency (USEPA) does not classify H_2S as either a criteria air pollutant or a hazardous air pollutant. The state of California, however, adopted an Ambient Air Quality Standard for H_2S to protect public health and decrease odor annoyance. Air pollution control/management districts may have short-term, maximum (for example, hourly) and annual average standards for stationary sources of H_2S, including geothermal power plants. The Great Basin Unified Air Pollution Control District (GBUAPCD) has adopted rules that all operator shall adhere to (GBUAPCD 2006). The US Supreme Court has upheld in Massachusetts v. Environmental Protection Agency (2007) that the EPA is to regulate carbon dioxide and other greenhouse gases (GHGs) as pollutants. The State of California through legislation has set targets to reduce CO_2-equivalents of GHG emissions that the Air Resources Board implements.

1) The operator will coordinate with the GBUAPCD to develop and implement an air quality monitoring plan.
2) Drilling, well testing and geothermal production will comply with appropriate GBUAPCD hydrogen sulfide emission limits.
3) The operator shall adhere to GBUAPCD Rules regarding control of fugitive dust and emissions of particulate matter, carbon dioxide, oxides of nitrogen, sulfur compounds, and adhere to geothermal emission standards.
4) Develop an emissions inventory, a list of both long-term (annual) and short-term (generally 1-hour or 8-hour) emission rates for each relevant pollutant from each emission point source (such as well venting, drill rig diesel engines, fugitive dust, plant silencers, sulfur plant exhaust, cooling towers).
5) Organize emissions inventory by project phase: exploration; well-field development (estimate number of wells to be drilled, vented each year); plant operations (estimate number of replacement wells to be drilled each year, and forced and planned outage rates).
6) Quantify the pollutants contained in the geothermal fluids and steam by testing well venting.
7) Collect fluid and gas samples for every well using independent laboratory and air quality specialist for at least one round of sample collection and chemical analysis.
8) Own both the geothermal production and injection wells as well as the geothermal power plant, so that responsibility for H_2S emission control is not lost between the steam producer and electricity generator.
9) As an integral part of an odor control program, implement an ambient monitoring program for H_2S and meteorology. Continue to operate the meteorological station used to collect baseline data. Use an USEPA reference sulfur dioxide monitor with an in-line sulfur dioxide (SO_2) scrubber and H_2S to SO_2 oxidizer for real-time collection of less than 1.0 part per billion H_2S. Record hourly H_2S and wind data for retrieval whenever odor issues arise.
10) When H_2S is detected in ambient air in amounts equal to or greater than 0.03 parts per million (ppm) per hour (standard established by the ARB), the H_2S must be oxidized by current technological methods. H_2S is exempt from regulation where measured H_2S in the Non-Compressible Gas (NCG) component of geothermal fluid is not exposed to the atmosphere and there are no detectable H_2S, locations around the same plant, and/or locations in the same well field t.
11) Remove H_2S when the maximum ambient air concentration exceeds the standard established by the California Air Resources Board (CARB) (i.e., 0.03 parts per million (ppm) per hour). Utilize a “Stretford”-type process or by chemical oxidation if the concentration in the NCG stream is low enough for these processes to be effective. This standard applies to any flash type geothermal plant, but not to a binary (Organic Rankin Cycle) plant. H_2S is required to be monitored at both types of plants.
12) The operator will prepare and submit to the agency an Equipment Emissions Mitigation Plan for managing diesel exhaust, an Equipment Emissions Mitigation Plan will identify actions to reduce diesel particulate, carbon monoxide, hydrocarbons, and nitrogen oxides associated with construction and drilling activities. The Equipment Emissions Mitigation Plan will require that all drilling/construction-related engines:
    a. Are tuned to the engine manufacturer’s specification in accordance with an appropriate time frame.
    b. Do not idle for more than five minutes (unless, in the case of certain drilling engines, it is necessary for the operating scope).
    c. Are not tampered with in order to increase engine horsepower.

d. Include particulate traps, oxidation catalysts, and other suitable control devices on all drilling/construction equipment used at the project site.

e. Use diesel fuel having a sulfur content of 15 ppm or less, or other suitable alternative diesel fuel as defined by CARB.

f. Include control devices to reduce air emissions. The determination of which equipment is suitable for control devices should be made by an independent Licensed Mechanical Engineer. Equipment suitable for control devices may include drilling equipment, work over and service rigs, mud pumps, generators, compressors, graders, bulldozers, and dump trucks.

13) H_2S emissions would be abated during well testing (e.g., above 2.5 kilograms per hour per well (kg/hr/well) of H_2S per GBUAPCD Rule 424), for example, through the injection of hydrogen peroxide and sodium hydroxide into the test line.

A.3.1.1 Construction Best Management Practices for Air Quality

General

1) Limit speed of vehicles in construction areas to 10 miles per hour (mph) or less.

2) Water unpaved roads and disturbed areas at least twice per day. Increase watering frequency when wind speeds exceed 15 mph.

Fugitive Dust Suppression Program (Construction)

1) Prior to soil disturbance, install windbreaks at the windward sides of construction areas. The windbreaks shall remain in place until the soil is either stabilized or permanently covered.

2) Immediately cover excavated and stockpiled soil upon completion of work.

3) Cover all trucks hauling dirt, sand, soil or other loose materials and maintain at least six inches freeboard between the top of the load and the top of the trailer.

4) Maintain cargo compartments so that no spillage or loss of material can occur.

5) Clean cargo compartments for all haul trucks at the delivery site, after removal of materials.

6) Prior to entering a public roadway, employ tire cleaning and gravel ramps to limit accumulated mud and dirt deposited on the roads.

7) Clean up spillage and material tracked out or carried out into a paved road surface within 8 hours.

Well Drilling Emissions and Testing Issues (Construction)

1) Contractors will be hired by the lessee to conduct well drilling activities. These contractors will be required to have Statewide Portable Equipment Registrations (SPER) issued by CARB or be permitted by GBUAPCD for their diesel fueled engines. Typical SPER requirements for these types of engines include:

a. The opacity shall be limited to 20 percent or less aggregating for more than three minutes in any one hour.

b. PM_{10} emissions shall be limited to less than 0.1 grain per dry standard cubic feet (DSCF) corrected to 12 percent carbon monoxide (CO).

2) The well flow testing shall be completed as expeditiously as possible.

3) Well drilling activities shall use engines that meet or exceed the following USEPA off-road engine emission standards: Tier 3 engines (at a minimum) from 2018 to 2020; and Tier 4 engines after 2020.

4) The brine from a flow test is routed to a well test unit designed to minimize the release of entrained brine, which contributes to the particulate matter and metals release.

5) Brine flow rates shall be limited to 800,000 pounds per hour (lbs/hr) for both production wells and injection wells (CEOE 2003b, Response #3a).

6) Flow tests shall last less than 96 hours after the completion of the drilling.

7) Use hydrogen peroxide, sodium hydroxide (or another non-pollutant, non-toxic oxidizing agent) to control the H_2S emissions during well flow tests and initial commissioning.

Heavy Duty Diesel Equipment (Construction)

1) Perform regular maintenance to prevent emission increases due to engine problems.
2) Use ultra-low-sulfur fuel meeting CARB standards (15 ppm) for motor vehicle diesel fuel.
3) All large construction diesel engines which have a rating of 100 horsepower (hp) or more shall be equipped with catalyzed diesel particulate filters (soot filters), unless certified by engine manufacturers or the on-site air quality control mitigation monitor (AQCMM) that the use of such devices is not practical for specific engine types. For purposes of this BMP, the use of such devices is not practical for the following reasons:
    a. There is no available retrofit control device that has been verified by either CARB or the USEPA to control the engine in question to the highest level of available control;
    b. The construction equipment is intended to be on-site for five days or less; or
    c. If the AQCMM can demonstrate a good faith effort to comply with this requirement and that compliance is not possible.
4) Paving of all major access/egress routes to the project site and requiring construction workers and deliveries to take paved routes to and from the project site.
5) Suspension of activities causing fugitive dust under windy (i.e., sustained winds >25 mph) conditions.

A.3.1.2 Operational Best Management Practices for Air Quality

Fugitive Dust Suppression Program (Operations)

1) Pave all access and internal power plant roads.

2) Direct load haul trucks with recently dewatered filter cake.

3) Use wind break shields or structures at all exposed operation areas as feasible.

4) Designate a person to oversee the implementation of the fugitive dust control program.

5) Employ electric motors for operations and maintenance equipment when feasible.

Cooling Tower Mitigation Measures (Operations)

1) Control H_2S using a LO-CAT System with a control efficiency of 99.5 percent (CEOE 2002a, Appendix G.3).

2) In addition to the LO-CAT System for H_2S abatement, the project will include a polishing system using a solid bed H_2S removal scavenger system.

3) Assess the necessity of removing ammonia with control technology.

4) Control benzene using carbon absorbers with a control efficiency of 95 percent (CEOE 2002a, Appendix G.3).

5) Minimize off-gassing of H_2S by using oxidizers designed to oxidize at least 90 percent of the H_2S in the condensate (CEOE 2003b, Response #3d).

6) Design and build cooling tower with a drift eliminator, such that the drift rate does not exceed 0.0005 percent (CEOE 2002b, DR#5).

7) Hexavalent chromium containing compounds will not be used in the circulating water.

8) Control mercury emissions through the utilization of sulfurized activated carbon filters, selenium ceramic mass, or other abatement technologies.

Filter Cake[1] Handling Mitigation Measures

1) Direct load filter cake into trucks, trailers or bins as it is generated.

2) Secure a tarp over trailers and bins immediately after loading.

3) Use sulfate scale inhibitors to minimize radioactivity from radium (Ra226 and Ra228) and radon from the silica filter cake.

4) Minimize releases of filter cake into the environment by enclosing filter cake bays with doors or replace filter cake bays with containers or trailers capable of holding the waste material.

5) Prevent filter cake from being released or disposed of into the environment during the transfer to, from, or while stored at the filter cake bays or in end-dump trailers.

A.3.2 Noise

BLM regulations seek to "minimize noise," but set no measurable standard. BLM relies on noise criteria published in 1975 by the USGS in "Geothermal Resources Operational Order No. 4." The order is applicable to people occupying nearby homes, hospitals, schools, and libraries and wildlife, according to the 2008 PEIS and states that federal land lessees may:

> *"not exceed a noise level of 65 dB(A) for all geothermal-related activity including but not limited to, exploration, development, or production operations as measured at the lease boundary line or 0.8 km (one-half mile) from the source, whichever is greater, using the A-weighted network of a standard Sound Level Meter. However, the permissible noise level of 65 dB(A) may be exceeded under emergency conditions or with [regulatory] approval if written permission is first obtained by the lessee from all residents within 0.8 km (one-half mile)."*

[1] Filter cake is a by-product of drilling mud. Liquid wastes (including spent brine, steam condensate, and cooling tower blowdown) from geothermal power plants are reinjected underground, but the precipitated solids must be diverted to a filtering and dewatering process and then formed into "filter cakes."

Geothermal resource exploration/testing involves well drilling and less invasive approaches such as geophysical remote sensing. Remote sensing can refine well targeting and reduce the number of wells drilled. The exploration/testing approach is generally identified in a reservoir management plan which includes, but is not limited to, the following measures:

1) Use as few drill sites as is feasible so that fewer people are noise-impacted.
2) Locate the sites as far from residences as possible. In addition, use terrain, such as ridges, and plan the drill site so that noise is projected away from residences, to shield noise impacts to the greatest extent possible.
3) To dampen drilling rig noise, install acoustical windows in structures occupied by affected parties.
4) Install adequate noise abatement equipment during construction and operation and maintain it in good condition to reduce noise from any drilling or producing geothermal well located within 1,500 feet of a habitation. Examples of such equipment include temporary noise shields, cyclone silencers, rock wall mufflers, and sound insulation in pipes. Silencers slow the velocity of steam in the steam processing facility.
5) The operator will take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.
6) All equipment will have sound-control devices no less effective than those provided on the original equipment. All construction equipment used will be adequately muffled and maintained.
7) All stationary construction equipment (i.e., compressors and generators) will be located as far as practicable from nearby residences.
8) If blasting or other noisy activities are required during the construction period, nearby residents will be notified by the operator at least one hour in advance.
9) Explosives will be used only within specified times and at specified distances from sensitive wildlife or streams and lakes, as established by the federal and state agencies.

A 5.3 Soils

1) Do not use geothermal fluids or exploratory well drilling muds for dust control under any circumstances.
2) Erosive soils (defined as having severe or very severe erosion potential by the Natural Resources Conservation Service) and soils on slopes greater than 30 percent should be protected to minimize the potential for adverse impacts as detailed in Section 5.4 such as hay, small-grain straw, wood fiber, live mulch, cotton, jute, or synthetic netting.
3) Adequate drainage control devices and measures will be incorporated into road and well pad design at sufficient intervals and intensities to adequately control and direct surface runoff above, below, and within the road and well pad environments to avoid erosive concentrated flows.
4) The amount of vegetation cleared will be kept to the minimum necessary to accommodate all necessary project components.
5) Hydraulic mulch or Bonded Fiber Matrix (BFM) will be applied to disturbed areas and windrowed topsoil during construction to reduce the impacts to soil from wind erosion until final reclamation occurs (see Section 5.0 for Reclamation BMPs).
6) During initial construction, and prior to completion of construction, reclamation stormwater management actions will be taken to ensure disturbed areas are quickly stabilized to control surface water flow and to protect both the disturbed and adjacent areas from erosion and siltation. This may involve construction and maintenance of temporary silt ponds, silt fences, berms, ditches, and mulching.
7) Where possible, access roads should be located to follow natural contours and minimize side hill cuts and fills.

8) Excessive grades (e.g., over 15 percent) on roads, road embankments, ditches, and drainages should be avoided, especially in areas with erodible soils.
9) Roads should be designed so that changes to surface water runoff are minimized and new erosion is not initiated with water regulations.
10) Access roads and onsite roads should be surfaced with aggregate materials where necessary to provide a stable road surface, support anticipated traffic, reduce fugitive dust, and prevent erosion. Culvert outlets should be rip-rapped to dissipate water energy at the outlet and reduce erosion.
11) Road use should be restricted during the wet season if road surfacing is not adequate to prevent soil displacement, rutting, etc., and resultant stream sedimentation.

A 5.4 Water Resources, Brine Injection and Water Supply

Properly designed and sited geothermal power plants address water supply and well injection issues. Flash geothermal power plants can satisfy up to 95 percent of their water supply needs, including cooling tower make-up water, by recycling steam condensed from produced geothermal brine (CE Obsidian Energy LLC 2009). Water-cooled binary power plants return 100 percent of the geothermal fluid to the reservoir, but often require an external source of cooling water because the brine remains within a closed-loop system until injected and is not used for cooling. The brine may include concentrated amounts of contaminants which would present problems to the cooling system and the environment. Use of dry cooling or non-potable or degraded surface or groundwater would protect potable water supplies. Dry cooling can reduce the efficiency of electrical energy output of the power plant by as much as 50 percent in hot weather and that is why some binary geothermal power plants include a supplemental solar installation to make up for lost binary plant efficiency in high temperature summer environments as an alternative to using outside water for cooling.

The quality of underground sources of drinking water can be protected through careful well and casing design. Contamination of groundwater aquifers could be caused by upflow through a fault or by leakage of the injected fluid behind the casing due to a poor cement bond or through a casing damaged by corrosion or mechanical causes.

Hydraulic fracturing, or “fracking,” is a well stimulation process that promotes subsurface fracture systems to facilitate the movement of the underground energy source—in this case geothermal fluid—from rock pores to production wells. Hydraulic fluids, typically consisting of cold water or water with chemical additives, are pumped into geological formation at high pressures. Once pressure is sufficient, the hydraulic fluid, or flowback fluid, will rise to the surface back through the wellbore.

Potential impacts associated with hydraulic fracturing include the use of high volumes of water, potentially degrading local water resources, and the discharge of hydraulic fluid containing chemical additives that may result in contamination of groundwater and surface waters. Flowback water is either discharged to surface waters, regulated under the National Pollutant Discharge Elimination System (NPDES) program, or injected into the ground as regulated by the EPA or state Underground Injection Control (UIC) program. The USEPA has completed a study to evaluate the potential impacts of hydraulic fracturing on drinking water and public health. (USEPA 2016). Mitigation measures as identified in the study include groundwater level and quality monitoring, as well as obtaining and complying with criterion set forth in applicable permits.

Geothermal operations may result in water loss through evaporation. Evaporative losses may vary from 5 to 33 percent (Clark 2010). Binary cycle geothermal power plants typically have lower evaporative losses (five percent). To mitigate impacts associated with evaporative water losses, appropriate technologies, such as binary cycle, may be implemented.

Water/Brine Injection Well Best Management Practices

1) Begin planning for injection early in the field development stage. Prepare a preliminary injection strategy as soon as the first few exploration and production wells have been drilled and tested.

2) Use tracer testing and numerical modeling of the reservoir to develop an optimum injection strategy (poorly functioning production wells should not necessarily be converted to injection wells).
3) Prevent injection pressure buildup with proper chemical treatment and/or filtering of the injection fluid to prevent scaling and/or plugging of injection wells.
4) Increase the spacing between injection wells, or the number of injection wells, to redistribute the total amount of injection fluid over a larger area and thereby correct for ground heaving.
5) Avoid locating injection wells near known active faults and do not allow injection pressure to exceed original pore pressure to avert induced seismicity.
6) Design wells with casing that run from the surface to the depth below the underground source of drinking water. A well should have two casing strings; each sealed its entire length. Test casings, cements, and other materials before selecting them for use in construction at the specific well site.
7) At shallow depths, include multiple casing strings in geothermal wells.
8) If injecting under pressure, monitor injection pressures to avoid excessive pressure and minimize likelihood of injection-induced seismic activity from increased subsurface pressure and the stresses on the injection well equipment.
9) Inject at a rate that will not cause a pressure build-up in the formation or result in reduced fluid temperature at production wells. Monitor injection rates along with pressure monitoring to assess and ensure casing integrity.
10) Design and construct cellars around the casing wellhead. Keep these cellars dry or well drained to prevent corrosion of the casing at the soil-air-water interface.
11) Monitor well integrity through mechanical testing using industry standard well test and measurement practices (spinner, temperature, and pressure tests and tracer surveys) to prevent unintended release from within the well to the surrounding formations and inter-zonal migration of fluids between the casing and the formation.
12) Inspect surface conditions daily for casing leaks.
13) If an injection well penetrates an underground source of drinking water, perform mechanical integrity testing periodically to detect actual and potential leaks, casing failures, and cementing problems. Perform these tests prior to initial injection, after well workovers and repairs, and on a routine schedule during normal operations.

Water Supplies Best Management Practices

The use of surface or groundwater for cooling a geothermal facility must be thoroughly evaluated and impacts mitigated. This assessment may result in lengthy delays of permitting timeframes.

1) For flash-steam cycle plants, minimize the use of fresh water by using geothermal fluid as the major source of cooling water. Use high-efficiency fills in cooling towers to enhance air-to-water contact.
2) For binary geothermal plants, use air-cooled condensers only, during fall, winter and spring (October through April). During the summer season (May through September), plant electrical efficiency can be improved by using one of the following pre-cooling strategies:
    a. Direct deluge cooling of the air-cooled condenser tubes. Add a purified water rinse to wash away new forming scale when the deluge system is shut down for the winter.
    b. Spray-cooling enhancement (that is, pre-cooling with spray nozzles capable of creating micron-sized water droplets).

c. Honeycomb, porous evaporative-cooling media (for example, Munters media). Use degraded or reclaimed water sources for geothermal-source water supplies as much as possible. Minimize use of fresh or potable water supplies.

Sufficient water supply (for construction, cooling, geothermal makeup water, etc.) must be guaranteed by an applicant before the lease can be approved. The Applicant may need a Conditional Use Permit (CUP) approved by Inyo County to present to BLM before any lease would be granted. Water consumption and use would be evaluated during the NEPA process at the project level.

A.3.3

1) Validate compliance of proposed actions with water regulations in all of phases of geothermal exploration, development, operation, and reclamation with the Lahontan Regional Water Quality Control Board and Department of Water Resources staffs.
2) In coordination with State regulatory agencies the operator will comply with all state and federal surface and ground water rules and regulations for all phases of geothermal exploration, development, operation and reclamation.
3) Operators will have a clear understanding of the local hydrogeology.
4) Identify areas of groundwater discharge and recharge and their potential relationships with surface water bodies.
5) Operators will avoid creating hydrologic conduits between naturally discrete aquifers during drilling, foundation excavation and other activities.
6) Freshwater-bearing and other usable water aquifers (less than 10,000 ppm total dissolved solids [TDS], USEPA standard) will be protected from contamination by assuring that all well casing (excluding the liner) is required to be cemented from the casing shoe to the surface.
7) Periodic testing and monitoring via observation wells will be conducted in a manner to assure maximum protection of quality and quantity of water resources from groundwater extraction, geothermal fluids or alterations in reservoir pressure.
8) Water use will be minimized and water required for exploration and development will be obtained in a manner to assure maximum protection of water resources.
9) The discharge of fill or dredged materials into waters of the United States, including wetlands, would be avoided to the greatest extent possible. Playa lakes and other wetlands provide important groundwater recharge functions in the Rose Valley.
10) Avoid development of impervious geothermal facilities and access roads on the alluvial fans draining the Sierra Nevada and Coso Range and recharging the Rose Valley Groundwater Basin. To the extent possible, span or avoid development in the flood zones of intermittent and ephemeral drainages.
11) Construct roads perpendicular to stream crossings and avoid paralleling streams.
12) To the extent possible, avoid development of geothermal facilities and access roads in the 100-year floodplain and playa lakes in Rose Valley.
13) Proposed geothermal exploration and development would comply with the Clean Water Act as implemented by the State Water Resources Control Board’s NPDES General Permit No. CAS000002, a general permit for construction activities, and the associated Order No. 92-08-DWQ, Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity. Projects of one acre or more are subject to this general construction permit process.
14) Developers would be required to eliminate or reduce non-stormwater discharges to stormwater systems, develop a Stormwater Pollution Prevention Plan (SWPPP) prior to beginning construction, inspect all stormwater control structures, and implement other pollution prevention measures, such as applicable BMPs and conservation measures during construction.

a. The SWPPP would include the specific measures and techniques for implementation to protect the project sites and adjacent areas from erosion and deposition during site grading, construction, and post-construction stabilization of sediment on the site.

b. The contractor would provide a copy of the SWPPP for the various crews performing work on the construction site, and a copy would be kept on-site during the project to satisfy the requirements of the NPDES permit. A draft of this SWPPP would be forwarded to the BLM for review prior to its finalization.

A 5.5 Vegetation

1) The construction crews and contractors shall be responsible for working around all shrubs and trees within the construction zone to the extent feasible. Particular avoidance shall be applied to riparian trees (i.e., cottonwoods and willows). Shrubs and trees shall be flagged by a qualified botanist to indicate top priority for avoidance.

2) Operators will develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities at the site. The most recent recommendations at the state and local level should be incorporated into any operating plan for the geothermal exploration and development. The plan will address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area will be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.

3) Certified, weed-free mulch designed by the BLM to meet reclamation standards will be required when stabilizing areas of disturbed soil.

4) All vehicles and equipment associated with ground disturbance must be washed upon entry and exit of all project sites. Washing shall include wheels, undercarriages, bumpers, and all exposed surface parts of the vehicle capable of transporting seed. All tools such as chainsaws, hand clippers, pruners, etc., must also be cleaned before and after entering all project sites. When vehicles and equipment are washed, a daily log must record the following: 1) Location; 2) Date and time; 3) Methods used; 4) Staff present; 5) Equipment washed; and 6) Signature of responsible crew member. The written logs will be turned in to the BLM botanist upon completion of the project. Interim reports must be provided if requested or if the project extends beyond the planned period.

5) Fill materials and road surfacing materials that originate from areas with known invasive vegetation problems will not be used.

6) Herbicides shall be applied in accordance with state and federal law. No herbicides shall be used where Threatened or Endangered species occur. No herbicides shall be sprayed when wind velocities are above five miles per hour. No herbicides shall be used on native vegetation unless specifically authorized, in writing, by the BLM. A BLM Pesticide Use Plan must be completed by the developer and approved by the BLM. Only BLM-approved herbicides may be applied to BLM lands.

7) Revegetation, habitat restoration and weed control activities will be initiated as soon as possible after construction or exploration activities are completed. See Section 5.0 of this Appendix for Reclamation Performance Standards.

A 5.6 Fish and Wildlife

1) The operator will 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 will identify revegetation, soil stabilization, and erosion reduction measures that will be implemented to ensure that all temporary use areas are restored. The plan will 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. The Restoration and Revegetation Plan shall be submitted to the

lead agencies for prior approval (see Section 5.0 of this Appendix). All project activities must comply with the approved Restoration and Revegetation Plan.

2) If work during the breeding/nesting season (February 15 through August 15) cannot be avoided, then prior to construction activities, a qualified biologist shall survey all breeding/nesting habitat. If vegetation is removed during March 15 through September 15, then pre-disturbance surveys will be conducted to determine whether active nests are present within the disturbance area. Nest surveys shall be conducted no more than three days prior to the start of construction activities. Documentation of findings, including a negative finding must be submitted to the CDFW prior to construction activities for review and concurrence. If no breeding/nesting birds are observed and concurrence has been received from CDFW, site preparation and activities may begin. If an active nest is discovered or breeding activities are located and concurrence has been received from the CDFW, the breeding habitat/nest site shall be fenced a minimum of 200 feet (500 feet for raptors, 0.5-mile for eagles) in all directions, and this area shall not be disturbed until the nest becomes inactive, the young have fledged, the young are no longer being fed by the parents, the young have left the area, and the young will no longer be impacted by the project. This buffer may be adjusted due to environmental factors or species-specific requirements upon consultation with the CDFW, BLM and/or the USFWS.

3) Prior to any construction activities and tree removal during the raptor nesting season, January 31st to September 1st, a qualified biologist shall conduct a single site survey for active nests no more than one week prior to any scheduled development. If an active nest is located, then no work shall be conducted within a 500 foot radius from the nest until the young have fledged and are independent of the adults. If an inactive raptor nest is observed within the vegetation at any construction sites proposed for vegetation removal, the CDFW shall be contacted to discuss mitigation measures should the nest become active during the project term.

4) The operator shall hire qualified biologists to survey for plant and animal species that are listed or proposed for listing as threatened or endangered and their habitats in areas proposed for development where these species could potentially occur; following accepted protocols and in consultation with the USFWS and the CDFW as appropriate. Particular care should be taken to avoid disturbing listed species during surveys. The operator will monitor activities and their effects on ESA-listed species throughout the duration of the project.

5) The operator shall hire qualified biologists to 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 will follow appropriate guidance and requirements from the BLM, and other resource agencies, as available and applicable.

6) If pesticides are used on the site, an integrated pest management plan will be developed to ensure that applications would be conducted within the framework of all federal, State, and local laws and regulations and entail only the use of USEPA-registered pesticides.

7) The operator will 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 will be controlled or excluded to avoid harassment and disturbance of wildlife.

8) Ponds, tanks and impoundments (including but not limited to drill pits) containing liquids can present hazards to wildlife. Any liquids contaminated by substances which may be harmful due to toxicity, or fouling of the fur or feathers (salts, detergents, oils, etc.), should be excluded from wildlife access by fencing, netting or covering at all times when not in active use. Liquids at excessive temperature 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.

9) In order to minimize risks of direct drainage into riparian areas or other sensitive habitats, equipment storage, fueling, and staging areas shall be located at upland areas at sufficient distance and in such a manner as to prevent runoff from entering sensitive habitat. Project related spills shall be reported to BLM/CDFW/USFWS or other appropriate agency, cleaned up immediately, and contaminated soils removed to approved disposal areas.

10) If excavations are to be left open and unattended, an escape ramp will be constructed to the bottom of the pit with less than a 3 to 1 slope to provide a means of escape for wildlife. Prior to commencement of work activity each day, staff will check any excavated pits for wildlife. All excavations to be backfilled must be inspected for wildlife immediately prior to backfilling.

11) Project personnel will be restricted to the approved project limits. The project will not allow pets or hunting, killing, or harassment of native wildlife. The project will shield lighting and restrict dusk to dawn work activity that could affect diurnal and nocturnal foraging by native wildlife. Construction area and disturbance to soil and vegetation will be restricted to the minimum area possible to avoid unnecessary adverse impacts to wildlife habitat and native vegetation.

12) Biological monitors will be present during project construction activities if sensitive biological resources within the area of potential impact would be adversely impacted. The monitors will be responsible for ensuring that impacts to special-status species, native vegetation, wildlife habitat, or unique resources will be avoided to the fullest extent possible. Where appropriate, monitors will flag the boundaries of areas where activities need to be restricted in order to protect native plants and wildlife or special-status species. Those restricted areas will be monitored to ensure their protection during construction.

13) Construction crews will avoid impacting streambeds and banks of streams along the route to the extent possible. If necessary, a Streambed Alteration Agreement (SAA) will be secured from CDFW. Impacts will be mitigated based on the terms of the SAA.

14) All pipelines outside of a power plant site or other fenced areas would be elevated at least 12 inches (0.3 meter) above the ground surface to allow wildlife mobility and prevent interference with natural drainage.

A 5.7 Cultural Resources

1) Before any specific permits are issued for leases, the BLM will identify, and consider effects to historic properties in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations at 36 CFR Part 800.

2) Proposed developments within approved leases will be subject to additional Section 106 review. Proposed developments will be reviewed consistent with the process identified in the DRECP PA. All contracted fieldwork conducted for Section 106 compliance for proposed leasing developments will be performed under the terms of a Cultural Resources Use Permit (CRUP) and a Fieldwork Authorization (FA) issued by the BLM. Section IV of the DRECP PA, which guides identification, evaluation, and assessment of effects, requires that a BLM Class I inventory, including records search and literature review, be undertaken prior to any field activities. The Class I inventory shall be utilized to develop a research design and work plan for all cultural resource studies. The work plan will include defining the Area of Potential Effects (APE) for direct and indirect effects for the proposed development inside the area to be leased. A new Class III inventory will be prepared after a FA is issued by BLM. BLM may also require the development of a geo-archaeological study of the entire direct effects APE, an indirect effects study of the indirect APE, and a separate historic-built environment study. Technical reports generated for the project will require a BLM-mandated peer review.

3) BLM will consult with tribal stakeholders to identify any resources that have cultural or religious significance to the Tribes or Tribal Organizations. The BLM may require the development of an

ethnographic assessment for the project, if the Tribes or Tribal Organizations indicate that they have additional information that should be considered in the Section 106 review.

4) Based on the results of the identification efforts described above, and the results of the peer review, BLM will determine if any of the cultural resources identified within the APE, including resources with cultural or religious significance to a Tribe, meets one or more of the NRHP eligibility criteria specified in 36 C.F.R. § 60.4 and possesses integrity. Resources that meet one or more criteria and possess integrity shall be considered historic properties. Once eligibility determinations have been made, BLM will submit the agency proposed determinations of eligibility to the project-specific consulting parties for review and comment and will concurrently request SHPO review and concurrence on the agency proposed determinations of eligibility and findings of effect.

5) Avoidance of impacts through project design will be given priority over mitigation as the preferred treatment measure associated with any potential adverse effects identified. Avoidance measures include moving project elements away from site locations, or into areas bearing previous development impacts, or restricting travel to existing roads.

6) If adverse effects to historic properties from any proposed development within the HGLA are identified, the BLM will execute a project-specific MOA pursuant to 36 C.F.R. § 800.6 to fulfill the intent of the DRECP PA. Historic properties will be treated and managed in accordance with the process identified in Section V.A.1 of the DRECP PA. All mitigation measures for historic properties that will be adversely affected by a specific leasing development will be identified in an Historic Properties Treatment Plan (HPTP) that will be included as an appendix to the MOA. The Applicant is responsible for implementing all of the terms of the MOA, with BLM oversight.

7) The BLM, in consultation with the SHPO, the ACHP (if participating), Indian tribes, and project-specific consulting parties, will develop a comprehensive plan to manage post-review discoveries and unanticipated effects during project construction. The plan will be attached to any project-specific MOA or PA as an appendix, and implemented by the Applicant, with BLM oversight. If an area exhibits a high potential for containing subsurface cultural resources, but no resources were observed during a Class III inventory, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area.

8) Should any post-review discoveries or unanticipated effects occur prior to the development of a monitoring plan, or where an MOA or PA for a specific project has not been executed, the BLM shall follow the process at 36 C.F.R. § 800.13(b).

9) The BLM shall ensure that any Native American human remains, funerary objects, sacred objects, or objects of cultural matrimony discovered on federal lands shall be treated in accordance with the provisions of NAGPRA and its implementing regulations at 43 CFR Part 10. In consultation with the Tribes and Tribal Organizations for any specific undertaking, the BLM shall seek to develop a written plan of action pursuant to 43 C.F.R. 10.5(e) to manage the inadvertent discovery or intentional excavation of human remains, funerary objects, sacred objects, or objects of cultural patrimony. Finally, The BLM shall ensure that the Native American Heritage Commission is notified so that Native American human remains and/or funerary objects discovered on non-federal lands are treated in accordance with the applicable requirements of the California Public Resources Code at Sections 5097.98 and 5097.991, and of the California Health and Human Safety Code at Section 7050.5(c).

10) The BLM shall ensure that a Historic Properties Management Plan (HPMP) will be developed for all projects where historic properties require long term management. The HPMP will be developed in consultation with the SHPO, the ACHP (if participating), and project-specific consulting parties. The HPMP will identify how historic properties will be managed through project Operations and Maintenance, and Decommissioning. The Applicant is responsible for implementing the terms of the HPMP, with BLM oversight.

A 5.8 Paleontological Resources

1) Any proposed development of a lease area must undergo a project-specific Potential Fossil Yield Classification (PFYC) analysis of geologic units on BLM-administered lands in the lease area. The PFYC analysis must, at minimum, include the general distribution of known fossil localities and the fossil-yield potential of the geologic units underlying the project site; the location, extent, and depth of construction-related land disturbances at the project site; and how public access may increase following the construction of access roads and transmission infrastructure, which could encourage unauthorized collection activities, theft, or vandalism.

2) Certain processes associated with project development are unlikely to impact paleontological resources: The PFYC will guide paleontological field surveys. Field surveys will be focused on areas of the proposed lease development that have the potential to impact geologic units with a PFYC rating of 3, 4, 5, or Unknown. For those areas of a project that will be excavated during construction but where no rock exposures exist, certain procedures such as geotechnical exploration shall be used in conjunction with the PFYC classification system to allow the professional paleontologist to determine, with BLM concurrence, whether paleontological monitoring is required in order to retrieve unique paleontologic data that would otherwise be lost.

3) If during the analysis for a proposed lease development project, the paleontologist determines that there is a moderate to high potential for impacts to paleontologic resources, BLM will require the development of a paleontological mitigation-monitoring plan and subsequent active construction-related monitoring. The plan must include a formal monitoring and collection program; identify measures to prevent potential looting/vandalism or erosion impacts during and after construction is completed; and address the education of workers and the public to make them aware of the consequences of unauthorized collection of fossils on public lands. The Plan must also include a curation agreement with an appropriate museum facility.

4) Unexpected discovery of paleontological resources during construction will be brought to the attention of the responsible BLM authorized officer immediately. Work will be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

A 5.9 Visual

1) The operator will incorporate visual design considerations into the planning and design of the project to minimize potential visual impacts of the proposal and to meet the Visual Resource Management objectives of the area and the agency.

2) “Dulled” or galvanized metal finish towers or poles shall be used for transmission lines to reduce visual contrast.

3) Non-specular (non-reflective) conductors shall be used for transmission lines to reduce visual contrast.

4) Construct low-profile structures whenever possible to reduce structure visibility.

5) Select and design materials and surface treatments to repeat or blend with landscape elements.

6) Site projects outside of the viewsheds of publicly accessible vantage points, or if this cannot be avoided, as far away as possible.

7) Site projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas.

8) Site facilities away from and not adjacent to prominent landscape features (e.g., foothills or mountains, and water features).

9) Avoid placing facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from visually sensitive areas.

10) Collocate facilities to the extent possible to use existing and shared rights-of-way, existing and shared access and maintenance roads, and other infrastructure to reduce visual contrast.

11) Site linear features (above-ground pipelines, rights-of-way, and roads) to follow natural land contours rather than straight lines (particularly up slopes) when possible. Fall-line cuts should be avoided.
12) Design and construction of all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use.
13) Site linear features to cross other linear features (e.g., trails, roads) at right angles whenever possible to minimize viewing area and duration.
14) Site and design structures and roads to minimize and balance cuts and fills and to preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.
15) Use appropriately colored materials for structures or appropriate stains and coatings to blend with the project's backdrop. Refer to the Standard Environmental Colors chart available from the BLM.
16) Use non-reflective or low-reflectivity materials, coatings, or paints whenever possible.
17) Site pipelines adjacent to roadways to reduce surface disturbance and minimize visual contrast.
18) No paint or permanent discoloring agents shall be applied to rocks or vegetation to indicate survey or construction activity limits.
19) Paint grouped structures the same color to reduce visual complexity and color contrast.
20) Design and install efficient facility lighting so that the minimum amount of lighting required for safety and security is provided but not exceeded and so that upward light scattering (light pollution) is minimized. This may include, for example, installing shrouds to minimize light from straying off-site, properly directing light to only illuminate necessary areas, and installing motion sensors to only illuminate areas when necessary to reduce offsite visual contrast during nighttime hours.
21) Site construction staging areas and laydown areas outside of the viewsheds of publicly accessible vantage points and visually sensitive areas, where possible, including siting in swales, around bends, and behind ridges and vegetative screens.
22) Discuss visual impact mitigation objectives and activities with equipment operators prior to commencement of construction activities.
23) Avoid installing gravel and pavement where possible to reduce color and texture contrasts with existing landscape.
24) Use excess fill to fill uphill-side swales resulting from road construction in order to reduce unnatural-appearing slope interruption and to reduce fill piles.
25) Prevent downslope wasting of excess fill material.
26) Round road-cut slopes, vary cut and fill pitch to reduce contrasts in form and line, and vary slope to preserve specimen trees and nonhazardous rock outcroppings.
27) Provide benches in rock cuts to accent natural strata.
28) Use split-face rock blasting to minimize unnatural form and texture resulting from blasting.
29) Segregate topsoil from cut and fill activities and spread it on freshly disturbed areas to reduce color contrast and to aid revegetation.
30) Bury utility cables in or adjacent to the road where feasible.
31) Undertake interim restoration during the operating life of the project as soon as possible after disturbances. During road maintenance activities, avoid blading existing forbs and grasses in ditches and along roads.
32) Randomly scarify perpendicular to the angle of cut slopes to reduce texture contrast with existing landscape and to aid in revegetation.
33) Cover disturbed areas with stockpiled topsoil or mulch and revegetate with a mix of native species establishing a composition to reduce contrast with the surrounding undisturbed landscape.

34) Restore rocks, brush, and natural debris whenever possible to approximate preexisting visual conditions.

A 5.10 Health, Safety Pesticides and Waste Management

1) Increase the pH of spent geothermal brine to keep silica in solution prior to reinjection.
2) Return spent geothermal brines, steam condensate, and cooling system blowdown to the geothermal resource via reinjection wells.
3) Assure that hazardous substances and wastes removed from surface impoundments are not leaked, spilled, or otherwise improperly released outside the surface impoundments and into the environment.
4) Remediate any contamination near and around surface impoundments, including the tops of berms and areas downwind from the impoundments, filter cake bay storage areas, hydroblast pads and adjacent areas, pipes containing hazardous waste scale and areas adjacent, and other areas where hazardous waste releases or disposals have occurred.
5) Ensure that all employees and contractors staff operating at any facility receive appropriate hazardous waste management and high pressure high temperature (HPHT) training prior to conducting any work involving hazardous waste, including hazardous waste treatment, storage, and disposal at the facility, or HPHT environments, including well site, pipeline, and power plant operations.
6) Conduct annual environmental audits to identify all hazardous waste streams and determine compliance with all applicable statutory and regulatory provisions of California's Hazardous Waste Control Law and the Unified Hazardous Waste and Hazardous Materials Management Regulatory Program.
7) Maintain a minimum freeboard of two feet at all times within the geothermal brine surface impoundment. Ensure the fluids and brine precipitates discharged to and contained in the surface impoundment never overflow.
8) Install a leak detection system beneath the membrane liner of the geothermal brine surface impoundment. Inspect the system quarterly to ensure brine is not collecting due a membrane-liner breach.
9) Monitor groundwater wells to determine whether the geothermal brine surface impoundment is releasing hazardous waste into groundwater.
10) Clean conveyance systems regularly to prevent buildup of silica scale and the potential for release of solid materials from conveyance systems.
11) Perform pipe maintenance and descaling only in areas designated for these activities.
12) Construct hydro blasting areas so that the base is impermeable and no wastewater can spray or run onto adjacent soil. For example, the hydro blasting area should have 12-foot-high walls on three sides. Convey wastewater from the hydro blasting process to the brine surface impoundment for reinjection to the geothermal resource.
13) Containerize and control drilling mud and cuttings by placing muds and cuttings in containers such as Baker tanks or other by other means to prevent discharging such wastes to land.
14) Hazardous and non-hazardous materials and management of used oil and underground storage tanks shall be treated in accordance with Resource Conservation and Recovery Act (RCRA) as detailed in Title 40 Code of Federal Regulations parts 239-259, parts 260-273, and parts 279-280. Remediation costs of spills shall be the sole responsibility of the leaseholder.
15) Operators will develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan will identify all hazardous materials that would be used, stored, or transported at the site. It will establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and

disposition of excess materials. The plan will also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.

16) Operators will develop a waste management plan identifying the waste streams that are expected to be generated at the site and addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan will address all solid and liquid wastes that may be generated at the site.

17) Operators will develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.

18) A safety assessment will be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.

19) A health and safety program will be developed to protect both workers and the general public during construction and operation of geothermal projects.

20) Regarding occupational health and safety, the program will identify all applicable federal and state occupational safety standards; establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; Occupational Safety and Health Administration standard practices for safe use of explosives and blasting agents; and measures for reducing occupational electric and magnetic fields exposures); establish fire safety evacuation procedures; and define safety performance standards (e.g., electrical system standards and lightning protection standards). The program will include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies will be established.

21) Regarding public health and safety, the health and safety program will establish a safety zone or setback for generators from residences and occupied buildings, roads, rights-of-way, and other public access areas that is sufficient to prevent accidents resulting from the operation of generators. It will identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or rehabilitation activities. It will also identify measures to be taken during the operation phase to limit public access to hazardous facilities (e.g., permanent fencing would be installed only around electrical substations, and facility access doors would be locked).

22) Operators will consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) will be identified and addressed in the traffic management plan.

23) Operators will develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.

24) Underground utilities will be installed to minimize the amount of open trenches at any given time, keeping trenching and backfilling crews close together. Avoid leaving trenches open overnight. Where trenches cannot be backfilled immediately, escape ramps should be constructed at least every 100 feet.

25) All refueling will occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.

26) Drip pans will be used during refueling to contain accidental releases.

27) Drip pans will be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.

28) Any containers used to collect liquids will be enclosed or screened to prevent access to contaminants by wildlife, livestock, and migratory birds.

29) Spills will be immediately addressed per the spill management plan, and soil cleanup and removal initiated as soon as feasible.

A 5.11 Wild Horses and Burros

1) The operator will ensure employees, contractors, and site visitors avoid harassment and disturbance of wild horses and burros, especially during reproductive (e.g., breeding and birthing) seasons. In addition, any pets will be controlled to avoid harassment and disturbance of wild horses and burros.

2) Observations of potential problems regarding wild horses or burros, including animal mortality, will be immediately reported to the agency.

A 5.12 Livestock Grazing

1) The operator will coordinate with livestock operators to minimize impacts to livestock operations.

A 5.13 Recreation

1) Any necessary temporary route closures for construction would be coordinated with BLM and before beginning construction.

2) Signs directing vehicles to alternative park access and parking would be posted in the event construction temporarily obstructs parking areas near trailheads.

3) Signs and/or flagging that advise recreational users of construction activities would be posted in coordination with BLM. Whenever active work is being performed, the area should be posted with "Construction Ahead" signs on any adjacent access roads or trails that might be affected.

4) Whenever possible, construction activities would be avoided during high recreation use periods.

A 5.14 Scenic and Historic Trails

1) When any right-of-way application includes remnants of a historic trail, is located within the viewshed of an historic trail's designated centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP or designated scenic trail, the operator will evaluate the potential visual impacts to the trail associated with the proposed project and identify appropriate mitigation measures for inclusion in the operation plan.

A 5.15 Transportation/Roads/Pads

1) Operators will consult with local planning authorities regarding increased traffic prior to the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) will be identified and addressed in the traffic management plan.

2) Signs will be placed along roads to identify speed limits, travel restrictions, and other standard traffic control information. Signs directing vehicles to alternative park access and parking will be posted in the event construction temporarily obstructs recreational parking areas near trailheads. Whenever active work is being performed, the area will be posted with "construction ahead" signs on any adjacent access roads or trails that might be affected.

3) Project personnel and contractors will be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow and to reduce wildlife collisions and disturbance and fugitive dust.
4) When practical, construction activities will be avoided during high recreational use periods.
5) To plan for efficient use of the land, necessary infrastructure will be consolidated wherever possible.
6) Existing roads and pad sites will be used to the maximum extent feasible, but only if located in a safe and environmentally sound location. No new roads and pad sites will be constructed without agency authorization. If new roads and pad sites have been authorized, they will be designed and constructed by the operator to the appropriate agency standard, no higher than necessary to accommodate their intended function. Roads and pad sites will be routinely maintained by the operator to assure public safety and to minimize impacts to the environment such as erosion, sedimentation, fugitive dust, and loss of vegetation.
7) An access road siting and management plan will be prepared incorporating existing Agency standards regarding road design, construction, and maintenance such as those described in the BLM 9113 Manual and the Surface Operating Standards for Oil and Gas Exploration and Development (i.e., the Gold Book, 4th Edition, 2007).
8) A traffic management plan will be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan will incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.
9) Access roads will be located to minimize stream crossings.
10) All structures crossing streams will be located and constructed so that they do not decrease channel stability or increase water velocity.
11) Operators will obtain all applicable federal and state water crossing permits.
12) Roads will be designed so that changes to the natural pattern of surface water runoff are minimized and new erosion is not initiated.
13) Access roads will be located to minimize stream crossings. All structures crossing streams will be located and constructed so that they do not decrease channel stability or increase water velocity.
14) The operator will obtain agency authorization prior to borrowing soil or rock material from agency lands.
15) Dust abatement techniques will be used before and during surface clearing, excavation, or blasting activities. Dust abatement techniques (such as those detailed GBUAPCD Rules regarding control of Fugitive Dust and as identified in Air Quality BMPs and Fugitive Dust Suppression Program detailed above) will be used on unpaved, unvegetated surfaces to minimize fugitive dust. Speed limits (e.g., 10 mph) will be posted and enforced to reduce fugitive dust. Construction materials and stockpiled soils will be covered if they are a source of fugitive dust.
16) Culvert outlets will be rip-rapped to dissipate water energy at the outlet and reduce erosion. Catch basins, roadway ditches, and culverts will be cleaned and maintained regularly.

A 4.0 BMPs For Pipelines

1) Pipelines constructed above ground due to thermal gradient induced expansion and contraction will rest on cradles above ground level, allowing small animals to pass underneath.
2) Projects should be analyzed to ensure adequate passage for all wildlife species. The pipeline will be raised higher to allow wildlife passage where needed.
3) Because pipeline corridors through certain habitat types can alter local predator-prey dynamics by providing predators with lines of sight and travel corridors, large projects should be analyzed to ensure there will be no significant changes to predator-prey balance.

A 5.0 Reclamation Performance Standards

The following reclamation performance standards shall be met:

A 5.1 Interim Reclamation

Interim reclamation of well locations and access roads shall occur soon after the well is put into production. Interim reclamation will include those disturbed areas that may be re-disturbed during operations and will be re-disturbed at final reclamation to achieve restoration of the original landform and a natural vegetative community.

Disturbed areas not needed for active, long-term production operations or vehicle travel have been re-contoured, protected from erosion, and revegetated with a self-sustaining, vigorous, diverse, native (or as otherwise approved) plant community sufficient to minimize visual impacts, provide forage, stabilize soils, and impede the invasion of noxious, invasive, and non-native weeds.

A 5.2 Final Reclamation

Final Reclamation includes those disturbed areas that will not be re-disturbed where the original landform and a natural vegetative community shall be restored.

- The original landform shall be restored for all disturbed areas including well pads, production facilities, roads, pipelines, and utility corridors.

- General: A self-sustaining, vigorous, diverse, native (or otherwise approved) plant community shall be established on the site, with a density sufficient to control erosion and invasion by non-native plants and to reestablish wildlife habitat or forage production. At a minimum, the established plant community will consist of species included in the seed mix and/or desirable species occurring in the surrounding natural vegetation.

- Specific: No single species will account for more than 30 percent total vegetative composition unless it is evident at higher levels in the adjacent landscape. Permanent vegetative cover will be determined successful when the basal cover of desirable perennial species is at least 80 percent of the basal cover on adjacent or nearby undisturbed areas where vegetation is in a healthy condition; or 80 percent of the potential basal cover as defined in the National Resource Conservation Service Ecological Site(s) for the area. Plants must be resilient as evidenced by well-developed root systems and flowers. [Shrubs, will be well established and in a "young" age class at a minimum (therefore, not comprised mainly of seedlings that may not survive until the following year).]

- Erosion features shall be equal to or less than surrounding area and erosion control is sufficient so that water naturally infiltrates into the soil and gullying, headcutting, slumping, and deep or excessive rills (greater than three inches) are not observed.

- The site shall be free of State- or county-listed noxious weeds, oil field debris and equipment, and contaminated soil. Invasive and non-native weeds are controlled.

A 5.3 Reclamation Actions

- During initial well pad, production facility, road, pipeline, and utility corridor construction and prior to completion of the final well on the well pad, pre-interim reclamation stormwater management actions will be taken to ensure disturbed areas are quickly stabilized to control surface water flow and to protect both the disturbed and adjacent areas from erosion and siltation. This may involve construction and maintenance of temporary silt ponds, silt fences, berms, ditches, and mulching.

- When the last well on the pad has been completed, some portions of the well location will undergo interim reclamation and some portions of the well pad will usually undergo final reclamation. Most well locations will have limited areas of bare ground, such as a small area around production facilities or the surface of a rocked road. Other areas will have interim reclamation where workover rigs and fracturing tanks may need a level area to set up in the future. Some areas will undergo final reclamation where portions of the well pad will no longer be needed for production operations and can be re-contoured to restore the original landform.

- The following minimum reclamation actions will be taken to ensure that the reclamation objectives and standards are met. It may be necessary to take additional reclamation actions beyond the minimum in order to achieve the Reclamation Standards.

A 5.4 Reclamation - General

Procedure:

- The agency will be notified 24 hours prior to commencement of any reclamation operations.

Site Maintenance and Hygiene:

- Immediately upon well completion, the well location and surrounding areas(s) will be cleared of, and maintained free of, all debris, materials, trash, and equipment not required for production.

- No hazardous substances, trash, or litter will be buried or placed in pits.

- All trash generated from this project will be collected and disposed of off BLM administered lands at an disposal site approved by the California Department of Toxic Substance Control . The project site shall be kept clean of debris and microtrash to avoid attracting wildlife. All food-related trash items shall be enclosed in sealed containers and regularly removed from the site.

Vegetation Clearing:

- Vegetation removal and the degree of surface disturbance will be minimized wherever possible.

- Temporary impacts shall be returned to pre-existing contours and revegetated with a BLM approved native plant species mix. Special Status vegetation will be flagged and voided when necessary.

- During site-specific review of projects, each area proposed for geothermal development will be assessed for site-specific requirements. [Example of site-specific requirement: During vegetation clearing activities, trees and woody vegetation removed from the well pad and access road will be moved aside prior to any soil disturbing activities. Care will be taken to avoid mixing soil with the trees and woody vegetation. Trees left for wood gathering will be cut [twelve inches or less from the ground], delimbed, and the trunks, six inches or more in diameter will be removed and placed either by the uphill side of the access road, or moved to the end of the road, or to a road junction for easy access for wood gatherers and to reduce vehicle traffic on the well pad. Trees with a trunk diameter less than six inches and woody vegetation will be used to trap sediment, slow runoff, or scattered on reclaimed areas to stabilize slopes, control erosion, and improve visual resources.]

Topsoil Management:

- Operations will disturb the minimum amount of surface area necessary to conduct safe and efficient operations. When possible, equipment will be stored and operated on top of ungraded or grubbed ground to minimize surface disturbance.

- In areas to be heavily disturbed, the top eight inches of soil material will be stripped and stockpiled around the perimeter of the well location to control run-on and run-off, and to make redistribution of topsoil more efficient during interim reclamation. Stockpiled topsoil may include vegetative material. Topsoil will be clearly segregated and stored separately from subsoils. Several layers of soil may occur within the top eight inches of material. If more than one subsoil layer is observed during excavation, those subsoil layers will also be segregated and stored separately from one another. All layers will be returned back onto the site in the reverse order that they were removed.

- Earthwork for interim and final reclamation will be completed within six months of well completion or plugging unless a delay is approved in writing by the BLM authorized officer.

- Salvaging and spreading topsoil will not be performed when the ground or topsoil is too wet to adequately support construction equipment. If such equipment creates ruts in excess of four inches deep, the soil will be deemed too wet.

- No major depressions will be left that would trap water and cause ponding.

- Water pipelines should be inspected daily to eliminate the potential for soil erosion caused by leaking or broken pipes.

Seeding:

- Seedbed Preparation. Initial seedbed preparation will consist of re-contouring to the appropriate interim or final reclamation standard. All compacted areas to be seeded will be ripped to a minimum depth of 18 inches with a minimum furrow spacing of two feet, followed by re-contouring the surface and then evenly spreading the stockpiled topsoil. Prior to seeding, the seedbed will be scarified and left with a rough surface.

  If broadcast seeding is to be used and is delayed, final seedbed preparation will consist of contour cultivating to a depth of 4 to 6 inches within 24 hours prior to seeding, dozer tracking, or other imprinting to loosen up the soil and create seed germination micro-sites.

- Seed Application. Seeding will be conducted no more than 24 hours following completion of final seedbed preparation.

  No seeding will occur from [May 15 to September 15]. Fall seeding is preferred and will be conducted after [September 15] and prior to ground freezing. [Shrub species will be seeded separately and will be seeded during the winter.] Spring seeding will be conducted after the frost leaves the ground and no later than [May 15].

Erosion Control and Mulching:

- Mulch, silt fencing, wattles, hay bales, and other erosion control devices will be used on areas at risk of soil movement from wind and water erosion.

- Mulch will be used if necessary to control erosion, create vegetation micro-sites, and retain soil moisture and may include hay, small-grain straw, wood fiber, live mulch, cotton, jute, or synthetic netting. Mulch will be free from mold, fungi, and certified free of noxious or invasive weed seeds.

- If straw mulch is used, it will contain fibers long enough to facilitate crimping and provide the greatest cover.

Pit Closure:

- Reserve pits will be closed and backfilled within 60 days of release of the rig. All reserve pits remaining open after 60 days will require written authorization of the authorized officer. Immediately upon well completion, any trash in the pit will be removed. Pits will be allowed to dry, be pumped dry or solidified in-situ prior to backfilling.

- Following completion activities, pit liners will be completely removed or removed down to the solids level and disposed of at an approved landfill, or treated to prevent their reemergence to the surface and interference with long-term successful revegetation. If it was necessary to line the pit with a synthetic liner, the pit will not be trenched (cut) or filled (squeezed) while containing fluids. When dry, the pit will be backfilled with a minimum of five feet of soil material. In relatively flat areas the pit area will be slightly mounded above the surrounding grade to allow for settling and to promote surface drainage away from the backfilled pit.

Management of Invasive, Noxious, and Non-Native Species:

- All reclamation equipment will be cleaned prior to use to reduce the potential for introduction of noxious weeds or other undesirable non-native species.

- An intensive weed monitoring and control program will be implemented prior to site preparation for planting and will continue until interim or final reclamation is approved by the authorized officer.

- Monitoring will be conducted at least annually during the growing season to determine the presence of any invasive, noxious, and non-native species. Invasive, noxious, and non-native species that have been identified during monitoring will be promptly treated and controlled. A Pesticide Use Proposal will be submitted to the BLM for approval prior to the use of herbicides.

A 5.5 Interim Reclamation Procedures – Additional

Recontouring:

- Interim reclamation actions will be completed as soon as is practicable when the final well on the location has been completed, weather permitting. The portions of the cleared well site not needed for active operational and safety purposes will be re-contoured to the original contour if feasible, or if not feasible, to an interim contour that blends with the surrounding topography as much as possible. Sufficient semi-level area will remain for setup of a workover rig and to park equipment. In some cases, rig anchors may need to be pulled and reset after re-contouring to allow for maximum interim reclamation.

- If the well is a producer, the interim cut and fill slopes prior to re-seeding will not be steeper than a 3:1 ratio, unless the adjacent native topography is steeper. Note: Constructed slopes may be much steeper during drilling, but will be re-contoured to the above ratios during interim reclamation.

- Roads and well production equipment will be placed on location so as to permit maximum interim reclamation of disturbed areas. If equipment is found to interfere with the proper interim reclamation of disturbed areas, the equipment will be moved so proper re-contouring and revegetation can occur.

Application of Topsoil and Revegetation:

- Topsoil will be evenly spread and revegetated over the entire disturbed area not needed for all-weather operations including road cuts and fills and to within a few feet of the production facilities, unless an all-weather, surfaced, access route or small "teardrop" turnaround is needed on the well pad.

- In order to inspect and operate the well or complete workover operations, it may be necessary to drive, park, and operate equipment on restored, interim vegetation within the previously disturbed area. Damage to soils and interim vegetation will be repaired and reclaimed following use.

Visual Resources Mitigation for Reclamation:

- Trees, if present, and vegetation will be left along the edges of the pads whenever feasible to provide screening.

- To help mitigate the contrast of re-contoured slopes, reclamation will include measures to feather cleared lines of vegetation and to save and redistribute cleared trees, debris, and rock over re-contoured cut and fill slopes.

- To reduce the view of production facilities from visibility corridors and private residences, facilities will not be placed in visually exposed locations (such as ridgelines and hilltops).

- Production facilities will be clustered and placed away from cut slopes and fill slopes to allow the maximum re-contouring of the cut and fill slopes.

- All long-term above ground structures will be painted [Dead Brown] (from the "Standard Environmental Colors" chart) to blend with the natural color of the late summer landscape background.

A 5.6 Final Reclamation Procedures - Additional

- Final reclamation actions will be completed within six months of well plugging, weather permitting.

- All disturbed areas, including roads, pipelines, pads, production facilities, and interim reclaimed areas will be re-contoured to the contour existing prior to initial construction or a contour that blends indistinguishably with the surrounding landscape. Salvaged topsoil will be spread evenly over the entire disturbed site to ensure successful revegetation. To help mitigate the contrast of re-contoured slopes, reclamation will include measures to feather cleared lines of vegetation and to save and redistribute cleared trees, woody debris, and large rocks over re-contoured cut and fill slopes.

- Water breaks and terracing will only be installed when absolutely necessary to prevent erosion of fill material. Water breaks and terracing are not permanent features and will be removed and reseeded when the rest of the site is successfully revegetated and stabilized.

- If necessary to ensure timely revegetation, the pad will be fenced to BLM standards to exclude livestock grazing for the first two growing seasons or until seeded species become firmly established, whichever comes later. Fencing will meet standards found on page 18 of the BLM/FS Gold Book, 4th Edition, or will be fenced with operational electric fencing.

- Final abandonment of pipelines and flowlines will involve flushing and properly disposing of any fluids in the lines. All surface lines and any lines that are buried close to the surface that may become exposed in the foreseeable future due to water or wind erosion, soil movement, or anticipated subsequent use, must be removed. Deeply buried lines may remain in place unless otherwise directed by the authorized officer.

A 5.7 Reclamation Monitoring and Final Abandonment Approval

- Reclaimed areas will be monitored annually. Actions will be taken to ensure that reclamation standards are met as quickly as reasonably practical.

- Reclamation monitoring will be documented in a reclamation report submitted to the authorized officer as determined on a site-by-site and project basis. The report will document compliance with all aspects of the reclamation objectives and standards, identify whether the reclamation objectives and standards are likely to be achieved in the near future without additional actions, and identify actions that have been or will be taken to meet the objectives and standards. The report will also include acreage figures for: Initial Disturbed Acres; Successful Interim Reclaimed Acres; and Successful Final Reclaimed Acres. Annual reports will not be submitted for sites approved by the authorized officer in writing as having met interim or final reclamation standards. Monitoring and reporting continues annually until interim or final reclamation is approved. Any time 30 percent or more of a reclaimed area is re-disturbed, monitoring will be reinitiated.

- The authorized officer will be informed when reclamation has been completed, appears to be successful, and the site is ready for final inspection.

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APPENDIX B

REASONABLE AND FORESEEABLE DEVELOPMENT SCENARIO

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APPENDIX B

REASONABLE AND FORESEEABLE DEVELOPMENT SCENARIO HAIWEE GEOTHERMAL LEASING AREA

B.1.0 INTRODUCTION AND BACKGROUND

Following guidance in BLM Handbook H-1624-1, *Planning for Fluid Mineral Resources*, a Reasonable Foreseeable Development (RFD) is project management activities and actions, including developments, which are likely to occur in the planning area over the life of the plan (i.e., generally 15 to 20 years or whatever has been determined to be the planning horizon or timeframe for the RMP) assuming continuation of existing management. The fluid minerals specialist focuses attention on projecting fluid minerals leasing, exploration, development, production and abandonment activities. The description of existing fluid minerals practices and information on existing leases and related exploration and development activities as well as the potential for development in the planning area provides the basis for projecting the RFD under existing management. The level of detail necessary for describing the reasonably foreseeably development scenario is basically a function of: the amount of geologic data available regarding fluid mineral potential; and the nature or level of resource conflicts or controversies, i.e., planning issues or management concerns involving fluid mineral leasing and development.

This Reasonable Foreseeable Development (RFD) scenario has been prepared as a basis for analyzing environmental impacts resulting from future leasing and development of federal geothermal resources within the Haiwee Geothermal Leasing Area (HGLA). As the name implies, the level and type of development anticipated in this RFD is a “best guess” of what may occur if these areas are leased. It is not intended to be a “maximum-development” scenario; however it is biased towards the higher end of expected development.

The foreseeable development described here could occur on any land within the HGLA (22,836 acres), regardless of surface or mineral ownership.

The anticipated total surface disturbance for the area as reflected by the assumptions described below is summarized as follows:

Planning Area	BLM Disturbance (acres)	Total Disturbance (acres)
Haiwee Geothermal Leasing Area	376 (initial) 257 (final)	404 (initial) 276 (final)

Twenty-four of the 38 sections in the HGLA boundaries are within the Coso Known Geothermal Resource Area (KGRA). This area was previously analyzed as having a moderate to high potential for the occurrence of geothermal resources. HGLA lands that are outside of the KGRA are adjacent to and similar in geology to lands within the KGRA. The HGLA lands also have similar mineralogy, lithology, and geologic structure to the Coso KGRA. Numerous technical papers and geologic analyses have documented the similarities in geologic setting between the two areas.[1] While no direct data is available to validate this RFD scenario, the proximity to the Coso geothermal operations and the KGRA suggests the possibility of a similar resource within the HGLA. The RFD analysis in this document is based on the proximity of the HGLA to the active Coso geothermal field and the ongoing operations that occur there.

The Coso geothermal field is located in an area of relatively recent volcanic activity which resulted from magma intruding to shallow depths along localized faults, thereby providing a heat source for the geothermal field. The

[1] Duffield, et al., 1980, Jackson & O’Donnell, 1980, Wohletz and Heiken, 1992, etc.

Coso geothermal field has produced as much as 273 megawatts (MW) of electricity from a total of nine 30 MW geothermal flash steam turbine power plants. The field currently produces significantly less than that rated capacity due to a decline in reservoir pressure resulting from geothermal production over more than three decades. The geothermal system is hot-water dominated, with a fluid temperature i.e., greater than 360 degrees Fahrenheit (oF) [182 degrees Celsius (oC)], high enough to support a "dual-flash" process.

Dual-flash uses changes in pressure to create steam vapor, which drive large turbines, and convert the heat energy into electricity. Since the geothermal resource fluid (geofluid) is used directly to turn the turbines in a flash plant, it can be cooled for reinjection only by means that result in large amounts of evaporation of the resource. The drawback to this type of production is that a significant proportion of the geothermal fluids are lost to evaporation and not re-injected into the geothermal reservoir. However, freshwater sources are not required for plant operations unless and until the resource reservoir is drawn down to the point where pressures begin to decline and production levels begin to suffer. In the latter years in the life of a flash plant (i.e., 27 years of continuous operation in the case of Coso), "makeup water" from an outside source, usually freshwater, can be injected into the reservoir to "recharge" the geothermal source reservoir. It is still not necessary for cooling, however.

Another type of flash plant technology is the direct use of dry steam to turn turbines. This type of a resource is found in only a few places in the world and is not expected to be identified within the HGLA. The choice of technology is largely controlled by the temperature of the produced water, although some geothermal companies have converted existing flash plants to binary systems with either wet or dry cooling technologies.

Binary systems represent a third type of commonly used geothermal development techniques, where power generation results from the geothermal fluid heating a secondary working fluid (with a lower boiling point than water) to turn the turbines for power generation. Because binary systems utilize a closed loop system where the geothermal fluid never touches the ambient atmosphere, there is no evaporation of the fluid, and so the geothermal reservoir does not become degraded over time, as in a flash plant. However, the produced fluid still needs to be condensed and cooled for reinjection to the source reservoir, and freshwater from outside sources have traditionally been used for cooling. Although the volumes of freshwater consumed for cooling a binary plant are far less in comparison to the direct evaporation of geothermal fluid that occurs in cooling a flash plant resource, such sources of water are in high demand for agriculture, domestic and recreational uses, and to recharge bodies of surface water. Binary geothermal technology is generally used where resource fluid temperatures are less than 360oF (182oC). Most existing binary plants are now turning to dry or air cooling technologies at least seasonally, because such cooling methods do not require any consumption of freshwater or geothermal resource fluid. In arid climates, however, plant efficiency and production levels decline seasonally in hotter months for plants utilizing dry cooling methods. The tradeoff is that binary plants with dry cooling will have virtually no impact on either freshwater aquifers or the geothermal reservoir once the plant is in operation. If the lands are leased, lessees will consider these factors in choosing a geothermal plant design and method of cooling.

No direct data currently exist on the presence of a geothermal resource within the HGLA. The assumption made in preparing this RFD scenario is that, if a potential geothermal resource were to be identified, factors including the temperature and thermodynamics of the geothermal reservoir and the local availability of water that may be necessary for geothermal energy production and plant operations will determine whether flash or binary technology is appropriate, as well as the method of cooling.

The Coso geothermal field is used as an example for what may be found in the HGLA. Unlike Coso, the HGLA has no surface features associated with geothermal activity such as hot springs and fumaroles. Based on this observation, it is assumed that any resource, should one be located, would be deeper than at Coso and less economically viable. The RFD scenario assumes that only two 30 MW power plants would be constructed, each with a useful life of 30 years, and that the most likely plant design would be dual-flash. For purposes of this RFD scenario, the foreseeable development described could occur on any land in the HGLA regardless of surface or mineral ownership.

Argonne National Laboratory (Clark et al. (2016)) evaluated a range of geothermal technologies to compare their relative water consumption rates, and concluded that for those temperatures where both hydrothermal binary and hydrothermal flash can operate, water consumption (from all sources including geothermal fluid) for the binary power plant (HB-1) was less than the flash power plant. The flash system relies on water from the geothermal reservoir for cooling, while the binary system requires another water source for cooling needs unless air cooling technology is used, which can impact plant efficiency seasonally, to the point of being uneconomic in some climates. However, over the course of a 30-year power plant lifetime, long-term water supply from the geothermal reservoir may require supplemental injection from another source in the latter years of a flash plant's operation.

Volumes of water that may be consumed are entirely dependent upon the overall design of the facility, its cooling systems and technical requirements. Wet, dry, or hybrid cooling systems can result in varying degrees of overall water use. Recycling technologies can also have an impact on water consumption. Ancillary systems may impact water consumption without regard to the geothermal technology being used.

Fluid Loss (usage) in California Wet-cooled Binary and Flash Geothermal Power Plants

	MW	% Loss	Acre-feet/year
Binary Powerplant			
Casa Diablo	40	4%	623
East Mesa	49.5	4%	2,518
Heber	92	6%	2,556
Multi-stage Flash			
Coso	273[2]	48%	13,540
Salton Sea	340	18%	10,807

Table from Shevenell, L., 2011 *Water Use in Geothermal Power Generation*; presentation to the National Water Resources Association annual meeting.

The following assumptions are made for this RFD scenario and the analysis of impacts:

1) The difference in disturbance footprint (acreage), between flash, dual-flash, and binary technology is negligible;
2) There will be adequate hydrothermal fluid in the geothermal reservoir for the life of each power plant, regardless of technology;
3) The geothermal reservoir is a confined aquifer and fluid production from that reservoir would not impact other aquifers; and
4) The difference in impacts between the flash, dual-flash and binary technologies is not significant.

There is a wide range of variability that may be expected from differing geothermal technologies in differing geological settings. While flash plants do not require freshwater from an external source for cooling, it is possible,,as previously stated, that a dual flash system might eventually also require injection from an external water source to recharge the geothermal reservoir in the event that years of evaporation of the geothermal fluid during cooling results in significant drawdown of the resource reservoir.

As a result of public comments on the DEIS regarding water usage of binary system and flash system geothermal power plants, the BLM conducted additional data collection to better understand the potential water usage of flash and binary geothermal systems. Argonne National Laboratory (ANL) evaluated and estimated water usage for four geothermal power plant scenarios using a model developed by U.S. Department of Energy (Clark et. al 2016). The Geothermal Electricity Technology Evaluation Model (GETEM) was developed to estimate and summarize the performance and cost of various geothermal power system configurations with a wide variety of physical characteristics. Argonne uses this model for its life cycle analysis of geothermal energy, particularly to estimate

[2] The volumes of acre-feet consumed in evaporative cooling in these flash plant examples appears more drastic due to the larger plant sizes (e.g., 273 MW for Coso vs. 40 MW for Casa Diablo). While it is an oversimplification to correct for the MW difference alone (as temperature and pressure differences also affect volume), such a calculation would show that 40 of Coso's MW might consume 1,983 acre-feet of geofluid annually, as compared to the 623 acre-feet of freshwater consumed to produce 40 MW at Casa Diablo.

operational fresh water and geofluid consumption for hydrothermal flash and binary systems.

In comparison to other electricity generating technologies, geothermal flash and binary are of the same magnitude and among the lowest consumers of water per kilowatt-hour, and also utilize the smallest "footprint" in terms of surface acreage necessary. For flash or multi-flash systems, geothermal fluid loss rates are typically larger than binary systems, because the produced fluid is directly flashed to steam and subsequently used in the evaporative cooling process. Binary systems are "closed loop" systems with all of the produced water being directly re-injected back into the geothermal reservoir. Binary systems always require an external source of water in a system utilizing wet or hybrid cooling, but binary systems that utilize dry cooling methods full time do not involve consumption of either freshwater or geothermal resource fluid.

B.2.0 AVAILABLE DATA AND ASSUMPTIONS

The HGLA encompasses about 38 sections, or approximately 22,805 acres. Of this, nearly all the land is BLM surface and subsurface. Of the 22,805 acre leasing area, only 1,572 acres are non-federal, for a total federal area of 21,233 acres. Included in the 21,233 acres of BLM-managed land are three pending lease applications covering about 4,460 acres.

The RFD includes total anticipated development for the entire 22,805 acres.

The RFD uses a simple ratio of 93% by dividing the total number of BLM managed acres with the total number of acres within the HGLA, and multiplying by 100:

$$(21{,}233_{\text{ acres BLM}} / 22{,}805_{\text{ acres Total}}) \times 100 = 93\%$$

This means that a maximum of 93% of the impacted acreage identified in the RFD scenario might be expected to occur on BLM-managed land that could be open to development under this RFD, only about 257 acres (93% of 276 acres), and 376 acres of total disturbance (93% of 404 acres) could occur on BLM-managed lands in the HGLA.

There are no direct data on which to base this RFD. There are no known temperature gradient wells in the immediate vicinity, nor have there been any deep exploration wells drilled in the area to date. Therefore, the basis of this RFD in terms of predicting likely plant design technology will be the proximity of the area to the Coso geothermal field, a field that currently produces approximately 100 MW to 200 MW (net) of electricity from a total of nine 30 megawatt (MW) geothermal turbine/generators.

The Coso field is located in an area of widespread ancient volcanic activity. This volcanic activity resulted from magma being intruded to unusually shallow depths, thereby providing a heat source for the geothermal field. The HGLA appears to be in the same general geologic regime.

The distance between the Coso geothermal field and the HGLA is about 10 to 15 miles. Proximity to a known producing geothermal field has little to do with the ultimate productivity of an area. However, from a geologic standpoint, there is a relatively high likelihood that some of the volcanic activity and fracturing in the Coso geothermal field may exist in the HGLA as well.

For the purpose of this RFD, it will be assumed that two 30 MW dual-flash power plants will be constructed and that the powerplants will have a useful life of 30 years. It will also be assumed that the productive areas will be less prolific than in the Coso geothermal field and will require more wells per MW than in the Coso geothermal field.

B.2.1 Exploration Activities

For exploration activities within an area open to geothermal leasing, an operator must file an exploration application with the BLM that identifies the areas to be explored and the method of exploration. The proposal identified in the application is initially reviewed to determine whether it is covered by regulations regarding "casual use" geothermal exploration or whether additional environmental and regulatory review is required. The BLM may, depending upon the results of the analysis undertaken during this review, approve, reject, or modify the project requested in the application.

Exploration may include geophysical exploration such as seismic reflection/refraction testing,2 and other forms of (low impact) surface geophysical testing. This RFD scenario anticipates that up to 20 temporary exploration or temperature gradient wells (TGW), could be drilled. Seismic testing can be either passive, to detect naturally-occurring events, or induced, which would use small charges to create seismic reflections. Seismic testing typically requires the drilling of very shallow holes (less than 100 feet) for the placement of explosives or seismic monitoring devices. Because there has not been any actual drilling in the leasing area, it will be assumed that some level of exploration will occur prior to full-field development. Exploration will include geophysical exploration such as seismic testing and the drilling of up to 20 temperature gradient wells. It is assumed that the total surface disturbance relating to seismic testing will be two acres.

Typical geophysical exploration is usually passive, measuring magnetic fields or electrical current, using receivers stationed at known locations. The size and intensity of the energy measured as it moves through the earth provides a clearer understanding of the subsurface. Geophysical testing is expected to create two acres of total surface disturbance in the RFD scenario.

TGWs are small diameter, relatively shallow boreholes that do not extend into a geothermal resource or reservoir. The purpose of these wells is to identify areas that have the greatest amount of heat flow. Once identified, these areas could be the targets for slim-hole resource confirmation wells on leased lands. It is assumed that the surface disturbance for each of the 20 exploration wells, or TGWs, is three acres. The three acres of disturbance includes a drilling site and an access road. It is likely that some of the drilling locations used for the TGWs may also be used for production well locations. For the purposes of the RFD scenario, however, it was assumed that these would remain separate disturbances.

The total temporary surface disturbance anticipated from exploration is 62 acres (20 TGWs x 3 acres each + 2 acres geophysics). It is assumed that this would be a temporary impact, because the exploration and TGWs will typically be plugged, abandoned, and these well sites, along with the two acres disturbed by geophysical testing, would be reclaimed. If a resource is identified, however, it is understood that some of the TGWs may be used for observation or monitoring for a period of time.

B.2.2 New Wells

Surface Disturbance- To support each of the two 30 MW power generation facilities, it is estimated that a total of 15 production wells and seven injection wells would need to be drilled over the course of the estimated 30-year useful life of each powerplant. This includes both wells drilled initially, estimated to be nine production wells and three injection wells, and makeup or replacement wells, estimated to be six production wells and four injection wells, that will need to be drilled over the 30-year period to maintain the 30 MW of net production. It is anticipated that one new well will be drilled every three years. The wells would be located on up to five new well pads, with each pad large enough to accommodate the drilling of up to five wells. All wells on BLM-managed land will be permitted by BLM using standard review methods that ensure: 1) protection of groundwater; 2) protection of public safety; and 3) that the environment is not unnecessarily or unduly damaged.

Each production or injection well has the potential to be from 6,000 feet to 15,000 feet deep. However, these depths should not be considered a limiting factor, since the potential environmental effects are not strongly correlated to the depth of a well, or to the number of wells on a well pad. For example, a 15,000-foot deep well could be drilled with only slightly more impacts than a 6,000 foot well. The RFD scenario considers the level of impacts associated with the deeper wells, providing a high-development bias, thus eliminating the need to analyze the shallower example. Surface impacts could be further minimized by requiring that multiple wells be drilled from existing single well pad locations. In the case of leases with NSO stipulations, wells would have to be directionally-drilled from adjacent lands located outside the NSO area to ensure that surface impacts do not occur.

Because the resource is expected to be relatively deep, directional drilling could be practical and result in drilling locations that could accommodate multiple wells. In this case, each well-pad would require approximately seven acres, including cut and fill. The extent of cut and fill could be important, as the topography is quite steep in parts of the HGLA. It is assumed that at least five wells could be drilled from each well location. The assumption of five wells per location should not be considered a limiting factor in this RFD because additional wells could be drilled from an existing location with few additional impacts.

Given the rugged topography, each well-pad is estimated to need three miles of 30-foot wide access road and one mile of pipeline. It is estimated that half the pipelines will follow the access roads in flatter areas, thereby adding 10 feet to the total width. It is estimated that the other half of the pipelines will be built in rugged areas and would go "cross country." These pipelines would require 30 feet of disturbance initially, but after construction, only a 15-foot access road will remain. Those disturbed acres not used for pipeline access road would be reclaimed to restore native vegetation.

Each production well is expected to take between 90 and 150 days to drill. During this time, greater than 95 dB noise could be generated by the diesel engines that power the drilling rigs and air compressors/mud pumps, as well as from the drawworks, drawworks brake, racking of pipe, and well testing. The racking of pipe and drawworks brake are higher-pitched noises that typically travel further than sources such as diesel engines. To limit the undesirable effects of noise on wildlife, drilling rigs may be required to implement best management practices (BMPs) that are commonly employed in more urban settings. All diesel engines will use mufflers, per standard industry practice. Well testing would also require that mufflers be used to reduce noise. Up to three drilling rigs could be in operation simultaneously and drilling is expected to take place 24 hours a day, seven days per week.

This estimate includes the acreage of surface disturbance for all new well pads, roads, and pipeline corridors associated with the well field needed to supply geothermal resources for one 30-MW power plant. If the maximum scenario envisioned in the RFD scenario (two 30-MW power plants) is realized, the expected disturbance would double: 212 acres of temporary disturbance (106 acres x 2 power plants) with 194 acres of disturbance (97 acres x 2 power plants) following initial reclamation.

Total foreseeable surface disturbance for new well pads, roads, and pipeline corridors associated with the wellfield for *each* 30 MW powerplant is summarized below.

Description	**Unit Surface Disturbance (acres)**	**Number**	**Total Surface Disturbance (acres)**
Well pads	7	5	35
Access roads	3.6 acres/mi	15 miles	54
Flat-land Pipelines	1.2 acres/mi	2.5 miles	3
Rugged-land Pipelines (initial)	3.6 acres/mi	2.5 miles	9
Rugged-land Pipelines (final)	1.8 acres/mi	2.5 miles	5
-			**106 acres (initial)** **97 acres (final)**

Considering the surface disturbance from two wellfields to supply geothermal resources to the two 30 MW powerplants, the initial ***total*** surface disturbance would be 212 acres (106 acres x 2) and then about 194 acres (97 acres x 2) after reclamation.

Potential Impacts

Noise- Each well is expected to take between 90 and 150 days to drill. During this time, greater than 95 dB of noise will be generated by the diesel engines that power the drilling rig and air compressors/mud pumps, as well as from the drawworks, drawworks brake, racking of pipe, and well testing. The racking of pipe and drawworks brake are higher pitched noises that typically travel further and are more difficult to mitigate than sources such as diesel engines. All diesel engines will use mufflers per standard industry practice. All well testing will be done through mufflers to reduce noise. Up to three drilling rigs could be in operation simultaneously and drilling is expected to take place 24 hours a day, seven days per week.

Air Quality- Diesel engine exhaust, well testing, and dust are the primary impacts to air quality from the drilling of wells. Vented steam during a well test can contain dust, carbon dioxide, hydrogen sulfide, mercury, benzene, and ammonium and other non-condensable gases. Hydrogen sulfide emissions are abated through the injection of hydrogen peroxide and sodium hydroxide into the test line. Dust emissions from roads can be mitigated by periodic watering.

Groundwater- There may be Underground Sources of Drinking Water in the HGLA, and groundwater may be potable in some parts of the basin. However, given the geology, significant groundwater sources of drinking water are unlikely. If potential drinking water from groundwater does occur, geothermal wells include multiple casing strings at shallow depths where aquifers are most likely to exist. For a 9,000-foot well, surface casing is normally set between 300 and 1,000 feet, an intermediate string is set at 2,000 to 4,000 feet, and a production string is set to 4,000 to 6,000 feet. Casing is either cemented in place or slotted linear (uncemented) using standard industry practice. In addition, all injection wells may be required to be periodically tested for mechanical integrity. The testing protocol will depend on the nature of any aquifers and the type of resource encountered.

B.2.3 Powerplants

Potential Impacts

Based on the type of reservoir encountered at the Coso geothermal field, it is anticipated that two dual flash powerplant locations will be built to utilize the hot water and steam from the leases in the HGLA. Each powerplant will be capable of generating 30 MW (net) of electricity.

In a dual flash powerplant, hot water from the wells is first sent to a high pressure separator where the pressure is reduced, thereby causing some of the hot water to flash to steam. The steam is sent to a high pressure turbine. The hot water that is not flashed to steam is then sent to a low pressure separator where the pressure is once again reduced and some of the hot water flashes into low pressure steam. The low pressure steam is sent to a low pressure turbine. Whatever hot water is not flashed into steam is sent to an injection well. Typically, this process only flashes 20% to 30% of the hot water into steam, on a mass basis.

After leaving the turbine, both the high and low pressure steam are condensed into water and then sent to a cooling tower for further temperature reduction. The cool water is circulated through the condenser to increase plant efficiency. Water that is not evaporated in the cooling process or used in the condenser loop is also sent to an injection well.

Each plant location would require about 20 acres, which would be 25 acres of total surface disturbance including cut and fill. Each plant would also require three miles of access road and four miles of new transmission line to intertie with an existing transmission line that runs through the southwest portion of the HGLA. It is assumed that the access road will require 30 feet of surface disturbance, which includes cut and fill. Transmission intertie lines require 100 feet of initial surface disturbance; however, once the lines are constructed all but a 20-foot wide access road would be reclaimed with native vegetation.

The total surface disturbance for both powerplants is summarized in the following table:

Description	Unit Surface Disturbance (acres)	Number	Total Surface Disturbance (acres)
Powerplant location	25 acres/powerplant	2 powerplants	50
Access roads	3.6 ac/mi	6 miles	22
Transmission lines - initial	12.1 ac/mi	4 miles	48
Transmission lines - final	2.4 acres/mi	4 miles	10
Total Disturbed Acres - Powerplants	-	-	**130 (initial)** **82 (final**)

Potential Impacts

Noise- Powerplant noise usually entails a constant low-level hum primarily created by the cooling tower fans.

Air Quality- A dual flash plant will discharge any non-condensable gases that are produced with the steam including carbon dioxide, methane, ammonia, and hydrogen sulfide. However, local air quality districts typically have strict limits on hydrogen sulfide emissions. To mitigate hydrogen sulfide emissions, the hydrogen sulfide gases are scrubbed from the steam using a "Stretford", iron chelate, or burner process.

Groundwater- Geothermal exploration and development will require water for well drilling, dust control during construction, and makeup water to compensate for evaporative loss during plant operation if the plant utilizes "wet" cooling towers. Water would be required during exploration and gradient well drilling activities occurring throughout the life of the project, as well. Makeup water necessary to maintain fluid pressures in the geothermal reservoir would also be necessary. Reinjection of less water than is produced from the geothermal reservoir would result in a gradual reduction in reservoir pressures and/or geothermal fluid yield and, as a consequence, result in a gradual reduction in the quantity of steam available to generate power.

Any additional groundwater extraction in the Rose Valley aquifer could cause localized or more wide-spread drawdowns in groundwater. Depending on groundwater extraction rates and proximity to sensitive features like Little Lake, water table drawdown could significantly impact the water available for residential use, irrigation, riparian and wetland habitat, and private wells. Increased groundwater extraction could also indirectly impact groundwater quality. Increased groundwater extraction could create upward groundwater gradients, causing an increase in Total Dissolved Solids (TDS) content, and could reduce suitability of groundwater for agricultural or drinking water uses. Increase of TDS could be great enough in some cases to render some groundwater no longer suitable as a drinking water source.

Overall, minor to no measurable short-term impacts would be expected from groundwater extraction needs for exploration, development, and dust control with the realized RDF. Higher impacts to existing groundwater users in Rose Valley are expected if continuous groundwater extraction would be conducted to augment the geothermal reservoir fluid. Long-term groundwater extraction from the local, near surface groundwater aquifer, to augment geothermal reservoir fluid levels could likely have significant long-term impacts on groundwater resources in Rose Valley, particularly, to Little Lake, if restrictions are not implemented.

Withdrawals could increase the depth to groundwater near existing water supply wells in the central portion and north end of Rose Valley leading to a drying of shallow wells, and long-term pumping could cause a reduction in groundwater flow towards Little Lake Ranch. Long-term reliance on water from the geothermal reservoir would likely require supplemental injection from another source.

Stipulations imposed by the BLM would require that groundwater extraction for consumptive use may be allowed, but may not exceed the safe yield or recharge rate to the Rose Valley Aquifer and may not cause a decline of 10 percent or more to the average annual flow of water of water flowing into the surface features at Little Lake. Therefore, impacts to the water resources are expected to be minor, and largely limited to local changes in groundwater recharge or runoff patterns.

Visual - Powerplants will be sited using terrain to obstruct visual impacts to the extent possible. All facilities will also be painted a color that blends into the natural setting. Steam plumes from the cooling towers, may rise several hundred feet above the cooling towers on cold, clear days, but may be absent on warm, dry days, especially in summer.

Seismic Impacts - Development at The Geysers geothermal field has resulted in the creation of micro-seismic events that seem to be tied to production and/or injection. This has been a cause for concern in the development of other geothermal fields as well. The Geysers is a unique dry-steam resource that is only found in two or three other places in the world. Induced seismicity is not typical to geothermal development. The induced seismicity experienced at The Geysers is less than magnitude 3.0 on the Richter scale. While larger earthquakes do occur within The Geysers, there is little evidence that these are tied to geothermal activity. More likely, the larger events are related to naturally-occurring movement along the many faults in the area.

Environmental analysis done at The Geysers has concluded that while micro-seismic events are a result of geothermal activity, these events are not large enough to cause structural damage to homes or other improvements. Therefore, this has not been considered a significant impact.

B.2.4 Decommissioning and Reclamation

Total disturbance from exploration, development, and operation of two 30 MW geothermal electrical generating facilities is projected to be 404 acres (see discussion above), with 368 of these acres (91 percent) expected to occur on BLM managed lands. Following initial exploration and development, 128 acres of disturbance are projected to be reclaimed to pre-project conditions. For the 30-year operational life of the facilities, the projected long-term disturbance is 276 acres. Of that, 251 acres (91 percent of 276 acres) are expected to occur on BLM managed lands.

The decommissioning of a facility typically occurs when the energy resource has been depleted. Close-out entails the removal of all hardware and infrastructure improvements that serviced the facility (i.e., roads, concrete pads, and structures) and the rehabilitation of the land in accordance with a reclamation plan approved by the BLM. The goal of the completed reclamation is to return the land to its pre-project condition.

APPENDIX C

ROSE VALLEY GROUDWATER CHEMISTRY

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APPENDIX C

ROSE VALLEY GROUNDWATER CHEMISTRY

C.1.0 Introduction

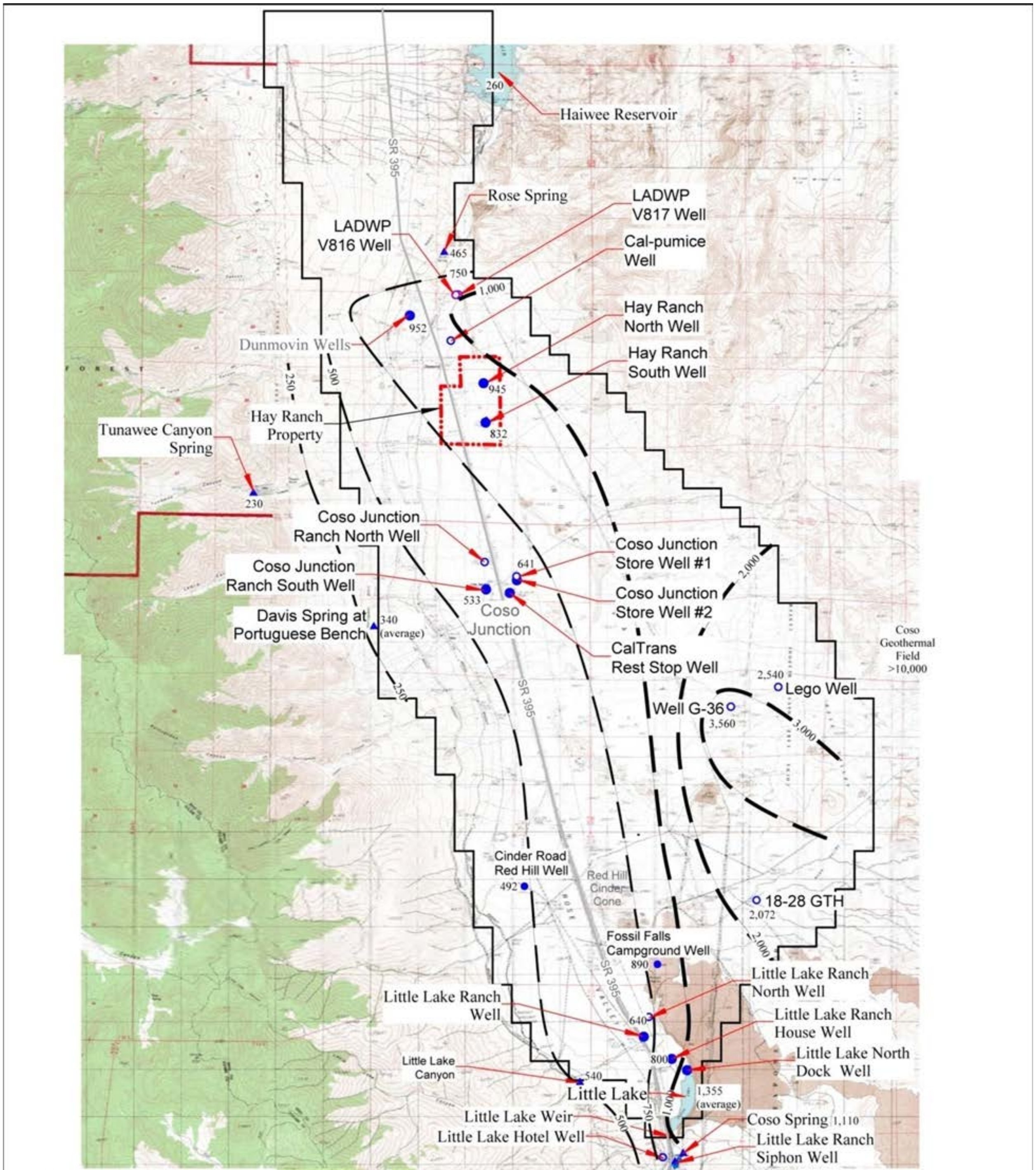
This section discusses the chemistry of the waters found in the vicinity of the Haiwee Geothermal Leasing Area (HGLA). Particular focus is given to identifying water types and distinguishing the sources of various waters as well as the relationship between a variety of waters identified in the area.

The chemistry of waters found in Rose Valley and the related watershed varies widely reflecting the multiple types of waters often found within hydrological systems of the semi-arid western United States with the addition of a hydrothermal system. Water chemistry in the Haiwee area is influenced by the interaction between groundwater and rock along the hydrological flow paths with the addition of a geothermal brine component. Recharge waters from drainage of the mountains surrounding Rose Valley have lower dissolved solids (TDS) than the valley's groundwater, which typically is higher in dissolved solids reflecting longer transit times and a greater degree of water-rock interaction. Surface water can be even higher in dissolved solids where it is impacted by evaporation (Güler 2002). Outflow of saline geothermal brines from the Coso geothermal system to the east may also provide a component of flow to the Rose Valley hydrological system.

Total dissolved solids (TDS) range from very low to a few hundred milligrams per liter (mg/L) in surface streams draining the Sierras to the west or in springs of the Coso-Argus Range to the east to several thousand mg/L in geothermal brines in the Coso Geothermal Reservoir and related geothermal surface manifestations to the east. Groundwater in the northern Rose Valley near Hay Ranch is characterized by TDS between 800 and 900 mg/L whereas groundwater in the southern Rose Valley is characterized by TDS from 500 to 700 mg/L. At Little Lake the water is slightly brackish with TDS from 1,500-2,500 mg/L. The TDS levels in the upper several hundred feet throughout the Rose Valley are shown in Figure C-1.

The Coso geothermal system was initially a liquid-dominated system containing sodium chloride brines with a small steam cap in the shallowest parts of the field. The fluids contain non-condensable gases which are primarily carbon dioxide. Where there is steam present, the gases partition into the steam phase. The steam cap has grown during the last 20 years of supplying power generation. Surface manifestations include both brine-fed and steam-fed features. The brine fed features are typically brine-groundwater mixtures while the steam-fed features are mud-pots and fumaroles affected by steam or steam condensate containing acidic gases mixing with surface waters or surface material. The chemistry of the geothermal system will be discussed further in the sections below. While the TDS of the geothermal fluids is distinctly higher than the rest of the area (10,000 mg/L), it is not included in the contours because the connection is not well defined.

Figure C-1 Distribution of Total Dissolved Solids in Rose Valley



SOURCE: Geologica 2008

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C.2.0 Hydrochemical Analyses and Water Types

Chemical analysis of water samples collected in the Rose Valley and vicinity indicates that there are several distinct water types. Sierran waters (and minor amounts of water from the Coso Range) recharge the area (Güler 2002, Williams 2004). There also appears to be or to have been a small inflow of subterranean discharge from the Coso Geothermal System which reaches as far as the LEGO well. The chemistry and isotopic signatures of the other types of water suggest that the Rose Valley hydrological system contains waters that have followed different and sometimes complex pathways from their mountain sources to points of discharge.

Güler (2002), and Williams (2004) compiled an extensive database of chemical analyses of waters within the area to evaluate and characterize water quality. They grouped the waters within the area into several water types:

- Sierran: springs and streams that drain the Sierras; calcium (Ca)- (sodium, Na)-bicarbonate (HCO3); average TDS≈200 mg/L
- Indian Wells Rose Valley: springs, streams and shallow groundwater in basins along the eastern side of the Sierra; Na-Ca-HCO3-(sulfate, SO4); average TDS≈700 mg/L
- Coso-Argus Group: surface and spring samples from the Coso and Argus Ranges; Ca-HCO3 - average TDS≈500 mg/L
- Little Lake Group: Samples from Little Lake and surrounding springs; Na-(Mg)-HCO3 -Cl; average TDS≈1,200 mg/L
- Geothermal Brine: from deep (500-3,000 m Coso geothermal reservoir); Na-Cl; TDS≈10,000 mg/L

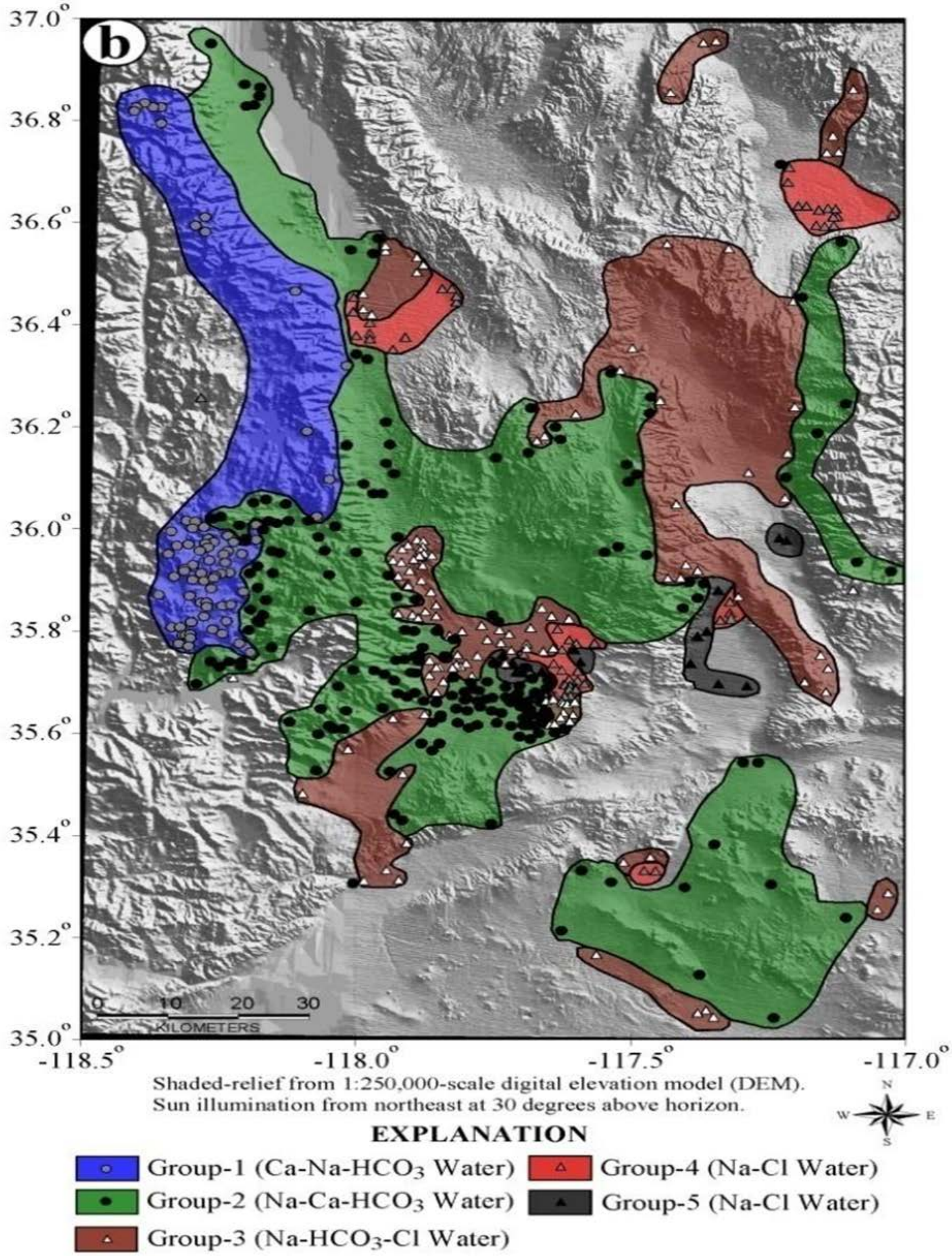
To these we add two types of waters found at Coso Hot Springs:

- Geothermal steam-fed surface fluid
- Geothermal brine-fed surface fluids

Waters in the vicinity of the program area have also been classified based on the relationship to the point of recharge; the chemistry of water in Basin and Range-type hydrological systems can be explained by increasing degrees of water-rock interaction and chemical evolution. High Sierra recharge waters (Group 1) are Ca-Na-HCO3 water with average TDS of 67 mg/l whereas low-elevation Sierra and Coso Range waters and basin fill groundwaters (Group 2) are slightly more evolved based on water-rock interaction and are typically Na-Ca-HCO3 water with average TDS of 356 mg/l. The waters in the program area are primarily Group 1 and 2 types, but within the area slightly to the north, there are more concentrated and evolved waters. Group 3 are transitional Na-HCO3-Cl waters typically found on basin floors with an average TDS of 1018 mg/l representing greater evolution. Group 4 are brackish Na-CL waters with average TDS of 5133 mg/l and Group 5 are brines with an average TDS of 94,000 mg/l.

Figure C-2 shows the distribution of these waters in the vicinity of the HGLA. Geothermal waters represent waters with higher degrees of water rock interaction partially influenced by higher temperatures, interaction with different minerals and the influence of magmatic influx. Although they are primarily NaCl brines, they are not included in this classification.

Figure C-2 Water Types in the Vicinity from Gruler (2002)



A review of chemical and isotopic analysis of water samples from Rose Valley and the adjacent mountains suggests that Sierran, Indian Wells-Rose Valley (IWRV), Little Lake (LL), and possibly a component of geothermal brine water types are present in Rose Valley groundwater. Within the IWRV type, Portuguese Bench, Coso Junction, and Hay Ranch waters are clearly distinguished from each other and from Little Lake and geothermal waters, particularly in the conservative element of chloride. Little Lake waters, represented by the LL Ranch House Well, LL (an average of surface waters), and the Coso Spring are clearly distinguished from other Rose Valley groundwaters by higher concentrations of all constituents except Ca and Mg according to Güler (2002), and Williams (2004). The only exception is the geothermal-influenced LEGO and 18-28 GTH wells. Williams (2004) suggests that elevated Na relative to Ca, Mg, and Cl, as well as boron (B) and lithium (Li) indicate a geothermal component in Little Lake waters. However, the elevated chloride in Little Lake waters may also be a result of evaporation (concentration) of waters from nearby Sierran recharge from the west (as represented by Little Lake Canyon Spring) combined with groundwater flow down the valley (represented by Little Lake north well water).

Hay Ranch groundwater appears to be a more concentrated version of Haiwee Reservoir water. The dominance of sulfate in waters in the northern part of Rose Valley (Hay Ranch and Dunmovin) distinguishes these waters from the rest of the valley. Although the Hay Ranch wells were drilled deeper than many of the other wells in the valley, the Dunmovin well is not, so depth alone probably does not produce the difference in water chemistry. Concentration of these waters by evaporation would not produce the chemistry of the Little Lake waters, suggesting that other waters must mix with the northern Rose Valley waters as they flow southward towards Little Lake prior to evaporation in the Lake which produces the distinct chemistry of Little Lake water.

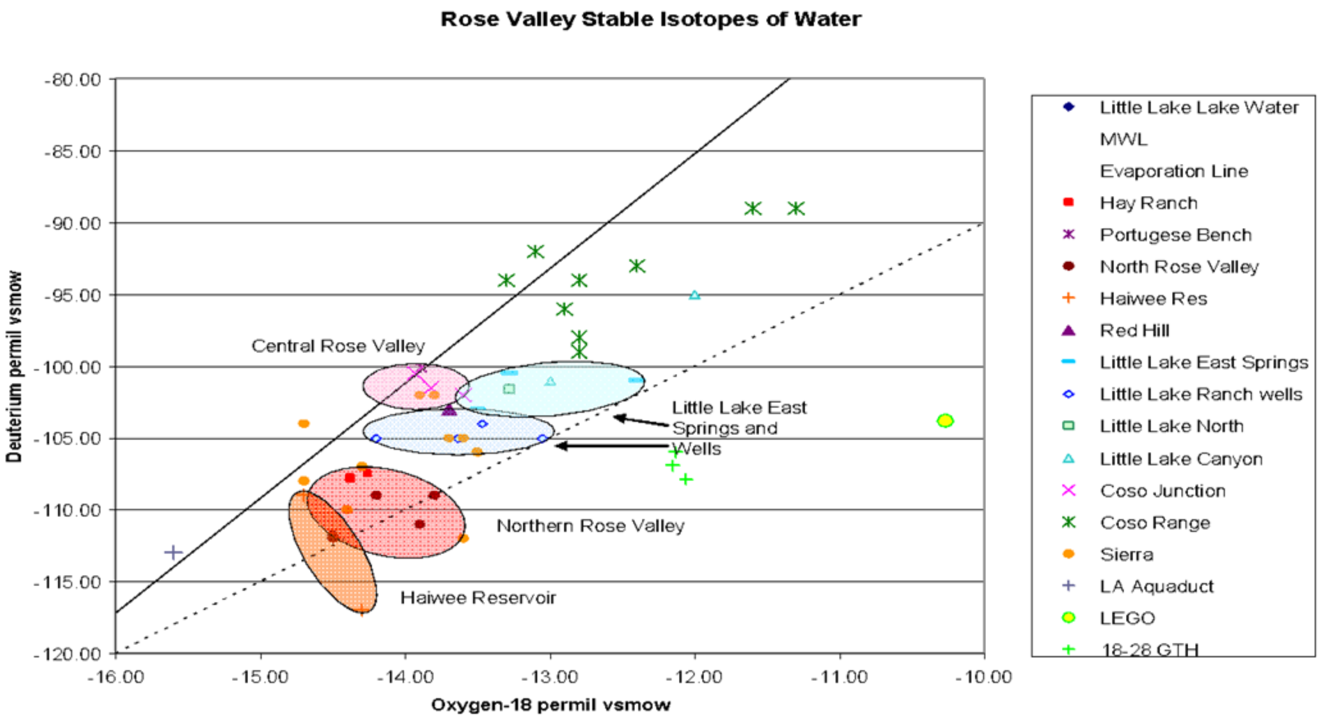
Despite the different chemistries of waters at discharge points within Rose Valley watershed most waters appear to generally have the same origin. Similar boron/chloride ratios (the ratio of two relatively conservative elements) support similar origins. Boron/chloride ratios within the Hay Ranch watershed are similar to water from the Sierras and to the Coso geothermal waters suggesting that although various processes change the absolute concentrations of these conservative elements, the source of the water is likely precipitation in the Sierra and Coso Ranges.

C.3.0 Isotope Data

Stable water isotope (oxygen-18 and deuterium) signatures are commonly used to evaluate the origins of waters. Isotope concentrations of waters from within the Rose Valley and its watershed reflect variable sources as well as evaporation. Stable isotopic data for Rose Valley waters was collected from numerous sources (MHA-RHT 2009) from analysis in many laboratories over many years. Within single data sets variation of oxygen-18 is around $\pm 0.2^{o}/_{oo}$ and deuterium is approximately $1^{o}/_{oo}$, the range of variability around the data presented below is probably greater that these numbers.

Evaporation enriches waters in the heavier stable isotopes making the waters less isotopically negative. At first glance, the stable isotopes of Little Lake waters appear different from all other waters. These differences can be explained by isotopic fractionation which occurs during the evaporation of these shallow lakes (Figure C-3).

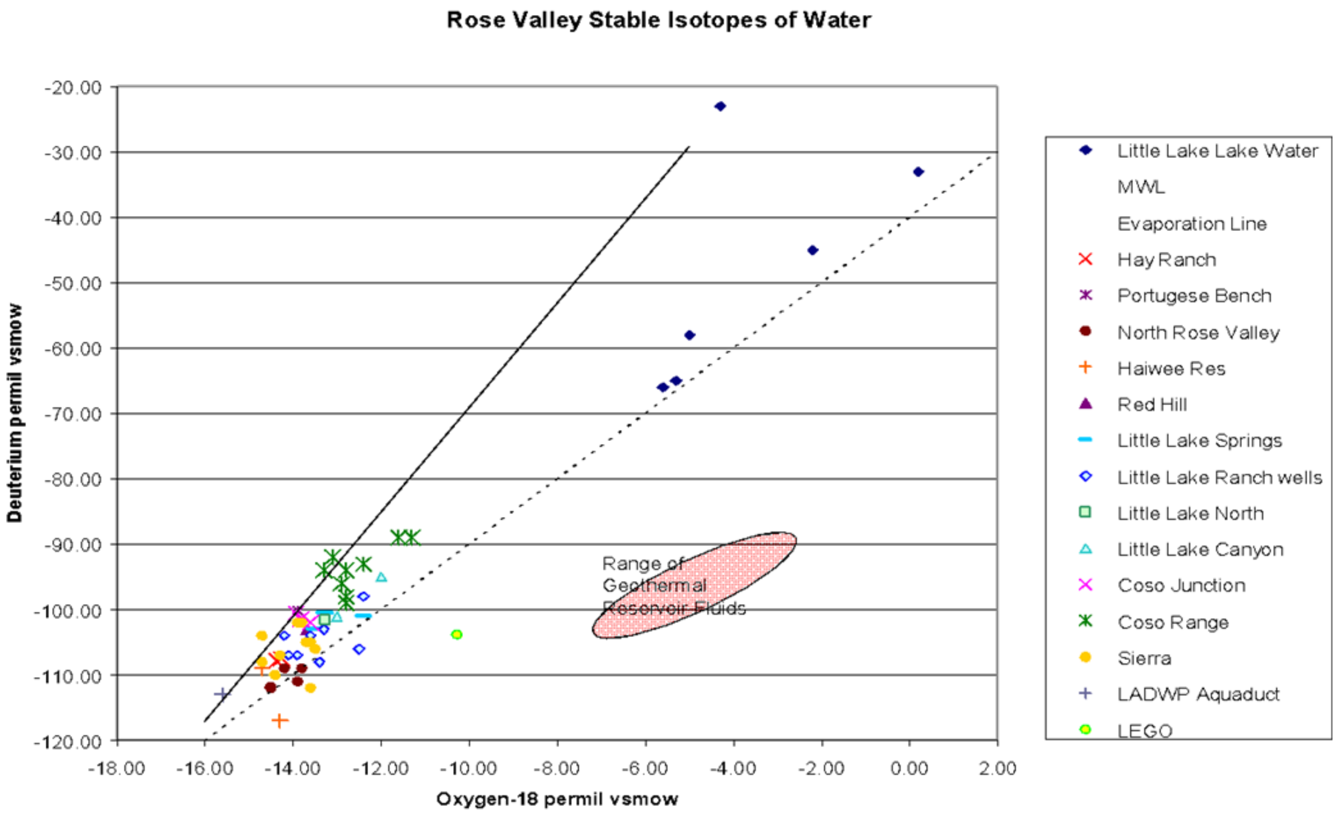
Figure C-3 Stable Isotopes of Rose Valley excluding the lake water from Little Lake



SOURCE: Fournier and Thompson (1980), Guler (2002), Geotrans, (2004), Coso Operating Company (2007), US Navy GPO (2007 and 2008).

Based on stable isotopic composition of groundwater represented by well and spring waters (minimizing the effect of evaporation), sources of groundwater from the northern to the southern end of the valley can be distinguished from each other. These differences may in part reflect differences in recharge from the Sierra, which is isotopically lighter (more negative) to the north as represented by the Los Angeles Department of Water and Power (LADWP) Aqueduct water and Haiwee Reservoir and isotopically heavier (less negative) in the south. The Haiwee reservoir sample may also be influenced by evaporation. The stable isotopic signature of the northern part of the Valley (including Hay Ranch waters) is similar to the Haiwee Reservoir and the highest or more northerly Sierras. Portuguese Bench and Coso Junction waters appear to be similar to each other and isotopically more like the Sierras farther south than Haiwee and more directly west of Rose Valley (Figure C-4). Thus, the isotopic signature of Rose Valley groundwaters suggest that there is recharge from the Sierras all along the north-south axis of the valley, with different isotopic signatures, in addition to some valley underflow from north to south.

Figure C-4 Stable Isotopes of Waters from Rose Valley and Vicinity



SOURCE: Fournier and Thompson (1980), Guler (2002), Geotrans, (2004), Coso Operating Company (2007).

The isotopic signature of groundwater in wells or springs down gradient from Little Lake (i.e., Little Lake East Spring, also known as Coso Spring, and Little Lake Ranch Wells) is probably affected by the isotopic shift related to evaporation of the lake water. Therefore, the Little Lake North Well probably represents un-evaporated recharge to the Lake from groundwater whereas Little Lake Canyon spring may indicate recharge to the Little Lake from the west. The source waters for Little Lake appear to be either:

1) From the Sierran source area similar to Portuguese Bench springs with a longer subsurface pathway (which increases oxygen-18 by water-rock interaction but not deuterium), or

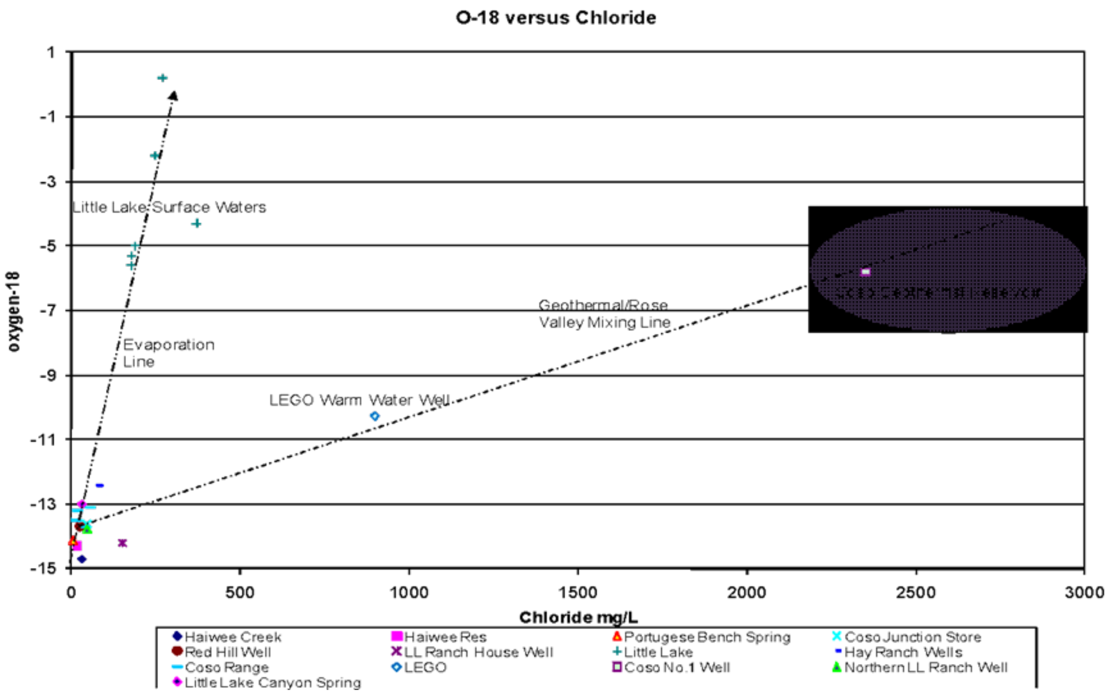
2) Predominantly Portugese Bench type Sierra water and a small amount of geothermal water (or geothermal mixed water), or

3) Predominantly Portuguese Bench type Sierra water and a small amount of Rose Valley underflow from the north.

If the major source of Little Lake water was directly from the Hay Ranch area via subsurface groundwater flow, significant evaporation would have to occur prior to arriving at Little Lake which is unlikely. In addition, groundwater flow within the Rose Valley would have a major diversion around Coso Junction.

While the chloride concentrations in Little Lake water could be produced by mixing a component of the geothermal water from the east, the combination of isotopic signature and chloride concentrations in Little Lake are most likely generated by evaporating water similar to that observed in the Little Lake North Well or in the Little Lake Canyon Spring to the west or a combination of the two (Figure C-5). In either case, water isotopes suggest the water sources for the Little Lake area are predominantly from the local Sierran watershed to the west and are distinct from the Northern Rose Valley water chemistries, potentially indicating more recharge to the Little Lake area from the west than from the north. Slight displacement towards a lighter isotopic signature from the area around Portuguese Bench may reflect a slight influence of groundwater underflow from north to south through Rose Valley.

Figure C-5 Oxygen-18 versus Chloride Relationships in Waters around Rose Valley



Water Potability

Drinking water quality (potability) of waters within the Rose Valley ranges from excellent to marginal. Available data (MHA-RMT, 2009) indicate that Hay Ranch waters exceed primary drinking water standards (EPA, 2003) for arsenic, nitrate and nitrite. Secondary drinking water standards are primarily related to aesthetics and taste. Several waters exceed the secondary drinking water standard levels for TDS and sulfate. Recent analysis of water samples from the Hay Ranch wells indicates the water does not meet secondary drinking water standards for TDS, sulfate, iron and manganese.

APPENDIX D

Supplemental Biological Data and Protected/Sensitive Wildlife Species

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APPENDIX D

PROTECTED/SENSITIVE PLANT AND WILDLIFE SPECIES

This appendix provides supplemental tables discussed in Section 3.7 and Section 4.7 of this FSEIS that have changed from or supplement the DEIS (BLM 2012). Also refer to Section 3.19, Section 4.19 and Appendix D of the DEIS.

Table D-1 List of Special-status Plant Species Expected to Occur in the Haiwee Geothermal Leasing Area

Common name *Scientific name*[1]	**Listing Status**[2] **Federal**	**State**	**Conservation Status**[3] **BLM FO**	**CNPS**	**Flowering Period**[4]	**Habitat Preferences**[4]	**Potential for Occurrence**[5]
Ripley's aliciella *Aliciella ripleyi*	-	-	-	1B.3	May-Jul	Perennial herb. Mojavean desert scrub, on limestone and carbonate soils; rocky slopes, rock/cliff faces, and rock crevices. 300–1950 m	**Low.** Some potential suitable habitat in action area, but no recent observations.
Spanish Needle onion *Allium shevockii*	-	-	SS	1B.3	May-Jun	Bulbiferous herb. Pinyon and juniper woodlands and upper montane coniferous forest; metamorphic outcrops and talus. 850–2500 m	**Low.** Very little potential suitable habitat in action area and nearest known location is 17 mi away.
Darwin Mesa milk-vetch *Astragalus atratus* var. *mensanus*	-	-	SS	1B.1	Apr-Jul	Perennial herb. Great Basin scrub, Joshua tree woodland, and pinyon and juniper woodlands; volcanic clay soils and gravel. 1340-2315 m	**High.** Some potential suitable habitat in action area and nearest known location is 3 mi away.
Walker Pass milk-vetch *Astragalus ertterae*	-	-	SS	1B.3	Apr-May	Perennial herb. Pinyon and juniper woodlands; open areas with sandy, granitic soil, among pines, live oaks. 1705-1900 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is 24 mi away.

Common name *Scientific name*[1]	Listing Status[2] Federal	State	Conservation Status[3] BLM FO	CNPS	Flowering Period[4]	Habitat Preferences[4]	Potential for Occurrence[5]
White pygmy-poppy *Canbya candida*	FS S	-	-	4.2	Mar-Jun	Annual herb. Joshua tree woodland, Mojavean desert scrub, and pinyon and juniper woodland; sandy places. 600-1460 m.	**High.** Some potential suitable habitat in action area and nearest known location is 4 mi away.
Muir's tarplant *Carlquistia muirii*	-	-	SS	1B.3	Jul-Aug	Rhizomatous herb. Chaparral, lower montane coniferous forest, and upper montane coniferous forest; dry, open sites on granitic soil. 1100-2500 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is 20 mi away.
Jaeger's caulostramina *Caulostramina jaegeri*	-	-	SS	1B.2	May-Jul	Perennial herb. Great Basin scrub, limestone, pinyon and juniper woodlands, and subalpine coniferous forest; rock crevices and cliffs. 1800 – 2800 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is 28 mi away.
Kern Canyon clarkia *Clarkia xantiana* ssp. *parviflora*	-	-	-	4.2	May-Jun	Annual herb. Chaparral, Cismontane woodland, Great Basin scrub, valley and foothill grassland; sandy, rocky soils on dry slopes and occasional roadsides. 700 -3620 m.	**Moderate.** Some potential suitable habitat in action area and nearest known location is 2 mi away.
Bristlecone cryptantha *Cryptantha roosiorum*	-	Rare	SS	1B.2	June-July	Perennial herb. Limestone and subalpine coniferous forest; carbonate, rocky soils and high ridges. 2440-3230 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is >30 mi away.
Desert cymopterus *Cymopterus deserticola*	-	-	SS	1B.2	Mar-May	Perennial herb. Joshua tree and Mojavean desert scrub; sandy desert. 630-1500 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.

Common name ***Scientific name***[1]	**Listing Status**[2] **Federal**	**State**	**Conservation Status**[3] **BLM FO**	**CNPS**	**Flowering Period**[4]	**Habitat Preferences**[4]	**Potential for Occurrence**[5]
Ripley's cymopterus *Cymopterus ripleyi* var. *saniculoides*	-	-	SS	1B.2	Apr-Jun	Perennial herb. Joshua tree woodland and Mojave desert scrub; sandy, gravelly carbonate soil. 1000-1660 m	**Moderate.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
July Gold *Dedeckera eurekensis*	-	Rare	SS	1B.3	May-Aug	Deciduous shrub. Desert wash, limestone, and Mojavean desert scrub; limestone outcrops and carbonate soils. 1220-2200 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Mojave tarplant *Deinandra mohavensis*		CE	SS	1B.3	June-Oct (Jan)	Annual herb. Chaparral, coastal scrub, and riparian scrub; mesic. 640-1600 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is 22 mi away.
Panamint daisy *Enceliopsis covillei*	-	-	SS	1B.2	Mar-Jun	Perennial herb. Mojavean desert scrub; subalkaline, stony hillsides and canyons. 400-1830 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Hall's daisy *Erigeron aequifolius*	-	-	SS	1B.3	Jul-Aug	Rhizomatous herb. Broadleaved upland forest, lower montane coniferous forest, pinyon and juniper woodlands, and upper montane coniferous forest; rocky and granitic substrate, rock ledges and crevices. 1500-2440 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is 20 mi away.
Kern buckwheat *Eriogonum kennedyi* var. *pinicola*	-	-	SS	1B.1	May-Jun	Perennial herb. Chaparral and pinyon and juniper woodlands; clayey substrate, dry ridges. 1340-1950 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is >30 mi away.
Pinyon Mesa buckwheat *Eriogonum mensicola*	-	-	-	1B.3	Jul-Sep	Perennial herb. Great Basin scrub, pinyon and juniper woodlands, and upper montane coniferous forest; open, rocky or gravelly substrate. 1800-2805 m.	**Low.** Some potential suitable habitat in action area and nearest known location is 6 mi away.

Common name ***Scientific name[1]***	**Listing Status[2] Federal**	**State**	**Conservation Status[3] BLM FO**	**CNPS**	**Flowering Period[4]**	**Habitat Preferences[4]**	**Potential for Occurrence[5]**
Panamint Mountains buckwheat *Eriogonum microthecum var. panamintense*	-	-	SS	1B.3	Jun-Oct	Deciduous shrub. Pinyon and juniper woodlands and subalpine coniferous forest; rocks. 1890-3250 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is >30 mi away.
Barstow Woolly-Sunflower *Eriophyllum mohavense*	-	-	SS	1B.2	Apr-May	Annual herb. Alkali playa, chenopod scrub, and Mojavean desert scrub; creosote bush scrub. 500-960 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Red Rock poppy *Eschscholzia minutiflora* ssp. *twisselmannii*	-	-	SS	1B.2	Mar-May	Annual herb. Mojavean desert scrub; volcanic tuff; desert washes, flats, and slopes. 680-1230 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Jaeger's hesperidanthus *Hesperidanthus jaegeri*	-	-	SS	1B.2	May-Jul	Perennial herb. Great Basin scrub, limestone, pinyon and juniper woodlands, and subalpine coniferous forest; rock crevices and cliffs. 1800 – 2800 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is 28 mi away.
Owens Peak lomatium *Lomatium shevockii*	-	-	SS	1B.3	Apr-May	Perennial herb. Lower montane coniferous forest and upper montane coniferous forest; rocky slopes and talus. 1770-2500 m.	**Low.** Very little potential suitable habitat in action area and nearest known location is >30 mi away.
Panamint Mountains lupine *Lupinus magnificus* ssp. *magnificus*	-	-	SS	1B.2	Apr-Jun	Perennial herb. Desert wash, Great Basin scrub, Mojavean desert scrub, and upper montane coniferous forest; desert slopes and washes. 1000-2500 m.	**Moderate.** Some potential suitable habitat in action area and nearest known location is 11 mi away.
Creamy blazing star *Mentzelia tridentata*	-	-	SS	1B.3	Mar-May	Annual herb. Mojavean desert scrub; creosote bush scrub; rocky, gravelly, or sandy substrate. 700-1160 m	**Moderate.** Some potential suitable habitat in action area and nearest known location is 6 mi away.

Common name *Scientific name*[1]	Listing Status[2] Federal	State	Conservation Status[3] BLM FO	CNPS	Flowering Period[4]	Habitat Preferences[4]	Potential for Occurrence[5]
Kelso Creek monkeyflower *Mimulus shevockii*	-	-	SS	1B.2	Mar-May	Annual herb. Joshua tree woodland and pinyon and juniper woodland; alluvial fans, dry streamlets, generally granitic soils. 800-1340 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Sweet-smelling monardella *Monardella beneolens*	-	-	SS	1B.3	Jul-Sep	Rhizomatous herb. Alpine boulder and rock field, subalpine coniferous forest, and upper montane coniferous forest; granitic substrates. 2500-3500 m.	**Low.** No potential suitable habitat in action area and nearest known location is 13 mi away.
Amargosa beardtongue *Penstemon fruticiformis* var. *amargosae*	-	-	-	1B.3	Apr- Jul	Perennial herb. Desert wash and Mojavean desert scrub; creosote bush scrub. 850-1400 m	**Moderate.** Some potential suitable habitat in action area and nearest known location is 4 mi away.
Inyo rock daisy *Perityle inyoensis*	-	-	SS	1B.2	Jun-Aug	Perennial herb. Great Basin scrub and Pinyon and juniper woodland; dry, rocky slopes. 1800-2710 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is 18 mi away.
Hanaupah rock daisy *Perityle villosa*	-	-	SS	1B.3	Jun-Sep	Perennial herb. Great Basin scrub and pinyon and juniper woodland; dry, rocky slopes. 1700-2600 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is >30 mi away.
Death Valley sandpaper plant *Petalonyx thurberi* ssp. *gilmanii*	-	-	SS	1B.3	May-Nov	Evergreen shrub. Desert dunes, desert wash, and Mojavean desert scrub; sandy washes and dunes. 260-1445 m.	**Low.** Some potential suitable habitat in action area, but nearest known location is 18 mi away.
Charlotte's phacelia *Phacelia nashiana*	-	-	SS	1B.2	Mar-Jun	Annual herb. Joshua tree woodland, Mojave desert scrub, and pinyon and juniper woodland; sandy to rocky, granitic slopes. 600-2200 m	**High.** Some potential suitable habitat in action area and nearest known location is 3 mi away.

Common name *Scientific name[1]*	**Listing Status[2] Federal**	**State**	**Conservation Status[3] BLM FO**	**CNPS**	**Flowering Period[4]**	**Habitat Preferences[4]**	**Potential for Occurrence[5]**
Nine Mile Canyon phacelia *Phacelia novenmillensis*	-	-	SS	1B.2	(Feb) May-Jun	Annual herb. Broadleaved upland forest, Cismontane woodland, pinyon and juniper woodland, and upper montane coniferous forest; open, sandy to gravelly soils. 1645-2640 m.	**Moderate.** Some potential suitable habitat in action area, but nearest known location is 10 mi away.
Owens Valley checkerbloom *Sidalcea covillei*	-	SE	SS	1B.1	Apr-Jun	Perennial herb. Chenopod scrub, Great Basin scrub, limestone meadow and seep, and wetlands; mesic alkaline soils and alkaline flats. 1095-1415 m	**Moderate.** Some potential suitable habitat in action area and nearest known location is 4 mi away.

1. Scientific and common names from CNDDB RareFind database (2017).
2. Plant status definitions are as follows:
   Federal: U.S. Fish and Wildlife Service designations:
   FE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.
   FT Threatened: Any species likely to become endangered within the foreseeable future.
   SC Species of concern: Other species of concern to the Service.
   SLC Species of local concern: Species of local or regional concern or conservation significance.
   State: California Department of Fish and Game designations:
   CE Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.
   CT Threatened: Any species likely to become endangered within the foreseeable future.
   United States Forest Service designations:
   FS S: Forest Service Sensitive species
3. Plant status definitions are as follows:
   BLM FO: BLM Ridgecrest Field Office
   SS Special status plant species
   CNPS: California Native Plant Society designations:
   1B Plants rare, threatened or endangered in California and elsewhere.
   2 Plants rare, threatened or endangered in California, but more common elsewhere.
   3 Plants for which more information is needed – a review list.
   Plants of limited distribution – a watch list.
   CNPS endangerment subcategories:
   .1 Seriously endangered in California.
   .2 Fairly endangered in California.
   .3 Not very endangered in California.
4. Flowering period and habitat preference information from CNDDB RareFind database (CDFG 2017), CNPS On-line Inventory (2017), BLM (2014), and Hickman (1993).
5. The following definitions for probability of occurrence are used:
   - **Present:** the species is known to occur.
   - **High:** historical records exist in the immediate vicinity or action area AND the habitat requirements strongly associated with the species occur in the action area.
   - **Moderate:** historical records exist in the immediate vicinity OR the habitat requirements strongly associated with the species occur in the action area.
   - **Low:** no recent historical records exist in the action area or immediate vicinity and/or the habitats needed to support the species are of poor quality.

Table D-2 Sensitive Wildlife Species with Potential to Occur within the Haiwee Action Area

Scientific Name	Species	Listing Status[1]			Habitat Requirements	Potential for Occurrence[2]
		FEDERAL	STATE	OTHER		
Birds						
Accipiter gentilis	Northern Goshawk	BLM Sensitive	-	DFG SC	Within, and in the vicinity of, coniferous forest. Uses old nests and maintains alternate sites. Usually nests on north slopes, near water; red fir, lodgepole pine, Jeffrey pine, and aspens are typical nest trees.	**Low.** Small area with potential habitat. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Aquila chrysaetos	Golden Eagle	-	-	DFG FG, USFWS BCC	Species occur in open habitats, especially in the mountains and hills, where it can spot prey from the air. They nest atop tall trees or high on rocky cliffs. Golden Eagles are uncommon year-round residents in Inyo County.	**High.** Small area with potential habitat. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Asio otus	Long-eared owl	-	-	DFG SSC	Long-eared Owls inhabit open woodlands, forest edges, riparian strips along rivers, hedgerows, juniper thickets, woodlots, and wooded ravines and gullies.. Roosting sites are usually in the heaviest forest cover available	**Low.** Small area with potential habitat. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Athene cunicularia	Burrowing Owl	BLM Sensitive	-	DFG SC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas. Uses rodent burrows in sparse grassland, desert, and agricultural habitats.	**High.** Suitable open habitat is found sporadically throughout the action area, especially in the open disturbed areas and grasslands. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Buteo swainsonii	Swainson's Hawk	-	ST	-	Breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs, agricultural areas, and ranches. Requires adjacent suitable foraging areas such as grasslands, or alfalfa or grain fields supporting rodent populations.	**Moderate.** Small area with potential habitat. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Falco peregrinus	Peregrine falcon	Delisted	SE	-	Near wetlands, lakes, rivers, or other water; on cliffs, banks, dunes, mounds, and man-made structures. Nest consists of a scrape on a depression or a ledge in an open site.	**Moderate.** Small patches of potential habitat found in western portion of the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species,
Haliaeetus leucocephalus	Bald Eagle	Delisted	ST	-	Ocean shore, lake margins, and rivers for both nesting and wintering. Most nests are within one mile of water. Nests in large, old-growth or dominant live trees with open branches, especially Ponderosa pine. Roosts communally in winter.	**Low.** Insufficient open aquatic habitat within the action area. It is determined that development in the action area will not affect this species.
Lanius ludovicianus	Loggerhead Shrike	-	-	DFG SSC, USFWS BCC	The Loggerhead Shrike occupies open country with lookout perches, woodlands, open scrub, and the margins of dry grasslands. It is a fairly common year-round resident in Inyo County.	**High.** Loggerhead Shrikes are expected to occur and nest in low numbers throughout the action area, especially near the transmission line corridors, where they can perch high above the habitat to search for prey. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Toxostoma lecontei	Le Conte's Thrasher	BLM Sensitive	-	DFG SSC, USFWS BCC	Inhabit low, hot, barren deserts and valleys, usually in regions of scant vegetation where the bird's light color blends with the sandy gravel environment. In Inyo County Le Conte's Thrashers are uncommon, year-round residents.	**High**. They are expected to occur and nest infrequently and in low numbers throughout the action area.

Scientific Name	Species	Listing Status[1]			Habitat Requirements	Potential for Occurrence[2]
		FEDERAL	STATE	OTHER		
Mammals						
Antrozous pallidus	Pallid Bat	BLM Sensitive, FSC	-	DFG SSC, WBWG: H	Deserts, grasslands, shrublands, woodlands and forests. Most common in open, dry habitats with rocky areas for roosting. Roosts must protect bats from high temperatures. This species is very sensitive to disturbance of roosting sites.	**High**. Potential foraging habitat in action area, but very limited rocky roosting habitat.
Corynorhinus tonwsendii	Townsend's Big-Eared Bat	BLM Sensitive, FSC	-	DFG SSC, WBWG: H	Occurs throughout California in a variety of habitats, but most common in mesic sites. Roosts in the open, hanging from walls or ceilings. Very sensitive to human disturbance.	**High.** Known sightings in the vicinity of the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Lasionycteris noctivagans	Silver-haired Bat	-	-	WBWG: H	Silver-haired bats are among the most common bats in forested areas of the United States. They are considered to be a solitary, tree-roosting species	**High.** Known sightings in the vicinity of the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Lasiurus blossivillii	Western Red Bat	-	-	DFG SSC, WBWG: H	Roosts primarily in trees, 2 to 40 feet off the ground. Occurs from sea level up through mixed conifer forests. Prefers habitat edges and mosaics with trees that are protected from above and open below, with open areas for foraging.	**High.** Known sightings in the vicinity of the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Spermophilus mohavensis	Mojave Ground Squirrel	-	ST	-	Open desert scrub, alkali scrub and Joshua tree woodland. Also feeds in annual grasslands, restricted to Mojave desert. Prefers sandy to gravelly soils, avoids rocky areas, uses burrows at base of shrubs for cover. Nests are in burrows.	**Present.** Known sightings in the vicinity of the action area. It is determined that development in the action area may adversely affect this species.
Taxidea taxus	American Badger	-	-	DFG SSC	It is most abundant in drier, open sites with friable soils in most shrub, forest, and herbaceous habitats. Badgers dig burrows for shelter and for natal dens.	**High.** Species is expected to occur and previous surveys have documented the species sign (i.e., dens, scat) within the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Vulpes macrotis arsipus	Desert Kit Fox	-	-	Ca Fur-bearing Mammal		**High.** Species is expected to occur and previous surveys have documented the species sign (i.e., dens, scat) within the action area. Multiple habitats including desert scrub, saltbush, chaparral, and grassland.

Scientific Name	Species	Listing Status[1]			Habitat Requirements	Potential for Occurrence[2]
		FEDERAL	STATE	OTHER		
Reptiles						
Gopherus agassizii	Desert Tortoise	FT	ST	-	Most common in desert scrub, desert wash and Joshua Tree habitats; occurs in almost every desert habitat. Requires friable soil for burrow and nest construction creosote bush habitat with annual wildflower blooms.	**Present.** Occurrence records exist for the species in the vicinity of the action area and suitable habitat exists. Additionally, known range of the desert tortoise includes Indian Wells Valley and Rose Valley (BLM 2005). Surveys conducted in 2009 found desert tortoises or their sign in low densities throughout these areas (Laberteaux 2009). It is determined that development in the action area may affect, but is not likely to adversely affect, this species.
Sceloporus graciosus gracisois	Northern Sagebrush Lizard	BLM Sensitive	-	DFG SSC	Occurs in the Great Basin and mountainous areas, inhabiting montane chaparral, hardwood and conifer habitats, eastside pine and juniper habitats, and Great Basin shrub habitats of the Sierra Nevada and the Cascades. Isolated populations occur at Sutter Buttes in the Sacramento Valley, in the Coast Range, and in the desert mountains of Inyo County.	**High.** Known sightings in the vicinity of the action area. It is determined that development in the action area may affect, but is not likely to adversely affect, this species.

[1]**Status Codes**
FE Federally listed as Endangered
FT Federally listed as Threatened
FPE Federally proposed for listing as Endangered
FPT Federally proposed for listing as Threatened
FPD Federally proposed for delisting
FC Federal candidate species (former Category 1 candidates)
FSC Species of Concern
SE State-listed as Endangered
ST State-listed as Threatened
SCE State candidate for listing as Endangered
SCT State candidate for listing as Threatened
SCD State candidate for delisting
BLM Sensitive
DFG SC: Department of Fish and Game Species of Concern
DFG FP: Department of Fish and Game Fully Protected Species
USFWS BCC: Fish and Wildlife Service Birds of Conservation Concern
WSBG:H The Western Bat Working Group Species designated as "High Priority

[2]**Potential for Occurrence (PFO)**
Absent from Site – Species is restricted to habitats that do not occur within the action area.
Low Potential for Occurrence – No historical records exits of the species occurring within the action area or its immediate vicinity, and/or the habitats needed to support the species on the site are of poor quality.
Moderate Potential for Occurrence –Either a historical record exists of the species within the immediate vicinity of the action area and/or the habitat requirements associated with the species occur within the action area
High Potential for Occurrence – Both a historical record exists of the species within the action area or its immediate vicinity and the habitat requirements strongly associated with the species occur within the action area.
Present – The species is known to occur.

Table D-3 Sensitive Wildlife Species with Potential to Occur within the Haiwee Action Area

SCIENTIFIC NAME	SPECIES	LISTING STATUS[1]			PROBABILITY OF OCCURRENCE[2]
		FEDERAL	STATE	OTHER	
Birds					
Accipiter gentilis	Northern Goshawk	BLM Sensitive	-	CDFG SC	Low
Aquila chrysaetos	Golden Eagle	BGEPA	-	CDFG FP, USFWS BCC	High
Asio otus	Long-eared owl	-	-	CDFG SSC	Low
Athene cunicularia	Burrowing Owl	BLM Sensitive	-	CDFG SC	Present
Buteo swainsonii	Swainson’s Hawk	-	ST	-	Moderate
Falco peregrinus	Peregrine falcon	Delisted	SE	-	Moderate
Haliaeetus leucocephalus	Bald Eagle	Delisted	ST	-	Low
Lanius ludovicianus	Loggerhead Shrike	-	-	CDFG SSC, USFWS BCC	High
Toxostoma lecontei	Le Conte's Thrasher	BLM Sensitive	-	CDFG SSC, USFWS BCC	High
Reptiles					
Gopherus agassizii	Desert Tortoise	FT	ST	-	Present
Sceloporus graciosus gracisois	Northern sagebrush lizard	BLM Sensitive	-	CDFG SSC	High
Mammals					
Antrozous pallidus	Pallid Bat	BLM Sensitive,	-	CDFG SSC, WBWG:H	High
Corynorhinus tonwsendii	Townsend’s Big-eared Bat	BLM Sensitive,	-	CDFG SSC, WBWG:H	High
Lasionycteris noctivagans	Silver-haired bat	-	-	WBWG:H	High
Lasiurus blossivillii	Western Red Bat	-	-	CDFG SSC, WBWG:H	High
Spermophilus mohavensis	Mojave Ground Squirrel	-	ST	-	Present
Taxidea taxus	American Badger	-	-	CDFG SSC	High

[1]**Status Codes**

FT Federally listed as Threatened
FSC Species of Concern
SE State-listed as Endangered

ST State-listed as Threatened
BLM Sensitive
CDFG SSC: Department of Fish and Game Species of Concern
CDFG FP: Department of Fish and Game Fully Protected Species
USFWS BCC: Fish and Wildlife Service Birds of Conservation Concern
WSBG:H The Western Bat Working Group Species designated as “High Priority”
BGEPA Bald and Golden Eagle Protection Act

[2]**Potential for Occurrence (PFO)**
Absent from Site – Species is restricted to habitats that do not occur within the action area.
Low Potential for Occurrence – No historical records exits of the species occurring within the action area or its immediate vicinity, and/or the habitats needed to support the species on the site are of poor quality.
Moderate Potential for Occurrence –Either a historical record exists of the species within the immediate vicinity of the action area and/or the habitat requirements associated with the species occur within the action area
High Potential for Occurrence – Both a historical record exists of the species within the action area or its immediate vicinity and the habitat requirements strongly associated with the species occur within the action area.
Present – The species is known to occur.

Table D-4 Impact Summary to Biological Resources

IMPACT TYPE	PROGRAM IMPACT	POTENTIAL IMPACT AND BIOLOGICAL RESOURCE EFFECTS	IMPACT LEVEL AND DURATION
Direct flora injury and/or mortality	Vehicle and human trampling during construction, operation and maintenance	Destruction, mortality, and injury to vegetation, reduction in habitat quantity and quality	**Moderate**. Long-term within the footprint from construction, access roads, and structures. Short-term in areas adjacent to drilling operations provided that restoration occurs.
Indirect plant injury and/or mortality	Soil compaction, spread of non-native species, deposition of dust and mud, soil erosion	Reduction in habitat quantity and quality, expansion of non-native species, reduction in plant vigor	**Low**. Short-term within the footprint from construction. Long-term for access roads.
Direct fauna injury and/or mortality	Vehicle and human trampling during construction, operation and maintenance	Destruction, mortality, and injury to wildlife species. Nest destruction. Fossorial species and species with limited mobility are most susceptible.	**Moderate**. Short-term within the footprint from construction, structures, and in areas adjacent to the geothermal plant. Long-term for access roads.
Indirect fauna injury and/or mortality	Vegetation removal, slope erosion, construction noise	Habitat quantity and quality reduction, habitat fragmentation, wildlife displacement	**Low**. Short-term within the footprint from construction. Long-term for access roads and/or vegetation maintenance.
Ground disturbance	Construction, well pads, geothermal plant, tower foundations, access roads	Habitat quantity and quality reduction, habitat fragmentation	**Moderate**. Short-term within the temporary footprint from construction. Long-term from access roads, well pads, pipeline and geothermal plant location.
Fugitive dust generation	Construction, maintenance, and repair activities	Reduced photosynthesis, impaired species respiration, reduction in habitat quality	**Low**. Short-term within the Program footprint from construction. Long-term from access roads and geothermal plant location.
Exposure to pollutants	Chemical spills from construction and maintenance	Reduce survival, population, and growth	**Low**. Short-term, localized to construction and maintenance sites.
Noise, human presence	Construction, maintenance, and repair activities	Displace wildlife, disrupt breeding, migration, and foraging	**Moderate**. Short-term within the footprint from construction. Long-term from access roads, well pads, and geothermal plant location.
Fire	Construction and maintenance equipment, human access	Habitat loss and reduction in habitat quality through the potential post-fire establishment of noxious weeds	**Low**. Short-term in the construction footprint for the transmission line provided that restoration occurs. Long-term for access roads, well pads, pipeline and geothermal plant location.

IMPACT TYPE	PROGRAM IMPACT	POTENTIAL IMPACT AND BIOLOGICAL RESOURCE EFFECTS	IMPACT LEVEL AND DURATION
Avian collisions	Conductors, shield wires, and guy-wires	Individual mortality; waterfowl and upland game birds would be most susceptible	**Moderate**. Long-term for transmission line ROW.
Increased predator habitat	Transmission towers	Raptors and corvids exploit perching opportunities, trash, and ponded water, resulting in increased predation on small mammal, tortoises and other bird species	**Moderate**. Long-term for transmission line ROW.

APPENDIX E

DEMOGRAPHICS

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APPENDIX E

This appendix provides supplemental tables and figures discussed in Section 3.19 and Section 4.19 of this FSEIS that have changed from the DEIS (BLM 2012). Also refer to Section 3.19, Section 4.19 and Appendix E of the DEIS.

Table E-1 Racial Composition of HGLA SSA Communities – Percent of Population

LOCATION	RACE[1]					
	WHITE	AFRICAN AMERICAN	ASIAN	HISPANIC	NATIVE AMERICAN[2]	NATIVE HAWAIIAN[3]
Inyo County	63.4	1.0	1.6	21.4	13.1	0.1
Independence	88.9	0.0	0.7	7.1	3.5	0.9
Lone Pine	79.6	0.1	0.8	23.7	7.4	0.0
Kern County	34.8	6.2	5.2	52.8	2.6	0.3
California City	68.2	12.8	3.7	17.0	1.6	0.3
Johannesburg	91.5	0.6	0.0	5.7	1.1	0.0
Mojave	67.5	5.6	2.0	28.3	1.3	0.1
Randsburg	85.7	0.0	0.0	5.2	5.2	0.0
Ridgecrest	82.0	3.5	3.9	12.0	1.1	0.6
San Bernardino County	29.3	9.5	7.4	52.8	2.0	0.5
Red Mountain / Trona	87.0	1.5	0.6	14.1	2.3	0.4
California	37.7	6.5	14.8	38.9	1.7	0.5

[1]Totals may be greater than 100 percent, based on USCB rounding data.
[2]Includes American Indian and Alaska Native ethnicities.
[3]Includes Native Hawaiian and Other Pacific Islander ethnicities.
Sources: USCB 2018a, USCB 2018b.

Table E-2 Rental, Ownership, and Vacant Housing Units in HGLA SSA Communities

LOCATION	HOUSING TYPE				TOTAL HOUSING UNITS*
	FOR RENT	FOR SALE ONLY	FOR MIGRANT WORKERS	OTHER VACANT UNITS	
Inyo County	120	68	4	272	1,540
Independence	7	1	0	40	290
Lone Pine	34	14	0	85	425
Kern County	6,693	2,806	192	10,203	28,955
California City	251	106	0	570	956
Johannesburg	0	0	0	99	99
Mojave	101	48	0	88	288
Randsburg	0	0	0	0	0
Ridgecrest	502	327	0	319	1,510
San Bernardino County	15,163	7,831	97	17,802	89,520
Red Mountain	Data not available.				
Trona	0	0	0	0	5
California	232,391	89,797	2,967	296,299	1,104,350

Sources: USCB 2012-2016 American Community Survey.
*The total number of housing units includes the data presented in Table E-2 and housing units that are rented, but not occupied; housing units that are sold and not occupied; and housing units for seasonal, recreational, or occasional use.

Table E-3 Median Household Income and Per Capita Income for Communities in the HGLA SSA

LOCATION	MEDIAN HOUSEHOLD INCOME	PER CAPITA INCOME
Inyo County	$47,278	$28,678
Independence	$54,423	$27,815
Lone Pine	$38,661	$23,796
Kern County	$49,788	$21,094
California City	$48,776	$19,849
Johannesburg	Data not available.	$10,679
Mojave	$34,280	$17,195
Randsburg	$26,314	$23,015
Ridgecrest	$59,780	$28,095
San Bernardino County	$54,469	$21,857
Red Mountain	Data not available.	
Trona	Data not available.	
California	$63,783	$31,458

Sources: USCB 2018a, USCB 2018b.

Table E-4 Population Trends in the Counties in the HGLA SSA

COUNTY	2000[1]	2010[2]	2016[2]	PERCENT CHANGE 2000-2016
Inyo	17,945	18,546	18,144	1.1
Kern	661,645	839,627	884,788	33.7
San Bernardino	1,709,434	2,035,212	2,140,096	25.2

Source: [1]USCB 2000; [2]USCB 2018a, USCB 2018b.

Table E-5 Census 2010 Populations by Zip Code

ZIP CODE	AREA NAME	COUNTY	2010 POPULATION	PERSONS PER SQ. MILE
92328	Death Valley-Homewood Canyon-Valley Wells	Inyo	445	0.2
93513	Big Pine	Inyo	1,763	7.0
93522	Darwin	Inyo	48	1.2
93526	Independence	Inyo	719	12.7
93545	Lone Pine	Inyo	2,082	50.0
93549	Olancha	Inyo	344	1.1
	INYO COUNTY TOTAL		**5,401**	**2.0**
93255	Onyx	Kern	614	2.4
93283	Weldon	Kern	2,040	7.8
93501	Mojave	Kern	5,467	13.5
93505	California City	Kern	14,038	130.2
93527	Inyokern	Kern	2,387	2.3
93554	Randsburg	Kern	72	1.1
93555	Ridgecrest	Kern	32,560	126.3
	KERN COUNTY TOTAL		**57,178**	**23.8**
93562	Trona	San Bernardino	1,818	52.8
		TOTAL	**64,397**	**12.5**

Table E-6 Population Projections, HGLA SSA Counties, to 2050

-	2020	2030	2040	2050
Inyo County	18,825	19,219	19,360	19,176
Kern County	929,787	1,067,631	1,213,558	1,350,705
San Bernardino County	2,235,282	2,483,568	2,735,646	2,981,484
California	40,719,999	44,019,846	46,884,801	49,158,401

Source: California Department of Finance (2017).

Table E-7 Population Projections, by Zip Codes, in the Kern County Portion of the HGLA SSA

		2010	2020	2030	AVERAGE ANNUAL GROWTH RATE
93501	Mojave	4,619	4,713	4,369	-0.3%
93527	Inyokern	1,904	1,866	2,268	0.9%
93554	Randsburg	45	39	298	9.9%
93555	Ridgecrest	30,965	31,602	31,084	0.0%
93505	California City	11,791	12,267	13,283	0.6%
Totals		**49,324**	**50,487**	**51,302**	**0.2%**

Source: Greater Antelope Valley Economic Alliance (2009).

Table E-8 Estimated Development Costs by Year 2010$ (2017 $)[1]

	ANNUAL CONSTRUCTION COST ($2010/$2017)	CUMULATIVE CONSTRUCTION COST ($2010/$2017)
2019	$10,595,361 ($11,894,174)	$10,595,361 ($11,894,174)
2020	$6,426,470 ($7,214,247)	$17,021,832 ($19,108,421)
2021	$11,270,422 ($12,651,986)	$28,292,254 ($31,760,407)
2022	$19,689,724 ($22,103,353)	$47,981,978 ($53,863,760)
2023	$31,476,747 ($35,335,267)	$79,458,725 ($89,199,027)
2024	$33,610,264 ($37,730,317)	$113,068,989 ($126,929,344)
2025	$48,694,230 ($54,663,324)	$161,763,219 ($181,592,668)
2026	$34,796,962 ($39,062,485)	$196,560,181 ($220,655,153)
2027	$48,753,542 ($54,729,907)	$245,313,723 ($275,385,060)
2028	$20,208,760 ($22,686,014)	$265,522,483 ($298,071,074)
2029 (operational)	**$16,807,468** (**$18,867,781**)	-
Total Construction cost	**$265,522,483** (**$298,071,074**)	-

Source: POWER Engineers and Economic Planning Resources 2010.

[1] 2011-2019 Development costs where escalated from the Draft Environmental Impact Statement (DEIS) 2010 dollars to 2017 dollars, and the development period was changed to 2019-2029 period for illustrative purposes. The analysis utilized 2010 DEIS estimated development costs and 2011-2021 period.

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APPENDIX F

EMISSIONS CALCULATIONS

HAIWEE DRILL RIG EMISSIONS

Table F-1
Drilling Rig
Emissions Calculations – Tier 3 Drilling Rig
Haiwee Geothermal Leasing Area

Table 1: Emissions from Drilling Rig Engines for Initial Wells

		Exploration		Operation	
Average Power Rating (hp)	500	20	Number of Wells	12	Number of Wells
Fuel Type	Diesel	24	Operating Hours per day/drill rig	24	Operating Hours per day/drill rig
Total Operating Hours – Exploration	2400	5	Drilling days per well	60	60 Drilling Days per well
Total Operating Hours – Initial Wells	17280				
Load Factor	0.75				

	Tier 3 Emission Factors (grams/hp-hr)							No of Generators	Hrs Per Day	Total Hours	Emissions, lbs/hour								Emission, tons (total)							
	CO	VOC	NOX	SOX	PM10	CO2	CH4				CO	VOC	NOX	SOX	PM10	PM2.5	CO2	CH4	CO	VOC	NOX	SOX	PM10	PM2.5	CO2	CH4
Exploration	2.60E+00	1.50E-01	2.85	1.25E+00	1.50E-01	5.26E+02	3.86E-02	1	24	2400	2.15	0.12	2.36	1.03	0.12	0.12	435.00	0.03	2.58	0.15	2.83	1.24	0.15	0.15	522.00	0.04
Initial Well Drilling	2.60E+00	1.50E-01	2.85	1.25E+00	1.50E-01	5.26E+02	3.86E-02	1	24	17280	2.15	0.12	2.36	1.03	0.12	0.12	435.00	0.03	18.57	1.07	20.35	8.91	1.07	1.06	3758.37	0.28
										lbs/day	51.59	2.98	56.55	24.74	2.98	2.95	10439.91	0.77								

CONSTRUCTION HEAVY EQUIPMENT EMISSIONS

Table F-2
Construction Heavy Equipment Emissions
Haiwee Geothermal Leasing Area

Emission Factors

Equipment	**FUEL**	**HP**	**ROG (lb/hr)**	**CO (lb/hr)**	**NOX (lb/hr)**	**SOX (lb/hr)**	**PM10 (lb/hr)**	**PM2.5 (lb/hr)**	**CO2 (lb/hr)**	**CH4 (lb/hr)**	**N2O (lb/hr)**	**No of Equipment**	**Hrs Per Day**	**Days in Service**	**ROG lbs/day**	**CO lbs/day**	**NOX lbs/day**
Exploration																	
Tracked Loader	DIESEL	108	0.1354	0.4732	0.8257	0.0008	0.0709	0.0631	65	0.0122	0.0784	1	8	180	1.08	3.79	6.61
Wheeled Loader	DIESEL	164	0.1312	0.6288	1.0135	0.0012	0.0583	0.0519	106	0.0118	0.0963	1	11	180	1.44	6.92	11.15
Motor Grader	DIESEL	174	0.1554	0.7363	1.1931	0.0014	0.0688	0.0612	124	0.0140	0.1133	3	8	180	3.73	17.67	28.63
Water Truck	DIESEL	189	0.1469	0.3944	1.3513	0.0019	0.0461	0.0410	167	0.0133	0.1284	1	8	180	1.18	3.16	10.81
Subtotal															**7.43**	**31.53**	**57.20**
Wellfield Development																	
Tracked Loader	DIESEL	108	0.1354	0.4732	0.8257	0.0008	0.0709	0.0631	65	0.0122	0.0784	1	8	250	1.08	3.79	6.61
Wheeled Loader	DIESEL	164	0.1312	0.6288	1.0135	0.0012	0.0583	0.0519	106	0.0118	0.0963	1	11	250	1.44	6.92	11.15
Motor Grader	DIESEL	174	0.1554	0.7363	1.1931	0.0014	0.0688	0.0612	124	0.0140	0.1133	3	8	250	3.73	17.67	28.63
Water Truck	DIESEL	189	0.1469	0.3944	1.3513	0.0019	0.0461	0.0410	167	0.0133	0.1284	1	8	250	1.18	3.16	10.81
Subtotal															**7.43**	**31.53**	**57.20**
Power Plant Construction																	
Tracked Loader	DIESEL	108	0.1354	0.4732	0.8257	0.0008	0.0709	0.0631	65	0.0122	0.0784	1	8	250	1.08	3.79	6.61
Wheeled Loader	DIESEL	164	0.1312	0.6288	1.0135	0.0012	0.0583	0.0519	106	0.0118	0.0963	1	11	250	1.44	6.92	11.15
Motor Grader	DIESEL	174	0.1554	0.7363	1.1931	0.0014	0.0688	0.0612	124	0.0140	0.1133	3	8	250	3.73	17.67	28.63
Roller Compactor	DIESEL	95	0.1054	0.4098	0.6619	0.0007	0.0574	0.0511	59	0.0095	0.0629	1	11	250	1.16	4.51	7.28
Crane	DIESEL	399	0.1635	0.5691	1.5327	0.0018	0.0571	0.0508	180	0.0148	0.1456	1	11	250	1.80	6.26	16.86
Truck Mounted Lift	DIESEL	60	0.0607	0.2451	0.4012	0.0004	0.0324	0.0288	38	0.0055	0.0381	1	8	250	0.49	1.96	3.21
Water Truck	DIESEL	189	0.1469	0.3944	1.3513	0.0019	0.0461	0.0410	167	0.0133	0.1284	1	11	250	1.62	4.34	14.86
Subtotal															**11.32**	**45.44**	**88.60**

Assumptions: SCAQMD Emission Factors, 2012
Horsepower ratings from URBEMIS defaults

Table F-2
Construction Heavy Equipment Emissions
Haiwee Geothermal Leasing Area

	Emissions								Emission, tons (total)						
Equipment	**SOX lbs/day**	**PM10 lbs/day**	**PM2.5 lbs/day**	**CO2 lbs/day**	**CH4 lbs/day**	**N2O lbs/day**	**ROG tons (total)**	**CO tons (total)**	**NOX tons (total)**	**SOX tons (total)**	**PM10 tons (total)**	**PM2.5 tons (total)**	**CO2 tons (total)**	**CH4 tons (total)**	**N2O tons (total)**
Exploration															
Tracked Loader	0.01	0.57	0.50	519.16	0.10	0.63	0.097	0.341	0.595	0.001	0.051	0.045	47	0.009	0.056
Wheeled Loader	0.01	0.64	0.57	1169.47	0.13	1.06	0.130	0.622	1.003	0.001	0.058	0.051	105	0.012	0.095
Motor Grader	0.03	1.65	1.47	2974.12	0.34	2.72	0.336	1.590	2.577	0.003	0.149	0.132	268	0.030	0.245
Water Truck	0.01	0.37	0.33	1332.36	0.11	1.03	0.106	0.284	0.973	0.001	0.033	0.030	120	0.010	0.092
Subtotal	**0.07**	**3.23**	**2.87**	**5995.11**	**0.67**	**5.43**	**0.67**	**2.84**	**5.15**	**0.01**	**0.29**	**0.26**	**539.56**	**0.06**	**0.49**
Wellfield Development															
Tracked Loader	0.01	0.57	0.50	519.16	0.10	0.63	0.135	0.473	0.826	0.001	0.071	0.063	65	0.012	0.078
Wheeled Loader	0.01	0.64	0.57	1169.47	0.13	1.06	0.180	0.865	1.394	0.002	0.080	0.071	146	0.016	0.132
Motor Grader	0.03	1.65	1.47	2974.12	0.34	2.72	0.466	2.209	3.579	0.004	0.206	0.184	372	0.042	0.340
Water Truck	0.01	0.37	0.33	1332.36	0.11	1.03	0.147	0.394	1.351	0.002	0.046	0.041	167	0.013	0.128
Subtotal	**0.07**	**3.23**	**2.87**	**5995.11**	**0.67**	**5.43**	**0.93**	**3.94**	**7.15**	**0.01**	**0.40**	**0.36**	**749.39**	**0.08**	**0.68**
Power Plant Construction															
Tracked Loader	0.01	0.57	0.50	519.16	0.10	0.63	0.135	0.473	0.826	0.001	0.071	0.063	65	0.012	0.078
Wheeled Loader	0.01	0.64	0.57	1169.47	0.13	1.06	0.180	0.865	1.394	0.002	0.080	0.071	146	0.016	0.132
Motor Grader	0.03	1.65	1.47	2974.12	0.34	2.72	0.466	2.209	3.579	0.004	0.206	0.184	372	0.042	0.340
Roller Compactor	0.01	0.63	0.56	648.88	0.10	0.69	0.145	0.563	0.910	0.001	0.079	0.070	81	0.013	0.086
Crane	0.02	0.63	0.56	1981.11	0.16	1.60	0.225	0.783	2.107	0.002	0.079	0.070	248	0.020	0.200
Truck Mounted Lift	0.00	0.26	0.23	304.57	0.04	0.30	0.061	0.245	0.401	0.000	0.032	0.029	38	0.005	0.038
Water Truck	0.02	0.51	0.45	1832.00	0.15	1.41	0.202	0.542	1.858	0.003	0.063	0.056	229	0.018	0.177
Subtotal	**0.10**	**4.88**	**4.35**	**9429**	**1.02**	**8.42**	**1.41**	**5.68**	**11.08**	**0.01**	**0.61**	**0.54**	**1179**	**0.13**	**1.05**
					2.36	**19.28**	**3.01**	**12.46**	**23.37**	**0.03**	**1.30**	**1.16**	**2238.60**	**0.25**	**2.01**

Assumptions: SCAQMD Emission Factors, 2012
Horsepower ratings from URBEMIS defaults

FUGITIVE DUST EMISSION CALCULATIONS

Table F-3
Fugitive Dust Emission Calculations
Haiwee Geothermal Leasing Area

Fugitive Dust Emissions by Activity

With watering 3 times daily
Control Efficiency: 61 percent

Grading	Total Area to be Disturbed	Maximum Daily Grading	Emission Factor, lbs PM10/acre/day	Emissions, lbs PM10/day	Emissions, lbs PM2.5/day	Emissions, lbs PM10/day	Emissions, lbs PM2.5/day
Exploration	62	6.2	20	124	26.04	48.36	10.1556
Wellfield Development	202	20.2	20	404	84.84	157.56	33.0876
Power Plant Construction	120	12	20	240	50.4	93.6	19.656

	PM10 Emissions, tons/year	PM2.5 Emissions, tons/year
	0.2418	0.050778
Assume 10% of site to be graded per day.	0.7878	0.165438
	0.468	0.09828

CONSTRUCTION WORKER COMMUTE EMISSION CALCULATIONS

Table F-4
Construction Worker Commute Emission Calculations
Haiwee Geothermal Leasing Area

Construction Phase	Vehicle Class	No. of Workers Per Construction Phase	Speed (mph)	VMT (mi/vehicle-day)	CO		NO_X		ROG						SOx		PM10				PM2.5				CO
					Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Hot-Soak (g/trip)	Resting Loss (g/hr)	Running Evaporative (g/mi)	Diurnal Evaporative (g/hr)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)
Exploration	Light-Duty Auto	7	35	80	2.875	12.15	0.318	0.625	0.109	1.046	0.334	0.039	0.058	0.083	0.003	0.002	0.01	0.015	0.008	0.013	0.009	0.014	0.002	0.005	310.451
	Light-Duty Truck	3	35	80	7.009	20.759	0.827	0.867	0.29	1.602	0.542	0.068	0.121	0.137	0.004	0.002	0.016	0.019	0.008	0.013	0.014	0.017	0.002	0.005	384.226
Wellfield Development	Light-Duty Auto	100	35	80	2.875	12.15	0.318	0.625	0.109	1.046	0.334	0.039	0.058	0.083	0.003	0.002	0.01	0.015	0.008	0.013	0.009	0.014	0.002	0.005	310.451
	Light-Duty Truck	100	35	80	7.009	20.759	0.827	0.867	0.29	1.602	0.542	0.068	0.121	0.137	0.004	0.002	0.016	0.019	0.008	0.013	0.014	0.017	0.002	0.005	384.226
Power Plant Construction	Light-Duty Auto	100	35	80	2.875	12.15	0.318	0.625	0.109	1.046	0.334	0.039	0.058	0.083	0.003	0.002	0.01	0.015	0.008	0.013	0.009	0.014	0.002	0.005	310.451
	Light-Duty Truck	100	35	80	7.009	20.759	0.827	0.867	0.29	1.602	0.542	0.068	0.121	0.137	0.004	0.002	0.016	0.019	0.008	0.013	0.014	0.017	0.002	0.005	384.226

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For light-duty trucks assume 2 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors

PM10	9.81231E-05

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b
Assume 61% control efficiency for watering 3 x daily
For light-duty trucks assume 2 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Emission Factors

PM10	0.357378738
PM2.5	0.035737874

Emission Factors from EMFAC2007 Model, assuming 2012
Assume startup after 8 hours
Assume 45 minutes run time total

Table F-4
Construction Worker Commute Emission Calculations
Haiwee Geothermal Leasing Area

		)2	CH4		N2O		Emissions, lbs/day												Total Emissions, tons						
Construction Phase	Vehicle Class	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	CO	NOx	VOCs	SOx	PM10	PM2.5	Paved Road Fugitive Dust PM10	Paved Road Fugitive Dust PM2.5	CO2	CH4	N2O	Construction Days	CO	NOx	VOCs	SOx	PM10	PM2.5	Paved Road Fugitive Dust PM10
Exploration	Light-Duty Auto	164.917	0.026	0.06	0.03	0.06	3.92	0.41	0.23	0.00	0.04	0.02	0.05	0.01	388.37	0.03	0.04	180	0.35	0.04	0.02114	3.39E-04	0.00349	0.00182	0.00495
	Light-Duty Truck	194.251	0.048	0.093	0.08	0.08	3.98	0.45	0.23	0.00	0.02	0.01	0.02	0.00	205.87	0.03	0.04	180	0.36	0.04	0.02075	1.93E-04	0.00178	0.00102	0.00212
							7.91	**0.86**	**0.47**	**0.01**	**0.06**	**0.03**	**0.08**	**0.02**	**594.24**	**0.06**	**0.08**		**0.71**	**0.08**	**0.04**	**0.00**	**0.01**	**0.00**	**0.01**
Wellfield Development	Light-Duty Auto	164.917	0.026	0.06	0.03	0.06	56.06	5.88	3.36	0.05	0.55	0.29	0.78	0.16	5548.16	0.49	0.56	250	7.01	0.74	0.41943	6.72E-03	0.06917	0.03605	0.09812
	Light-Duty Truck	194.251	0.048	0.093	0.08	0.08	132.77	14.97	7.68	0.07	0.66	0.38	0.78	0.16	6862.27	0.89	1.42	250	16.60	1.87	0.96042	8.93E-03	0.08262	0.04723	0.09812
							188.84	**20.85**	**11.04**	**0.13**	**1.21**	**0.67**	**1.57**	**0.33**	**12410.44**	**1.37**	**1.98**		**23.60**	**2.61**	**1.38**	**0.02**	**0.15**	**0.08**	**0.20**
Power Plant Construction	Light-Duty Auto	164.917	0.026	0.06	0.03	0.06	56.06	5.88	3.36	0.05	0.55	0.29	0.78	0.16	5548.16	0.49	0.56	250	7.01	0.74	0.41943	6.72E-03	0.06917	0.03605	0.09812
	Light-Duty Truck	194.251	0.048	0.093	0.08	0.08	132.77	14.97	7.68	0.07	0.66	0.38	0.78	0.16	6862.27	0.89	1.42	250	16.60	1.87	0.96042	8.93E-03	0.08262	0.04723	0.09812
							188.84	**20.85**	**11.04**	**0.13**	**1.21**	**0.67**	**1.57**	**0.33**	**12410.44**	**1.37**	**1.98**		**23.60**	**2.61**	**1.38**	**0.02**	**0.15**	**0.08**	**0.20**

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For light-duty trucks assume 2 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors
PM10 9.81231E-05

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b
Assume 61% control efficiency for watering 3 x daily
For light-duty trucks assume 2 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Emission Factors
PM10 0.357378738
PM2.5 0.035737874

Emission Factors from EMFAC2007 Model, assuming 2012
Assume startup after 8 hours
Assume 45 minutes run time total

Table F-4
Construction Worker Commute Emission Calculations
Haiwee Geothermal Leasing Area

Construction Phase	Vehicle Class	Total Emissions, tons			
		Paved Road Fugitive Dust PM2.5	CO2	CH4	N2O
Exploration	Light-Duty Auto	0.00104	35	0.00306	0.00352
	Light-Duty Truck	0.00045	19	0.00240	0.00384
		0.00	**53.48**	**0.01**	**0.01**
Wellfield Development	Light-Duty Auto	0.02061	694	0.06063	0.06987
	Light-Duty Truck	0.02061	858	0.11095	0.17775
		0.04	**1551.30**	**0.17**	**0.25**
Power Plant Construction	Light-Duty Auto	0.02061	694	0.06063	0.06987
	Light-Duty Truck	0.02061	858	0.11095	0.17775
		0.04	**1551.30**	**0.17**	**0.25**

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For light-duty trucks assume 2 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors
PM10 9.81231E-05

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b
Assume 61% control efficiency for watering 3 x daily
For light-duty trucks assume 2 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Emission Factors
PM10 0.357378738
PM2.5 0.035737874

Emission Factors from EMFAC2007 Model, assuming 2012
Assume startup after 8 hours
Assume 45 minutes run time total

CONSTRUCTION TRUCK TRIP EMISSIONS

Table F-5
Construction Truck Trip Emissions
Haiwee Geothermal Leasing Area

			Speed	VMT	CO	NO_X	ROG	SOx	PM10			PM2.5			CO2	CH4	N2O	Emissions, lbs/day				
Construction Phase	Vehicle Class	No. of Trucks per day	(mph)	(mi/vehicle-day)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	Running Exhaust (g/mi)	CO	NOx	VOCs	SOx	PM10
Exploration																						
Support Truck	Medium Duty Truck, Diesel	4	35	80	1.362	5.316	0.154	0.014	0.199	0.012	0.013	0.183	0.003	0.005	1505.00	0.007	0.51	0.96	3.75	0.11	0.01	0.16
Delivery Truck	Heavy Duty Truck, Diesel	1	35	80	3.883	13.537	0.769	0.017	0.434	0.036	0.028	0.399	0.009	0.012	1827.808	0.036	1.29	0.68	2.39	0.14	0.00	0.09
Wellfield Development																		**1.65**	**6.14**	**0.24**	**0.01**	**0.25**
Support Truck	Medium Duty Truck, Diesel	16	35	80	1.362	5.316	0.154	0.014	0.199	0.012	0.013	0.183	0.003	0.005	1505.00	0.007	0.51	3.84	15.00	0.43	0.04	0.63
Delivery Truck	Heavy Duty Truck, Diesel	3	35	80	3.883	13.537	0.769	0.017	0.434	0.036	0.028	0.399	0.009	0.012	1827.808	0.036	1.29	2.05	7.16	0.41	0.01	0.26
Power Plant Construction																		**5.90**	**22.16**	**0.84**	**0.05**	**0.90**
Support Truck	Medium Duty Truck, Diesel	8	35	80	1.362	5.316	0.154	0.014	0.199	0.012	0.013	0.183	0.003	0.005	1505.00	0.007	0.51	1.92	7.50	0.22	0.02	0.32
Delivery Truck	Heavy Duty Truck, Diesel	2	35	80	3.883	13.537	0.769	0.017	0.434	0.036	0.028	0.399	0.009	0.012	1827.808	0.036	1.29	1.37	4.78	0.27	0.01	0.18
																		3.29	**12.28**	**0.49**	**0.03**	**0.49**
Subtotal																						

Emission Factors from EMFAC2007 Model, assuming 2012 composite emission factors.
Assume startup after 8 hours
Assume 45 minutes run time total

Assume 45 minutes run time total
2012 Emission Factors from EMFAC2007, average temp 60F; Great Basin

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For LDT assume 2 tons/vehicle, MDT assume 13 tons/vehicle, HDT assume 20 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors

PM10, LDT	9.81231E-05
PM10, MDT	0.008944829
PM10, HDT	0.017495628

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b

For LDT assume 2 tons/vehicle, MDT assume 13 tons/vehicle, HDT assume 20 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Assume 61% control efficiency for watering 3x daily
Emission Factors

PM10, LDT	0.357378738
PM10, MDT	0.829735596
PM10, HDT	1.007230136
PM2.5, LDT	0.035737874
PM2.5, MDT	0.08297356
PM2.5, HDT	0.100723014

Assume 6 miles each way of unpaved road travel

Table F-5
Construction Truck Trip Emissions
Haiwee Geothermal Leasing Area

Construction Phase	Vehicle Class	Emissions, lbs/day							Total Emissions, tons										
		PM2.5	Paved Road Fugitive Dust PM10	Paved Road Fugitive Dust PM2.5	CO2	CH4	N2O	Construction Days	CO	NOx	VOCs	SOx	PM10	PM2.5	Paved Road Fugitive Dust PM10	Paved Road Fugitive Dust PM2.5	CO2	CH4	CH4
Exploration																			
Support Truck	Medium Duty Truck, Diesel	0.13	5.60	1.18	1061.75	0.00	0.36	180	0.09	0.34	0.00978	8.89E-04	0.01422	0.01213	0.50387	0.10581	96	0.00044	0.03207
Delivery Truck	Heavy Duty Truck, Diesel	0.07	1.40	0.29	322.37	0.01	0.23	180	0.06	0.21	0.01221	2.70E-04	0.00790	0.00667	0.12597	0.02645	29	0.00057	0.02041
Wellfield Development		**0.21**	**7.00**	**1.47**	**1384.12**	**0.01**	**0.58**		**0.15**	**0.55**	**0.02**	**0.00**	**0.02**	**0.02**	**0.63**	**0.13**	**124.57**	**0.00**	**0.05**
Support Truck	Medium Duty Truck, Diesel	0.54	22.39	4.70	4247.01	0.02	1.43	270	0.52	2.03	0.05867	5.33E-03	0.08534	0.07276	3.02324	0.63488	573	0.00267	0.19239
Delivery Truck	Heavy Duty Truck, Diesel	0.22	4.20	0.88	967.12	0.02	0.68	270	0.28	0.97	0.05493	1.21E-03	0.03557	0.03000	0.56686	0.11904	131	0.00257	0.09186
Power Plant Construction		**0.76**	**26.59**	**5.58**	**5214.12**	**0.04**	**2.11**		**0.80**	**2.99**	**0.11**	**0.01**	**0.12**	**0.10**	**3.59**	**0.75**	**703.91**	**0.01**	**0.28**
Support Truck	Medium Duty Truck, Diesel	0.27	11.20	2.35	2123.50	0.01	0.71	270	0.26	1.01	0.02933	2.67E-03	0.04267	0.03638	1.51162	0.31744	287	0.00133	0.09620
Delivery Truck	Heavy Duty Truck, Diesel	0.15	2.80	0.59	644.74	0.01	0.45	270	0.18	0.64	0.03662	8.10E-04	0.02371	0.02000	0.37791	0.07936	87	0.00171	0.06124
		0.42	**14.00**	**2.94**	**2768.25**	**0.02**	**1.17**		**0.44**	**1.66**	**0.07**	**0.00**	**0.07**	**0.06**	**1.89**	**0.40**	**373.71**	**0.00**	**0.16**
Subtotal																			

Emission Factors from EMFAC2007 Model, assuming 2012 composite emission factors.
Assume startup after 8 hours
Assume 45 minutes run time total

Assume 45 minutes run time total
2012 Emission Factors from EMFAC2007,
average temp 60F; Great Basin

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For LDT assume 2 tons/vehicle, MDT assume 13 tons/vehicle, HDT assume 20 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors

PM10, LDT	9.81231E-05
PM10, MDT	0.008944829
PM10, HDT	0.017495628

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b

For LDT assume 2 tons/vehicle, MDT assume 13 tons/vehicle, HDT assume 20 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Assume 61% control efficiency for watering 3x daily
Emission Factors

PM10, LDT	0.357378738
PM10, MDT	0.829735596
PM10, HDT	1.007230136
PM2.5, LDT	0.035737874
PM2.5, MDT	0.08297356
PM2.5, HDT	0.100723014

Assume 6 miles each way of unpaved road travel

OPERATIONAL VEHICLE EMISSION CALCULATIONS

Table F-6
Operational Vehicle Emission Calculations
Haiwee Geothermal Leasing Area

		No. of Workers	Speed	VMT	CO		NO_X		ROG						SOx		PM10				PM2.5				CO2	
Operations	Vehicle Class	Per Construction Phase	(mph)	(mi/vehicle-day)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Hot-Soak (g/trip)	Resting Loss (g/hr)	Running Evaporative (g/mi)	Diurnal Evaporative (g/hr)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start)[a]	Tire Wear (g/mi)	Brake Wear (g/mi)	Running Exhaust (g/mi)	Start-Up (g/start)[a]
Workers	Light-Duty Auto	60	35	80	2.875	12.15	0.318	0.625	0.109	1.046	0.334	0.039	0.058	0.083	0.003	0.002	0.01	0.015	0.008	0.013	0.009	0.014	0.002	0.005	310.451	164.917
	Light-Duty Truck	25	35	80	7.009	20.759	0.827	0.867	0.29	1.602	0.542	0.068	0.121	0.137	0.004	0.002	0.016	0.019	0.008	0.013	0.014	0.017	0.002	0.005	384.226	194.251

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For light-duty trucks assume 2 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors
PM10 9.81231E-05

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b
Assume 61% control efficiency for watering 3 x daily
For light-duty trucks assume 2 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Emission Factors
PM10 0.357378738
PM2.5 0.035737874

Emission Factors from EMFAC2007 Model, assuming 2012
composite emission factors.
Assume startup after 8 hours
Assume 45 minutes run time total

Table F-6
Operational Vehicle Emission Calculations
Haiwee Geothermal Leasing Area

Operations	Vehicle Class	CH4		N2O		Emissions, lbs/day										
		Running Exhaust (g/mi)	Start-Up (g/start)[a]	Running Exhaust (g/mi)	Start-Up (g/start)[a]	CO	NOx	VOCs	SOx	PM10	PM2.5	Paved Road Fugitive Dust PM10	Paved Road Fugitive Dust PM2.5	CO2	CH4	N2O
Workers	Light-Duty Auto	0.026	0.06	0.03	0.06	33.64	3.53	2.01	0.03	0.33	0.17	0.47	0.10	3328.90	0.29	0.34
	Light-Duty Truck	0.048	0.093	0.08	0.08	33.19	3.74	1.92	0.02	0.17	0.09	0.20	0.04	1715.57	0.22	0.36
						66.83	**7.27**	**3.93**	**0.05**	**0.50**	**0.27**	**0.67**	**0.14**	**5044.47**	**0.51**	**0.69**

Operations	Vehicle Class		Total Emissions, tons												
		Work Days	CO	NOx	VOCs	SOx	PM10	PM2.5	Paved Road Fugitive Dust PM10	Paved Road Fugitive Dust PM2.5	CO2	CH4	N2O
Workers	Light-Duty Auto	250	4.20	0.44	0.25166	4.03E-03	0.04150	0.02163	0.05887	0.01236	416	0.03638	0.04192
	Light-Duty Truck	250	4.15	0.47	0.24011	2.23E-03	0.02065	0.01181	0.02453	0.00515	214	0.02774	0.04444
			8.35	**0.91**	**0.49**	**0.01**	**0.06**	**0.03**	**0.08**	**0.02**	**630.56**	**0.06**	**0.09**

Paved Road Fugitive Dust
EPA's AP-42, Section 13.2.1, November 2006
E = k(sL/2)^0.65 x (W/3)^1.5 - C
For light-duty trucks assume 2 tons/vehicle
Assume silt loading for 10,000 ADT roadways = 0.03 g/m3
Assume k = 0.016 PM10
Assume 6 miles in addition for track-out for PM10
Emission Factors

PM10	9.81231E-05

Unpaved Road Fugitive Dust
EPA's AP-42, Section 13.2.2
Industrial Roads
E = k (s/12)^a x (W/3)^b
Assume 61% control efficiency for watering 3 x daily
For light-duty trucks assume 2 tons/vehicle
k = 1.5 for PM10, 0.15 for PM2.5
s = 8.5, a = 0.9, b = 0.45
Emission Factors

PM10	0.357378738
PM2.5	0.035737874

Emission Factors from EMFAC2007 Model, assuming 2012
composite emission factors.
Assume startup after 8 hours
Assume 45 minutes run time total

APPENDIX G

NUMERICAL GROUNDWATER FLOW MODELING

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APPENDIX G

NUMERICAL GROUNDWATER FLOW MODELING
ROSE VALLEY, INYO, COUNTY, CALIFORNIA

Prepared by

Daniel W. Matthews, R.G.

On Behalf of
U.S. Bureau of Land Management

February 2010

G1. INTRODUCTION

This appendix describes the numerical groundwater flow model used to evaluate potential impacts of groundwater extraction from the uppermost groundwater-bearing zone in the Rose Valley, California, groundwater basin for the Geothermal Leasing Environmental Impact Statement (EIS) being prepared by Power Engineers on behalf of the U.S. Bureau of Land Management (BLM). For this project, GEOLOGICA Inc. (GEOLOGICA) revised and recalibrated a numerical model previously developed by GEOLOGICA (2008) for the Rose Valley groundwater basin. Groundwater flow evaluations were conducted using the U.S.G.S. MODFLOW computer code (McDonald and Harbaugh, 1988) implemented in the Groundwater Vistas graphical environment (Environmental Simulations, 2007).

G1.1. Purpose

The purpose of the evaluations and analysis described in this appendix were: to evaluate the groundwater conditions; and to analyze the potential impacts to groundwater resources in Rose Valley that might develop as a result of geothermal exploration, well, well field, and power plant construction, and well field and power plant operation and maintenance.

G1.2. Scope

The scope of this task included evaluating information regarding hydrogeologic conditions in Rose Valley, revising an existing numerical groundwater flow model of Rose Valley developed by GEOLOGICA (2008) to better represent those conditions, calibrating the model to new monitoring data collected by Inyo County between November 2007 and November 2009, and developing scenarios to forecast the potential impacts of alternatives to the proposed project. In addition, GEOLOGICA conducted sensitivity analyses to evaluate the impact of uncertainty in various input parameters on model predictions.

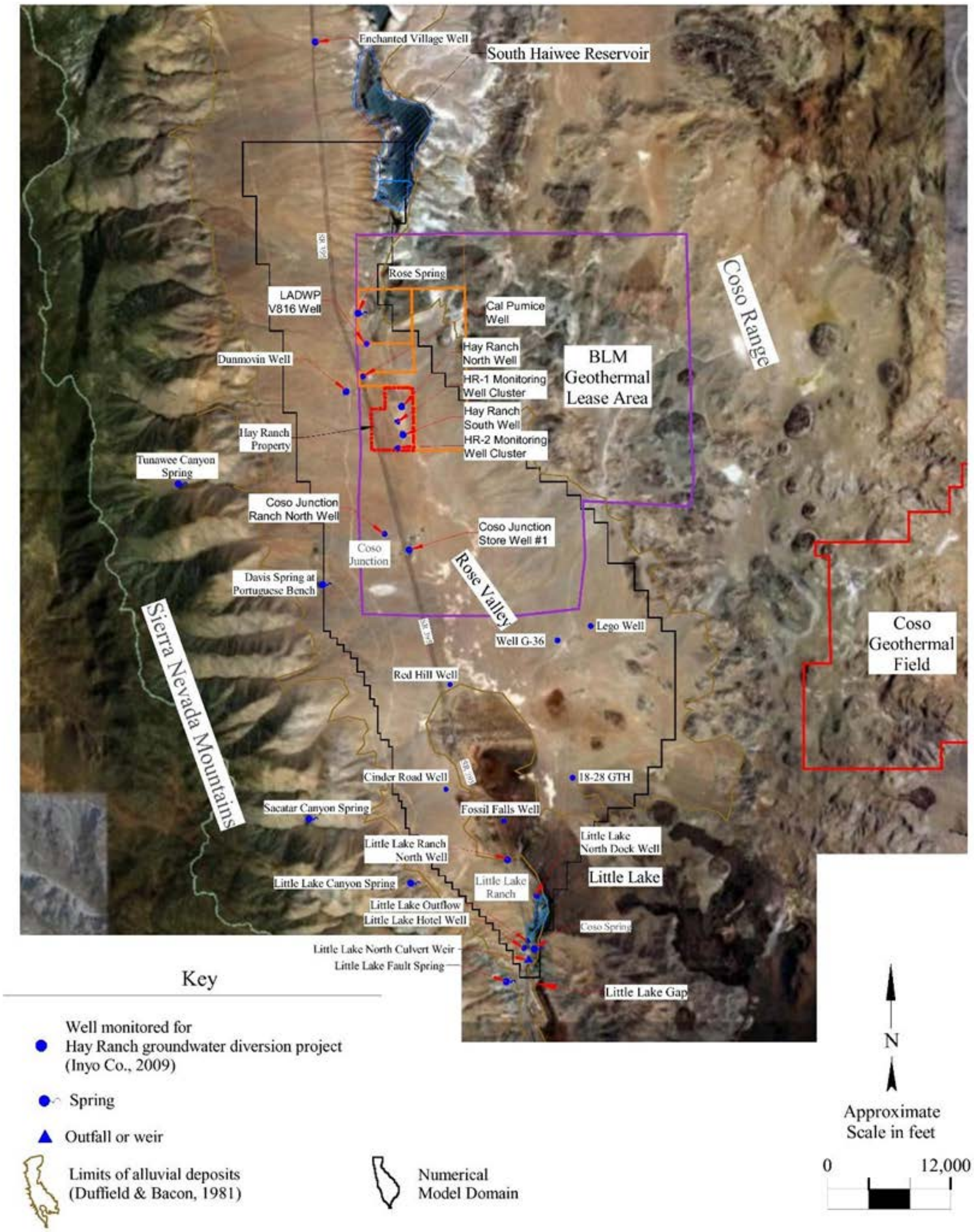
G2. ENVIRONMENTAL SETTING

Sections below describe the environmental setting of the study area including physiography, geology, hydrogeology, surface water, and concludes with an evaluation of the water budget for Rose Valley.

G2.1. Physiography

Rose Valley is a long, narrow valley located on the eastern flank of the Sierra Nevada Mountains in Inyo County, California. The alluvial portion of the groundwater basin is approximately 16 miles long from the southern end of the Haiwee Reservoir to just south of Little Lake, and has a maximum width of approximately 6 miles at its widest point.

Figure G-1: Physiographic Features of Rose Valley



Rose Valley is topographically separated from the Owens Valley to the north by Dunmovin Hill, a topographic high that is composed of a massive landslide or series of debris flow deposits that originated from the Sierra Nevada range to the west (Bauer, 2002). Rose Valley is separated from the Indian Wells Valley to the south by a topographic high formed by a combination of granitic rocks and volcanic flows, and by the Little Lake Gap, which is an approximately 1,000 ft wide water-carved canyon within the volcanics (Bauer, 2002). **Figure G-1** depicts relevant physiographic features of the study area. The ground surface of the valley floor generally slopes gently to the south at a rate of approximately 30 to 35 feet per mile.

G2.2 Geology

Rose Valley is a graben surrounded and underlain by igneous and metamorphic basement rocks of the Sierra Nevada and Coso Ranges. Alluvial sediments were encountered to depths as great as 3,489 feet in borings advanced in the north central portion of the basin (Schaer, 1981) and may extend to depths greater than 5,000 feet below ground surface (bgs) based on gravity surveys (GeoTrans, 2004). Younger (30 to 0.4 million years old) volcanic rocks of the Coso Range outcrop east of the central and northern Rose Valley and are predominately rhyolitic, dacitic, and andesitic in composition. The southern boundary of the Rose Valley groundwater basin is marked by outcrops of volcanic rocks related to eruptions within or flows from the Coso Range and volcanic cinder cones in the Red Hill area. **Figure G-2** provides a geologic map of the study area.

As summarized by Bauer (2002), the basin fill consists, in descending order, of recent alluvial fan deposits including debris flows from the bordering Sierra Nevada Mountains, volcanic deposits including basalt, ash, cinders, and tuff, lacustrine deposits of the Coso Formation, and older alluvial fan deposits from the Sierra Nevada and Coso Ranges. The recent alluvial deposits usually occur between ground surface and depths of up to 800 ft, and consist of a mixture of sands and gravels interbedded with clay. The maximum drilled thickness of these deposits occurs in the north central part of the valley near the Hay Ranch property. The Coso Formation uncomformably overlies basement rocks in the Coso Range and Rose Valley, and is comprised of a heterogeneous assemblage of primarily lacustrine deposits, with lesser amounts of volcanic tuff and alluvial fan deposits. Bauer (2002) described the Coso Formation as being comprised of four members in descending stratigraphic order: the Rhyolite Tuff Member, the Coso Lake Beds Member, the Coso Sand Member, and the Basal Fanglomerate Member.

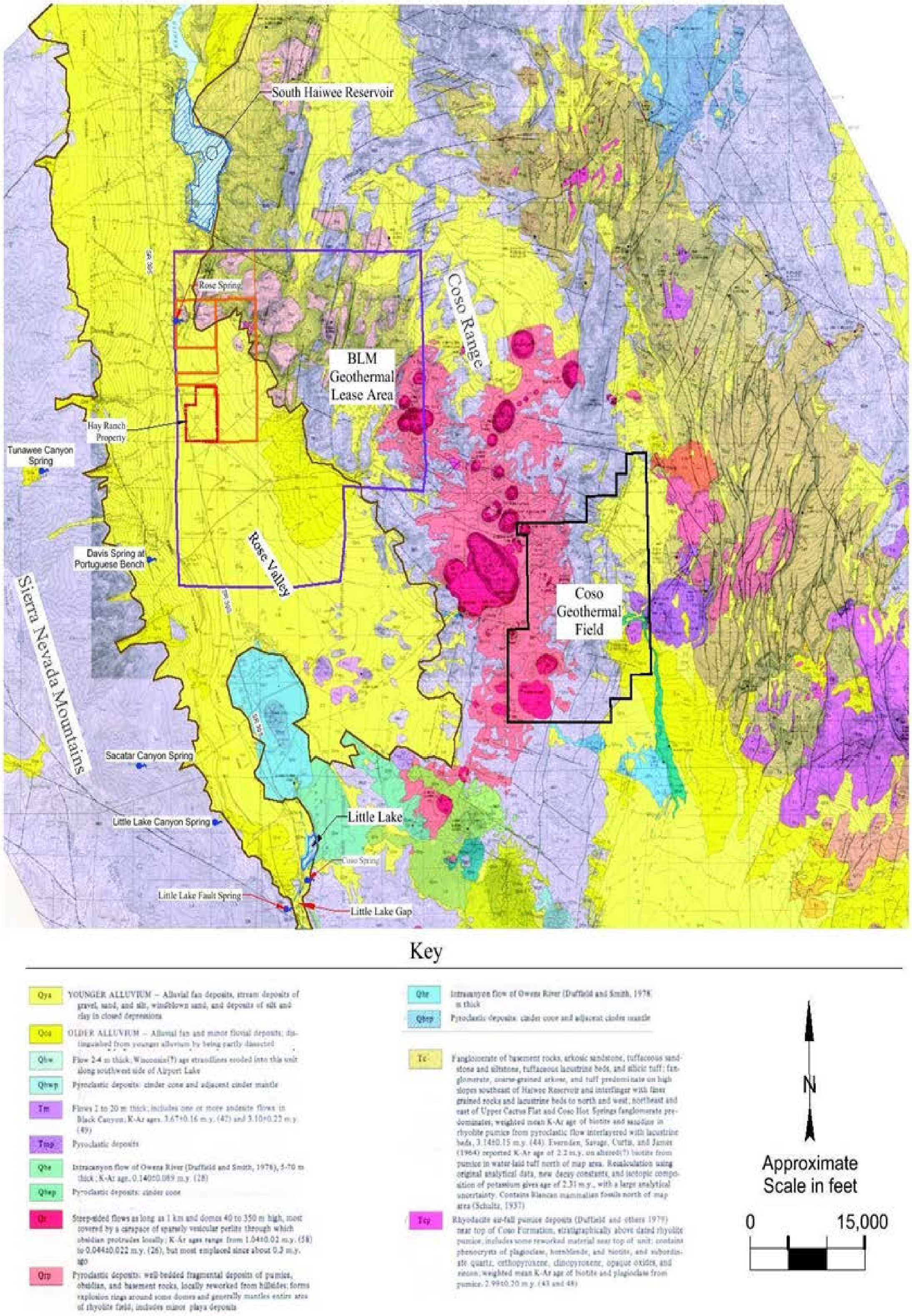
- **Rhyolite Tuff Member** – The Rhyolite Tuff Member occurs along the east side of the southern Haiwee Reservoir and extends south into the north end of the valley along the western slope of the Coso Range.

- **Coso Lake Beds Member** – The Coso Lake Beds Member reportedly is composed of alternating beds of fine to-coarse-grained sand, arkosic, green clay with interspersed volcanic ash, and thin-bedded white rhyolitic tuffs containing pumice fragments. Deposits of the Coso Lake Beds Member reportedly extend north into the southern Owens Valley, where it is known as the Owens Lake Bed Member.

- **Coso Sand Member** – The Coso Sand Member consists of poorly consolidated, fine-to-coarse grained alluvial gravels, sand, and red clay beds derived from the granitic basement rocks of the Coso Range and reworked Sierra Nevada alluvial fan materials. The Coso Sand Member occurs at depths from 1,500 ft to 3,000 ft bgs and the unit is thickest to the west, decreasing in thickness rapidly to the east.

- **Basal Fanglomerate Member** – The Basal Fanglomerate Member was infrequently encountered in well borings drilled in the valley. It consists of reworked colluvial deposits localized by basement topography and structures.

Figure G-2: Geologic Map



*Basemap and key from
*Geologic Map of the Coso Volcanic Field and Adjacent Areas, Inyo County, California
by Wendell A. Duffield and Charles R. Bacon. 1981*

Geologic Map

Coso Operating Company (COC) recently completed two sets of clustered multi-level monitoring wells to depths of up to 605 feet (ft) below ground surface (bgs) on the Hay Ranch property (SGSI, 2009a; 2009b; and 2009c). The lithology encountered during drilling was described as alluvium consisting of fine to coarse sand with gravel to 20 ft bgs, which is underlain by fluvial-type deposits containing silt, fine to coarse sand, cobbles, and boulders down to 200 feet bgs. Below 200 feet bgs SGSI reported encountering lacustrine-type deposits containing fine to coarse sand, numerous silt and clay interbeds, and occasional gravel interbeds to a total depth of 570 feet bgs. At depths of approximately 308 to 336 feet bgs and 464 to 478 feet bgs, two significant swelling clay units were encountered in the HR-1 and HR-2 well clusters which were confirmed by geophysical logging. The lithology observed in HR-1 and HR-2 is not inconsistent with the existing model construction.

G3.

G3.1 Hydrogeology

G3.1.1 Hydrostratigraphic Units

The principal hydrostratigraphic units that comprise the Rose Valley aquifer consist of recent alluvial deposits, and the Coso Lake Bed and Coso Sand Members of the Coso Formation. Older bedrock is largely impermeable or low permeability and typically impedes or excludes groundwater flow.

SGSI (2009c) concluded that the uppermost groundwater-bearing unit in Rose Valley, which occurs within the upper 600 ft of the sediment column is separated into three aquifer-zones (upper, intermediate, and deep) as a result of the presence of low permeability clay horizons encountered at depths of approximately 325 ft and 475 ft bgs in the HR-1 well cluster and approximately 30 ft deeper in the HR-2 well cluster and south Hay Ranch production well. The horizontal extent of the clay horizons cannot be determined with available information.

G3.1.2 Groundwater Occurrence and Flow

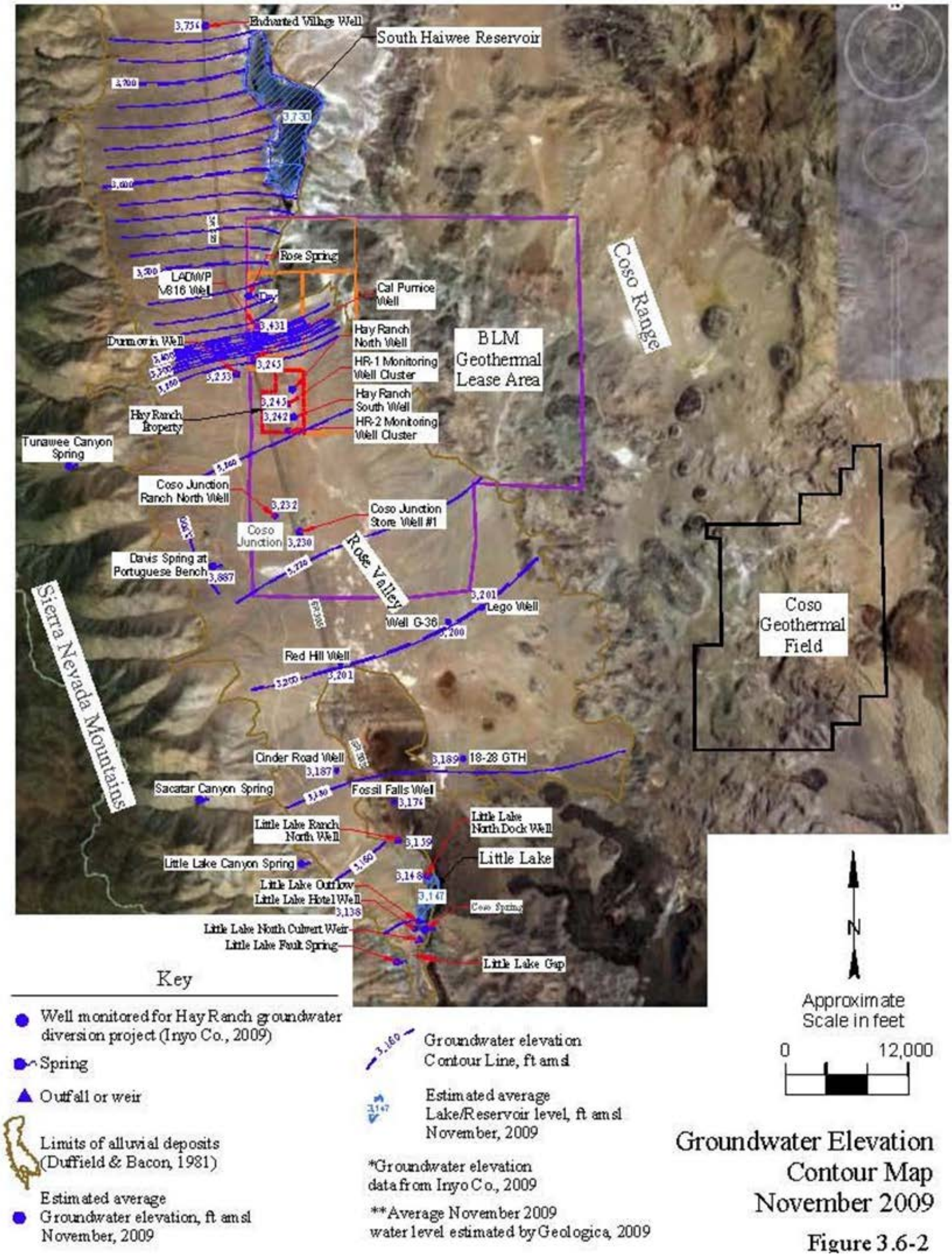
The groundwater table is typically first encountered during drilling within the upper portion of the recent alluvial deposits. Depth to groundwater ranges from 140 to 240 ft bgs in the north and central parts of Rose Valley, decreases to approximately 40 ft bgs at the northern end of the Little Lake Ranch, and surfaces near the south end of the Little Lake Ranch property. Because the ground surface slopes more steeply to the south than the groundwater table, the groundwater table surfaces at and discharges from springs beneath Little Lake, sustaining the lake and the surface water discharge from Coso Spring immediately to the south of the lake. At the south end of Rose Valley, groundwater flow through the Little Lake Gap is constrained by bedrock on the west, an apparent subsurface bedrock rise below, and low or reduced permeability in the basalt lava flows to the east.

Groundwater elevation data obtained from the Inyo County for the Hay Ranch Monitoring Project (Inyo Co. 2009, 2010) were used to develop a groundwater elevation contour map for November 2009 (**Figure G-3**). Groundwater elevation data used to develop the contour map are tabulated in **Table G-1**. The November 2009 groundwater elevation contour map of Rose Valley indicated southeasterly groundwater flow along the axis of the northwest to southeast trending valley.

Table G-1: Rose Valley Groundwater Elevation Data

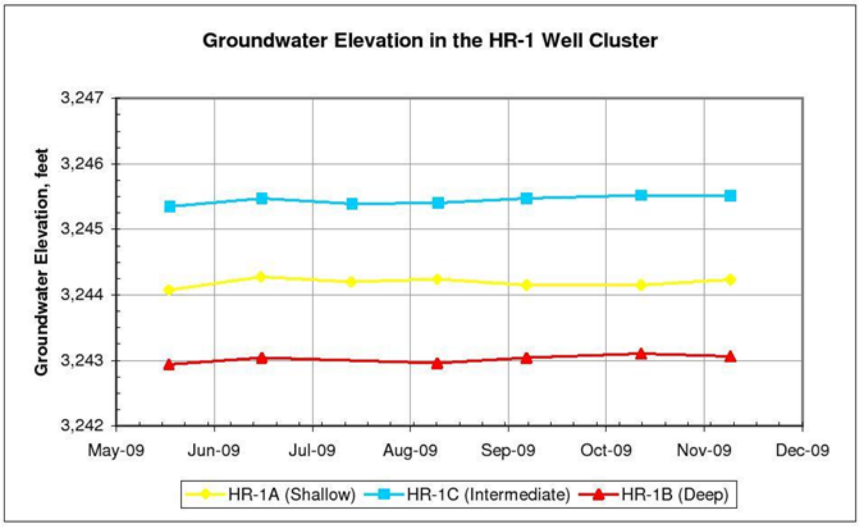
Groundwater Elevation, ft amsl		
Well	November 2007(1)	November 2009(2)
Enchanted Village	NM	3,755.5
LADWP 816	3435.2	3,438
Dunmovin	NM	3,253.0
Cal Pumice	3266	3,265.4
Hay Ranch North	3,245	3,245.3
HR-1A	NM	3,244.3
HR-1B	NM	3,243.1
HR-1C	NM	3,245.6
HR-2A	NM	3,241.1
HR-2B	NM	3,238.5
HR-2C	NM	3,242.6
Hay Ranch South	3,240.90	3,241.8
Coso Junction Ranch	3232.7	3,232.2
Coso Junction Store #1	3229.3	3,229.8
Red Hill	NM	3,200.8
Lego	3200.5	3,200.6
G-36	3199.6	3,200.0
Cinder Road	NM	3,187.0
18-28 GTH	3188.2	3,188.5
Fossil Falls	NM	3,175.6
Little Lake Ranch North	3158.95	3,158.9
Little Lake Ranch Dock	NM	3,147.9
Little Lake Surface	NM	3,147.4
Little Lake Ranch Hotel	NM	3,138.3
Notes:		
(1) MHA (2008).		
(2) Average November 2009 groundwater elevation estimated by Geologica from groundwater elevation hydrographs presented at the Inyo County Water Department's Hay Ranch Monitoring Website, http://www.inyowater.org/coso/default.html accessed December 4, 2009.		
** See Figure G-3 for well locations.		
NM = Not measured.		

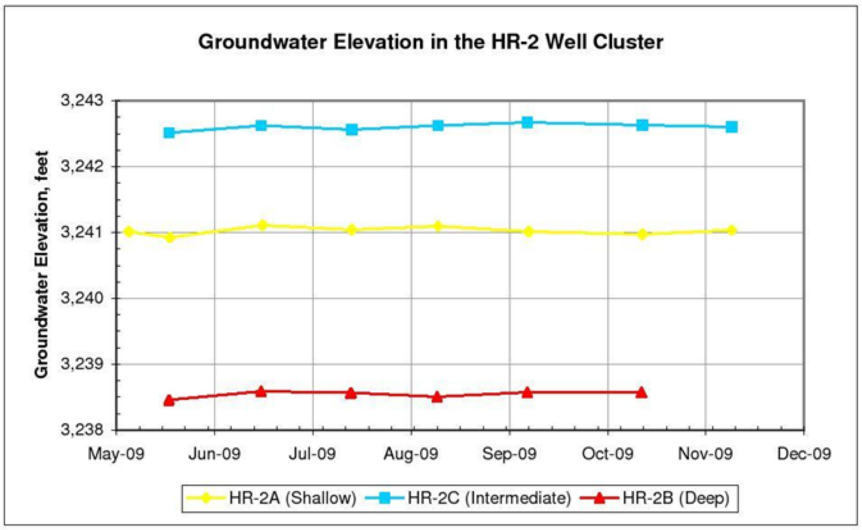
Figure G-3: November 2009 Groundwater Elevation Contour Map



Water level measurements in the clustered multi-level wells (HR-1A, HR-1B, and HR-1C and HR-2A, HR-2B, and HR-2C) advanced on the Hay Ranch property in the north central part of the valley indicated the presence of groundwater elevation differences that suggest generally downward hydraulic gradients overall but with higher potentiometric elevations in the intermediate groundwater-bearing zone compared to the upper and deep groundwater-bearing zones (see **Figure G-4**).

Figure G-4: Vertical Groundwater Elevation Gradients on the Hay Ranch Property





Groundwater elevation hydrographs published at the Inyo County Water Department's website (Inyo Co., 2010) for wells monitored in Rose Valley were reviewed to evaluate long-term trends in groundwater elevation. Over the 2-year model calibration period from November 2007 to November 2009, water levels in wells in Rose Valley generally changed less than 0.5 ft. Observations over the longer term are summarized as follows:

- The LADWP 816 well located at the north end of Rose Valley shows fluctuations of up to 5 ft between January 1995 and January 2010 with a relatively steady average level of approximately 3,438 ft.
- The Pumice Mine well (aka Cal Pumice) generally shows small fluctuations of up to 1 to 2 ft with a relatively steady average level of approximately 3,265.5 ft, except for a sudden unexplained 5 ft drop in December 2009.
- Water level monitoring data for the Hay Ranch North production well, Hay Ranch South production well, and Coso Ranch North well, Coso Junction Store #1 well between January 2003 and January 2010 indicate a generally upward trend of 1-1/2 to 2 ft.
- Rising water level trends of 1 to 1-1/2 ft were also observed in the Lego and G-36 wells on Navy property approximately 3-1/2 miles southeast of Coso Junction

- Long term monitoring data were not available for the wells near the south end of the valley (Cinder Road, Red Hill, or Fossil Falls) or the wells on the Little Lake Ranch property.

The groundwater levels in the LADWP wells 2 miles south of the Haiwee Reservoir were consistently approximately 170 ft higher than groundwater levels in the closest monitored well to the south, Cal-Pumice, throughout the long term monitoring period, consistent with a surface water flow component or input from a groundwater basin at a different groundwater elevation potential (i.e., Owens Valley), and, the presence of a lower permeability zone between the LADWP property and the remainder of the valley. Groundwater levels in the LADWP wells were more variable than any other wells in the valley. The source of this variation is unknown. Water levels in Haiwee Reservoir and the flow rate in the LADWP aqueduct rose during the time water levels were monitored for the 2007 pumping test while groundwater levels in the LADWP wells fell; positive correlation between rising reservoir levels and groundwater elevation would be expected if seepage from the reservoir strongly influenced groundwater levels. The absence of correlation between reservoir levels and groundwater levels in the LADWP wells suggests varying rates of groundwater influx from Owens Valley may be the cause of groundwater level fluctuations at the north end of Rose Valley. The cause of the apparent rising water level trend in the central part of the valley is unknown but could reflect changes in recharge along the margins of the valley and/or long term recovery from agricultural pumping on the Hay Ranch property in the 1970's.

G3.1.3 Aquifer Properties

The transmissivity of the upper portion of the alluvial deposits was previously estimated to range from 9,000 to 69,800 gpd/ft (1,200 to 9,330 ft^2/day) based on data presented in the Rockwell Report (1980). Based on 24-hour pumping tests conducted in the Hay Ranch wells, GeoTrans (2003) concluded that the transmissivity of the Rose Valley aquifer near Hay Ranch was approximately 10,000 ft^2/day and estimated that the horizontal hydraulic conductivity was approximately 20 ft/day. GeoTrans concluded that they had insufficient data to estimate aquifer storage properties.

Based on a 14-day pumping test conducted in the southern production well on the Hay Ranch property and monitored in wells throughout the valley, GEOLOGICA (2008) estimated the transmissivity and horizontal hydraulic conductivity of the aquifer were approximately 14,750 ft^2/day and 24 ft/day, respectively. The vertical hydraulic conductivity of the alluvial aquifer in central Rose Valley was estimated to be 0.01 ft/day using a Neuman "Beta" coefficient of 0.01 from the aquifer testing type curve match and an aquifer thickness of 600 ft. The storage coefficient applicable to early time response and saturated soil below the water table was found to be 0.001.

The City of Los Angeles Department of Water & Power (LADWP) conducted a short-term pumping test on property they own at the north end of Rose Valley in the spring of 2009 (LADWP, 2009). Well V817 was pumped at a rate of 1.84 cubic feet per second (cfs) for 6.5 days. The pumping test resulted in 270 feet of drawdown in the pumping well, 48 feet of drawdown in monitoring well V816 located 197 feet west of the pumping well, and no drawdown in other nearby wells. LADWP concluded that the observed response indicated a small zone of influence and a deep cone of depression. LADWP estimated an average transmissivity of 1,340 ft^2/day and a storage coefficient of 0.004 using pumping test data for the aquifer near well V817.

G3.2 Surface Water

The average annual precipitation in Rose Valley ranges from 5 to 7 inches while the area's annual evapotransporation rate is estimated to be on the order of 65 inches (CWRCB, 1993). Consequently, surface water bodies in the Rose Valley area consist of perennial springs sustained by groundwater flow, ephemeral streams and washes that mainly flow in the winter, and a groundwater-fed lake (Little Lake) and nearby ponds. Surface water features of interest are shown on **Figure G-1** and discussed below.

G3.2.1 Haiwee Reservoir

The South Haiwee Reservoir is located at the north end of Rose Valley approximately 6 miles north of Coso Junction, CA. The crest of the south Haiwee Dam is located at an elevation of approximately 3,766 ft MSL.

Because of seismic stability concerns, the water level in the reservoir is currently limited to a maximum elevation 3,742 ft MSL. During construction of the dam, a trench was reportedly excavated to a depth of up to 120 ft below ground surface, until it tagged basalt bedrock, and backfilled with clay to seal the base of the dam (LADPS, 1916); however, the remainder of the reservoir is unlined. Weiss (1979) estimated that underflow from Haiwee Reservoir contributed approximately 600 acre-ft of water per year to the Rose Valley groundwater basin.

G3.2.2 Springs

Several springs are located in or near Rose Valley as follows:

- **Rose Spring** – Rose Spring is reportedly (USGS Topographic Map) located in the Haiwee Geothermal Leasing Area approximately two miles south and west of the South Haiwee Reservoir at an elevation of approximately 3,640 feet amsl. A table of spring discharge data presented in Rockwell (1980) indicated that the spring was flowing in November 1975 but did not list discharge rates data for the spring. While the Rose Spring was reportedly sampled by the USGS in the early 1970's, no discharge has been observed from the spring in recent years. During a biological reconnaissance survey conducted on April 5, 2008, no surface water was observed. A concrete storage structure lies below the spring; however, water pipes that once fed the structure are no longer functioning (MHA 2008). When flowing, the spring apparently drains shallow groundwater in alluvial sediments south of the reservoir. Due to its higher elevation and lack of discharge, the Rose Spring is not believed to be directly connected to the Rose Valley groundwater aquifer system.

- **Tunawee Canyon Spring** – Tunawee Canyon Spring is located in Tunawee Canyon approximately four miles northwest of the town of Coso Junction at approximately 5,200 feet amsl. Several springs are identified in the upper reaches of Tunawee Canyon on the USGS topographic map of the area. Tunawee Canyon Spring is likely sustained by high elevation precipitation infiltration in the Sierra Nevada Mountains to the west. Rockwell (1980) reported discharge rates of 1.6 to 15 gallons per minute (2.6 to 24 acre-feet/yr) from the spring in November 1975.

- **Davis Spring** – The Davis Spring is located on the Davis Ranch, approximately two miles west of Coso Junction. The Davis Spring is located on the west central side of Rose Valley at Portuguese Bench at an elevation of approximately 3,870 feet amsl. The estimated groundwater discharge rate from the Davis Spring was reported to be approximately 7 acre-feet per year (ac-ft/yr) on an annualized basis in November/December 2007 (MHA 2008), and approximately 9 ac-ft/yr in October/November 2009 (Inyo Co. 2009). The Davis Spring discharge point is located more than 600 feet higher than the groundwater table in the Rose Valley aquifer east of the Davis property at Coso Junction. Spring flow is sustained by high elevation precipitation infiltration in the Sierra Nevada Mountains west of the Davis property. Discharge from the spring that is not used on the Davis property infiltrates back into the ground, after which it percolates downward to recharge the alluvial aquifer. Due to its higher elevation, the Davis Spring is not believed to be directly connected to the Rose Valley groundwater aquifer system. Differences in the stable isotopic composition of the discharge from Davis Spring and Rose Valley waters support the conclusion that the source of Davis Spring is separate from Rose Valley groundwater (MHA, 2008)

- **Sacatar and Little Lake Canyon Springs** – Rockwell (1980) presents data from sampling springs in Sacatar Canyon and Little Lake Canyon in February 1979. The springs were reportedly located at elevations of 4,950 and 3,650 ft amsl, respectively. Sacatar Spring reportedly flowed at a rate of 1 to 5 gallons per minute (1.6 to 8 acre-feet/yr) in November 1975. No flow rate data were identified for Little Lake Canyon Spring. Both springs are located in bedrock outcrops above and west of Rose Valley; and, as a result are not believed to be directly connected to the Rose Valley groundwater aquifer system.

- **Little Lake Fault and Coso Springs** – The Little Lake Fault Spring and Coso Spring are located at the south end of Rose Valley. Little Lake Fault Spring is located on the west side of US 395 approximately one mile south of Little Lake. Coso Spring is located on the east side of US 395, on the Little Lake Ranch property, approximately ¼ mile south of Little Lake. No data have been identified regarding the groundwater discharge rate from the Little Lake Fault Spring. Because it is located in close proximity to Little Lake, Coso Spring is discussed further in the "Little Lake" section below.

G3.2.3 Lakes, Ponds, and Other Surface Water Features

Little Lake, is a perennial lake located at the south end of Rose Valley, to the south of the Haiwee Geothermal Leasing Area, approximately seven miles south of the town of Coso Junction (**Figure G-1**). The majority of Little Lake is located within the Little Lake Ranch, which is a 1,200 acre privately-owned recreational preserve owned and managed by Little Lake Ranch, Inc. Ten acres at the southeast corner of Little Lake is owned by the BLM and includes a visitor overlook. The property includes the approximately 90-acre Little Lake, two smaller perennial ponds, a "siphon well", several other ponds that reportedly contain water intermittently, and adjacent wetland habitat. Little Lake is reportedly 3 to 5 feet deep (MHA 2008); the depths of the other ponds are unknown. The depth and area of the lake have been enhanced by the construction of a low dike along its southern perimeter; consequently, the water level in the lake is regulated by the rate of groundwater inflow into the lake and the setting of a discharge weir located at the south end of the lake.

Because the Little Lake Ranch property is located in a desert area that receives little rainfall, the surface water features and riparian habitat on the property are heavily dependent on an uninterrupted supply of groundwater to maintain surface water flow rates and to sustain plant growth. As a requirement of the approval of the Hay Ranch groundwater diversion project, Inyo County is currently monitoring surface water discharge rates at three locations on the property including the Little Lake Outlet, Coso Spring, and a surface water collection ditch called the North Culvert as well as water levels in Little Lake, several wells on the property (Inyo Co., 2009), and additional wells throughout Rose Valley.

G3.3 Conceptual Groundwater Water Budget

The Rose Valley groundwater system is primarily recharged by mountain front recharge derived from precipitation and snowmelt that falls at higher elevation in the Sierra Nevada front range. The south sloping groundwater table observed at the north end of Rose Valley indicates groundwater enters Rose Valley from Owens Valley to the north and/or from seepages losses from the south Haiwee Reservoir. This inflow is incorporated into the model.

Some precipitation recharge likely occurs in the Coso Range on the east side of the valley but was conservatively neglected for the current modeling effort. The U.S.G.S. (2009) estimated that the recharge from the Coso range might be on the order of 310 to 630 acre-ft/yr, based on analysis using what they termed an "uncalibrated" regional recharge basin characterization model. Also, perhaps as much as 250 acre-ft/yr of groundwater may enter southeastern Rose Valley as upwelling from the Coso geothermal system based on proportions of chloride and stable isotopes in groundwater in southeastern Rose Valley, but was conservatively neglected in this analysis. Leakage from the LADPW aqueducts that traverse Rose Valley was assumed to be a negligible component of total groundwater inflow to the basin.

Currently, the principal groundwater outflow components consist of groundwater underflow and surface water discharges to the Indian Wells Valley to the south, and evapotranspiration from Little Lake and phreatophytic vegetation on the Little Lake Ranch property. Because of the dry climate, essentially all of the precipitation falling on Rose Valley is lost to evapotranspiration. However, because the groundwater table is located 40 or more feet below ground surface over all but the southern tip of the valley, evapotranspiration does not factor into the groundwater budget except on the Little Lake Ranch property. On the Little Lake Ranch property, groundwater rises to the surface through springs, and sustains the 90-acre lake and several ponds. In this area, evaporation from the lake and ponds and transpiration from riparian plants are significant. Inflow and outflow components of the groundwater budget for Rose Valley are discussed in more detail below.

G3.3.1 Simulated Groundwater Inflow Components

Principal inflow components consist of mountain front recharge, groundwater inflow from Owens Valley to the north and/or seepage from Haiwee Reservoir.

- **Mountain Front Recharge** – Precipitation recharge in the Sierra Nevada range west of Rose Valley is the principal source of groundwater to the Rose Valley basin. Due to the rain shadow effect caused by the Sierra Nevada's, the precipitation rate in the Coso Range on the east side of Rose Valley is low. To be conservative, it was assumed that the evapotranspiration potential exceeded potential precipitation recharge throughout Rose Valley and the Coso Range. Methodologies to directly measure mountain front recharge are poorly defined; typically groundwater recharge from precipitation is estimated as a percentage of total recharge.

  Brown and Caldwell (2006) concluded that precipitation rates in the Rose Valley area range from about 6 inches per year (in/yr) on the valley floor to up to 20 in/yr at the crest of the Sierra Nevada range and that only precipitation falling at elevations above 4,500 ft results in groundwater recharge. In the mountains, precipitation rate (including rainfall and snow melt) is strongly dependent on altitude. Danskin (1998) established an empirical relationship between precipitation rate and altitude based on precipitation and snow records collected routinely for more than 50 years in 20 survey stations along the western side of Owens Valley. Using the empirical relationship developed in the Danskin report, Brown and Caldwell estimated that the average precipitation rate for the elevation ranging from 4,500 ft to 6,500 ft was 10 in/yr, increasing to 15 in/yr for parts of the watershed above 6,500 ft. Using a geographic information system (GIS), to evaluate the contribution from areas of varying elevation in the Sierras west of Rose Valley, Brown and Caldwell estimated that the total precipitation volume that could potentially recharge the Rose Valley groundwater basin was approximately 42,000 acre-ft/yr.

  For the purposes of the initial evaluation of potential impacts of groundwater development at Hay Ranch, they further assumed that only 10 % (4,200 acre-ft/yr) of the potential mountain front precipitation recharge actually reaches Rose Valley. Danskin (1998) used a value equivalent to 6% of Sierra Nevada range precipitation for the mountain front recharge component of the numerical groundwater flow model developed to evaluate groundwater development in Owens Valley. Williams (2004) estimated that mountain front precipitation recharge in Indian Wells Valley amounted to approximately 8% of precipitation in the Sierra Nevada range to the west. However, Williams noted that the Maxey-Eakin Method for estimating precipitation recharge in the Sierra Nevada range conservatively neglects areas receiving less than 8 in/yr of precipitation; consequently, higher recharge rates are possible. Because the mountain front precipitation recharge rate as assumed for the Brown and Caldwell groundwater flow model yielded reasonable calibration results in the steady state model, a recharge rate of approximately 4,200 acre-ft/yr was also used in this study.

- **Groundwater Inflow/Seepage from the North** – As noted previously, Weiss (1979) estimated seepage losses from the Haiwee Reservoir to be on the order of 600 acre-ft/yr. Previous investigators (Bauer, 2002; Brown and Caldwell, 2006) and GEOLOGICA's review of groundwater elevation contour patterns in the north end of Rose Valley indicate that groundwater inflow from southern Owens Valley and/or seepage losses from the south Haiwee Reservoir recharge the Rose Valley groundwater basin at the north end of the valley. Using a steady-state numerical groundwater flow model of the Rose Valley groundwater basin, Brown and Caldwell (2006) estimated the groundwater influx from the north to be approximately 788 acre-ft/yr, which is similar to the estimate of Weiss (1979). Recalibration of the numerical groundwater flow model for the 2008 Hay Ranch EIR indicated a slightly higher groundwater inflow rate from the north (Owens Valley/Haiwee Reservoir) of 890 acre-ft/yr.

G3.3.2 Simulated Groundwater Outflow Components

Principal groundwater outflow components from Rose Valley consist of discharge to the Indian Wells Valley from the Little Lake area and an area in the southeast part of the valley, east of Red Hill, and evapotranspiration in the Little Lake area. Limited groundwater extraction was identified in Rose Valley.

- **Groundwater Discharge from Southeastern Rose Valley** – Brown and Caldwell (2006) estimated that approximately 2,050 acre-ft/yr of groundwater discharges from Rose Valley in the southeast part of the valley (southeast of Navy well 18-28) as underflow to Indian Wells Valley. Williams (2004) concluded that existing estimates of recharge to the Indian Wells Valley significantly underestimated interbasin transfers and referenced an estimate of groundwater underflow from Rose Valley to Indian Wells Valley of 10,000 acre-ft/yr developed by Thompson (1929). Recalibration of the numerical groundwater flow model for Rose Valley indicated an underflow rate from Rose Valley to Indian Wells Valley in this area of 850 acre-ft/yr. This is less than half the value of 2,050 acre-ft/yr assigned to this term in the Brown and Caldwell (2006) numerical modeling analysis. This difference is discussed in the model calibration section.

- **Groundwater Discharge at Little Lake** – Groundwater discharge by several processes in the Little Lake area is the dominant outflow component from Rose Valley. The processes operating at Little Lake include:

  - Evaporation from the lake surface;
  - Transpiration from phreatophyte plants on the property;
  - Discharge from Coso Spring;
  - Discharge from the Little Lake Weir; and
  - Discharge from the Little Lake Siphon well.

  Bauer (2002) estimated that evaporation from the Little Lake water surface consumes approximately 500 acre-ft/yr based on a lake surface area of 75-90 acres and evaporation rate of 80 in/yr. Plant communities identified on the Little Lake Ranch property were described as akalai desert (saltbush scrub), palustrine (pond) and lacustrine (lake) wetlands, and riparian (creek) habitat. Beginning in 2000, Little Lake Ranch, Inc., conducted various projects intended to restore or enhance 90 acres of lacustrine wetlands, 10 acres of palustrine emergent wetlands, about 6 acres of palustrine/riparian habitat (1.6 mile long creek corridor), and an additional 220 acres of wetland and upland habitat, and 1 acre of wetland and associated upland habitat was acquired. As a result of shallow groundwater in this area, plant communities on and near the Little Lake Ranch property have greater access to groundwater than occurs elsewhere in the valley. GEOLOGICA (2008) estimated that transpiration processes in the Little Lake area could consume up to 700 acre-ft of groundwater per year. The domestic well by the ranch house, several irrigation wells, and the former Little Lake Hotel well are not believed to extract significant quantities of groundwater. All of the groundwater discharged in the Little Lake area that is not evaporated or transpired by plants reportedly infiltrates back into the ground on the property and continues as groundwater underflow to Indian Wells Valley (no surface water flow leaves the property). Because of considerable uncertainty in actual evapotranspiration rates, and the relative contribution of groundwater underflow, overland flow, and evaporation from ponds and other surface water features further south on the ranch property, groundwater consumption on the Little Lake Ranch property was calculated in the 2010 version of the numerical model using evapotranspiration cells to represent evaporation from Little Lake and drain cells to represent discharge to Indian Wells Valley and all other consumptive uses of groundwater on the property.

- **Existing Extraction Wells** – Groundwater in Rose Valley is used for domestic drinking water supply, limited irrigation, light industrial processes, and, at the south end of the valley, for maintenance of riparian habitat in the Little Lake area. The Draft EIR for the Hay Ranch Water Extraction and Delivery System Project (MHA 2008) estimated that approximately 40 acre-ft/yr of groundwater production from wells occurs in Rose Valley. As many as 30 domestic wells are believed to extract relatively small quantities of groundwater for domestic uses and small scale irrigation in the Dunmovin area. Several wells at Coso Junction including a well at the Coso Junction Ranch, Coso store, and the CalTrans rest area produce water for drinking, irrigation, or light industrial purposes. The Coso Ranch North well and northern Coso Junction Store well (Coso Junction #1) are not being used at present. Rockwell (1980) reported that irrigation pumping at the Rose Valley Ranch (now referred to as the Hay Ranch) started in 1975, and averaged approximately 3,000 acre-ft/yr. In 1979 the Rose Valley Ranch reportedly pumped approximately 3,130 acre-ft/yr of groundwater from the two wells on the property for alfalfa irrigation. Alfalfa farming ceased sometime in the early 1980's. No significant agricultural irrigation, or groundwater extraction for any other purpose, has occurred in the valley since that time. Wells on the Navy property in Rose Valley including the Lego well, well G-36, and well 18-28 are not being pumped.

Groundwater extraction is specified in several existing wells in Rose Valley in the steady-state model including:

- Domestic supply in the Dunmovin area is represented in the groundwater flow model with a single well pumping at a steady rate of 8.5 acre-ft/yr based on estimates from the Rockwell (1980) hydrologic study.
- Water supply for the Coso Junction store and CalTrans rest stop is represented in the groundwater flow model with a single well pumping at a steady rate of 17 acre-ft/yr.
- Irrigation and light industrial supply at the Coso Junction Ranch property is represented in the groundwater flow model with a single well pumping at a steady rate of 17 acre-ft/yr.

The same steady state groundwater extraction rates were specified in the transient model. In addition, two intervals of pumping from the LADWP's V817 well in March 2009 (of 1-1/2 days and 6-1/2 days) and pumping for 14 days from the Hay Ranch south well in late November 2007 were simulated in the transient calibration model.

G3.3.3 Groundwater Budget

The groundwater elevation monitoring data suggest that groundwater inflows have equaled or slightly exceeded groundwater outflows from the Rose Valley groundwater basin in the past five years. Assuming that groundwater inflows equal outflows, that is, that steady state conditions prevail, the resulting conceptual Rose Valley groundwater budget is tabulated in the table below. Some of these components are estimated based on independent studies (e.g. Mountain Front Recharge) and some values are derived from the model after adjustments for model calibration (e.g. groundwater underflow from Rose Valley to Indian Wells Valley). Values from the 2008 version of the Rose Valley numerical groundwater flow model are also listed for comparison purposes:

Table G-2: Rose Valley Groundwater Budget

Budget Components	Values Cited in the Literature	2008 Model		2010 Model	
		Flow Rate acre-ft/yr	Simulation Package used in Model	Flow Rate acre-ft/yr	Simulation Package used in Model
Groundwater Inflow					
Mountain Front Recharge from west	2,040-4,070(5)	4,197	Well (Specified Flux)	4,197	Well (Specified Flux)
Recharge from Coso Range	310-630(5)	0	--	0	--
Groundwater Underflow from the North	0(5) 600(6) 788(1)	898	Constant Head	898	Well (Specified Flux)
Total Inflow		**5,095**		**5,095**	
Groundwater Outflow					
Existing extraction wells		38	--	42	Well
Groundwater underflow to Indian Wells Valley exiting from southeastern Rose Valley	2,050(1)	848	General Head	2,102	General Head
Evaporation from Little Lake	500(2)	462	Evapo-transpiration	416	Evapo-transpiration
Phreatophyte and Riparian plant transpiration on Little Lake Ranch property	700(7)	--	--	--	--
Groundwater Discharge through Little Lake Gap to Indian Wells Valley	0(5) 3,300(3) 10,000(4)	3,747	General Head	2,537	Drain
Total Outflow		**5,097**		**5,097**	

Source:
1) Brown & Caldwell (2006)
2) Bauer (2002)
3) Williams (2004)
4) Thompson (1929)
5) U.S.G.S. (2009)
6) Weiss (1979)
7) GEOLOGICA (2008)

G4. NUMERICAL MODEL DEVELOPMENT

Brown and Caldwell (2006) developed a three-dimensional, numerical model of the Rose Valley groundwater basin which was then revised, and recalibrated, by GEOLOGICA for the Hay Ranch Groundwater Extraction Project EIR (GEOLOGICA, 2008), and, revised and recalibrated, by GEOLOGICA for the current study. Groundwater flow evaluations were conducted using the U.S.G.S. MODFLOW computer code (McDonald and Harbaugh, 1988) implemented in the Groundwater Vistas graphical environment (Version 5, Environmental Simulations, 2007). The revised model incorporates new groundwater elevation data and lithologic information from monitoring well drilling and logging conducted for the Hay Ranch Monitoring Project (Inyo Co. 2009, 2010), as well as time-drawdown data from a 6-1/2-day pumping test conducted on the LADWP property in March 2009.

G4.1. Overview of Model Revisions

The numerical groundwater flow model of Rose Valley modified for Hay Ranch Groundwater Extraction Project EIR (GEOLOGICA, 2008), aka, the Rose Valley Model, was revised for the current study to better represent the structure of the local aquifer system, and to address comments from various sources regarding model input parameters, boundary conditions, calibration, and sensitivity analysis. Specific revisions are summarized below:

- **Northern Inflow Boundary** – The 2008 version of the Rose Valley Model utilized a Constant Head Boundary condition along the northern edge of the model domain to represent groundwater inflow from Owens Valley, seepage losses from the South Haiwee Reservoir, and mountain front recharge at the far north end of the valley. Several reviewers noted that the groundwater flux calculated by MODFLOW for a Constant Head Boundary could be artificially high if groundwater extraction was specified too close to the boundary. For the current study, the Constant Head Boundary nodes were removed from the model and replaced with specified flux (well) cells to limit groundwater inflow in this area to specified rates based on the water budget analysis discussed in Section G.2.5.1.

- **Southern Outflow Boundary** – The 2008 version of the Rose Valley Model utilized a General Head Boundary condition along the southern edge of the model domain near Little Lake to represent groundwater outflow from the Rose Valley aquifer to the Indian Wells valley to the south. Several reviewers commented that under conditions of extreme aquifer drawdown, the General Head Boundary nodes could allow the simulation code to force water to enter the model along the southern boundary, which is implausible in the conceptual model for the site. In addition, the U.S.G.S. (2009) noted that the close proximity of the General Head Boundary nodes to the evapotranspiration nodes specified to represent evaporation from Little Lake could make the model unstable. The General Head Boundary nodes were replaced with Drain nodes, which only allow outflow, and moved approximately 2,000 feet to the south to provide additional separation from Little Lake.

- **Model Layering Scheme** – The 2008 version of the Rose Valley Model was subdivided into 4 model layers, with the two uppermost layers representing alluvial deposits, and the two lower layers representing the Coso

- Lake Bed and Coso Sand members, respectively. Several reviewers commented that the representation of the Coso Lake Bed and Coso Sand geologic units in the model exaggerated the amount of groundwater available for extraction. Consequently, to ensure a conservative evaluation of impacts from groundwater extraction in the valley, the two lower model layers were removed from the model. It should be noted that the revised model, comprised of two model layers, only approximately represents groundwater conditions in the north central part of the valley around the Hay Ranch property where recent drilling and lithologic logging activity suggests that there may be three groundwater-bearing zones, which would require, at a minimum, three model layers to represent in greater detail. Revising the model to represent this condition was beyond the scope of this study and impractical with available hydrogeologic data.

- **Location of Mountain Front Recharge** – The U.S.G.S. (2009) noted that the presence of springs east of the Sierra Nevada mountain front suggests that there is a lateral barrier to groundwater flow (on the western edge of the model domain) that would limit the direct infiltration of mountain front recharge such that most, if not all, of the mountain-front recharge should be simulated in model-layer 1. Consequently, mountain-front recharge simulated using specified flux cells was limited to model-layer 1 in the revised model rather than being distributed across the deeper model layers as was done previously.

- **Lack of Transient Calibration** – Several reviewers commented that the 2008 version of the Rose Valley Model was only calibrated to steady-state conditions which may unconservatively represent conditions during pumping. To address this concern, a transient calibration was conducted using water level data collected in Rose Valley during the two year period from November 2007 to November 2009. In addition, the model was calibrated to time-water level data collected during pumping tests conducted in September/October 2007 on the Hay Ranch property and March 2009 on the LADWP property. The accuracy of the transient model calibration was further assessed by conducting a model confirmation run using time-water level data from the first nine days of intermittent pumping for the Hay Ranch Groundwater Transfer Project beginning in late December 2009.

- **Uncertainty in Aquifer Storage Properties** – Because insufficient data were available to estimate aquifer specific yield, the 2008 version of the Rose Valley Model used a range of values (10, 20, and 30%) for groundwater resource development scenarios that were not used in the model calibration process. The groundwater development scenarios used in the current development impact analysis utilize the final calibrated specific yield value estimated from the transient model calibration. In addition, sensitivity analysis was conducted to assess the sensitivity of the transient model calibration to uncertainty in specific yield.

- **Excessive Model Error near LADWP Wells** – The reviewer for the LADWP noted that the 2008 version of the Rose Valley Model underpredicts groundwater elevation at the LADWP's wells at the north end of the valley by nearly 120 ft. Using data from the pumping test conducted on that property in March 2009 to adjust local aquifer properties, the recalibrated model reduces the error in simulated groundwater elevation at this location to less than 3 ft.

- Model Grid Spacing – To further improve the accuracy of the model, the maximum grid spacing was reduced from ¼ mile (1,320 ft) to 1/8 mile (660 ft). In addition, the model grid was refined to a minimum spacing of approximately 220 ft near the Hay Ranch property where new monitoring wells were recently installed to allow better representation of response to pumping.

G4.2 Model Domain and Finite Difference Grid

The model domain covers approximately 132 square miles, extending up to 8.25 miles in the east-west direction and up to 16 miles in the north-south direction (**Figure G-1**). The model domain extends from the groundwater divide near the south Haiwee Reservoir on the north to the Little Lake Gap area to the south, and is bounded by impermeable boundaries representing the Sierra Nevada Mountains on the west and by Coso Range to the east. Consistent with the representation developed in the 2006 and 2008 numerical models of Rose Valley, the southern edge of the active portion of the model grid extends to just beyond the south edge of Little Lake; consequently, Coso spring, the Little Lake Ranch siphon well, and palustrine and riparian wetland areas south of Little Lake are not explicitly represented in the model.

The model domain was discretized into 137 rows, 71 columns, and 2 layers. The maximum cell size of the grid is 1/8 mile in both length and width, representing a 10-acre area. The model grid was refined to a minimum spacing of approximately 220 ft near the Hay Ranch property where new monitoring wells were recently installed to allow better representation of response to pumping. No flow (inactive) model cells were specified along the east and west margins of the model domain to represent the shape of the aquifer within basin fill deposits.

G4.2.1 Model Layer Configuration

Three model layers were originally used to represent the aquifer system in the 2006 version of the Rose Valley groundwater model. As part of the 2008 recalibration process, GEOLOGICA subdivided the uppermost model layer into two layers to better represent the semi-confined behavior of the aquifer, resulting in a four-layer model. The location of the contact between layers 1 and 2 was specified as being just below the bottom depth of shallower wells in the valley (including Cal-Pumice, Coso Store #1 and #2, and the Lego, G-36, and 18-28 wells) which is on the order of 400 ft bgs. The uppermost two layers (layers 1 and 2) were configured to represent: debris flows and debris avalanche in the Dunmovin Hill in the northern part of Rose Valley; the recent alluvial deposits in the center of Rose Valley, and interbedded volcanic deposits and alluvium in the south and southeast part of Rose Valley. The lower two layers were intended to represent the Coso Lake Bed and Coso Sand members, respectively. As noted in Section G3.1, the two lower model layers were removed from the current version of the Rose Valley model to more conservatively represent potential impacts from groundwater extraction.

Model layer 1 is specified as unconfined with transmissivity determined by MODFLOW as the product of horizontal hydraulic conductivity and current saturated thickness and storage represented using specific yield.

Layer 2 is configured as a confined, but variable transmissivity unit in MODFLOW with transmissivity calculated as the product of horizontal hydraulic conductivity and the layer thickness at that location and storage represented using a confined aquifer storativity value.

Model layers 1 and 2, together, were constructed to have variable thickness and spatial extent. The basis for specifying layer thickness and the bottom elevation of each of layers is described in Brown and Caldwell (2006). Total model thickness from land surface ranges from 150 ft within Little Lake Gap to approximately 800 ft near the Hay Ranch property.

G4.2.2 Model Boundary Conditions

The active portion of the model domain is bounded on the west and east by by inactive cells representing igneous and metamorphic rocks of the Sierra Nevada and Coso Range which are presumed to be impermeable. Groundwater discharge to Indian Wells Valley in the southeast part of Rose Valley (east of Red Hill) through fractured basalt flows and/or basalt flows overlying alluvial deposits was represented using a head dependent boundary condition. Model cells that represent bedrock areas form the inactive portion of the model domain and also serve as no-flow boundaries. Boundary conditions specified in Layers 1 and 2 are depicted in Figures G-a and G-b, respectively.

- **No Flow Boundaries/Inactive Cells** – The location of no flow boundaries, and thereby, inactive cells in the model domain were similar to those specified in the 2008 model with the exception that after the model grid spacing was refined, the shape of the southern model boundary was smoothed to better conform to the estimated extent of alluvial deposits in that area. **Figure G-5** shows the location/configuration of inactive model cells.

- **Specified Flux Boundaries** – Specified flux boundary cells in model layer 1 were used to represent mountain front recharge derived from precipitation and snowmelt that falls on the Sierra Nevada on the west side of the model grid, and, groundwater inflow from the north and seepage from the South Haiwee Reservoir along the northern model boundary. The flow rates for the specified flux cells were set to constant annualized rates based on the groundwater budget developed for the Hay Ranch EIR (Geologica, 2008) and discussed in

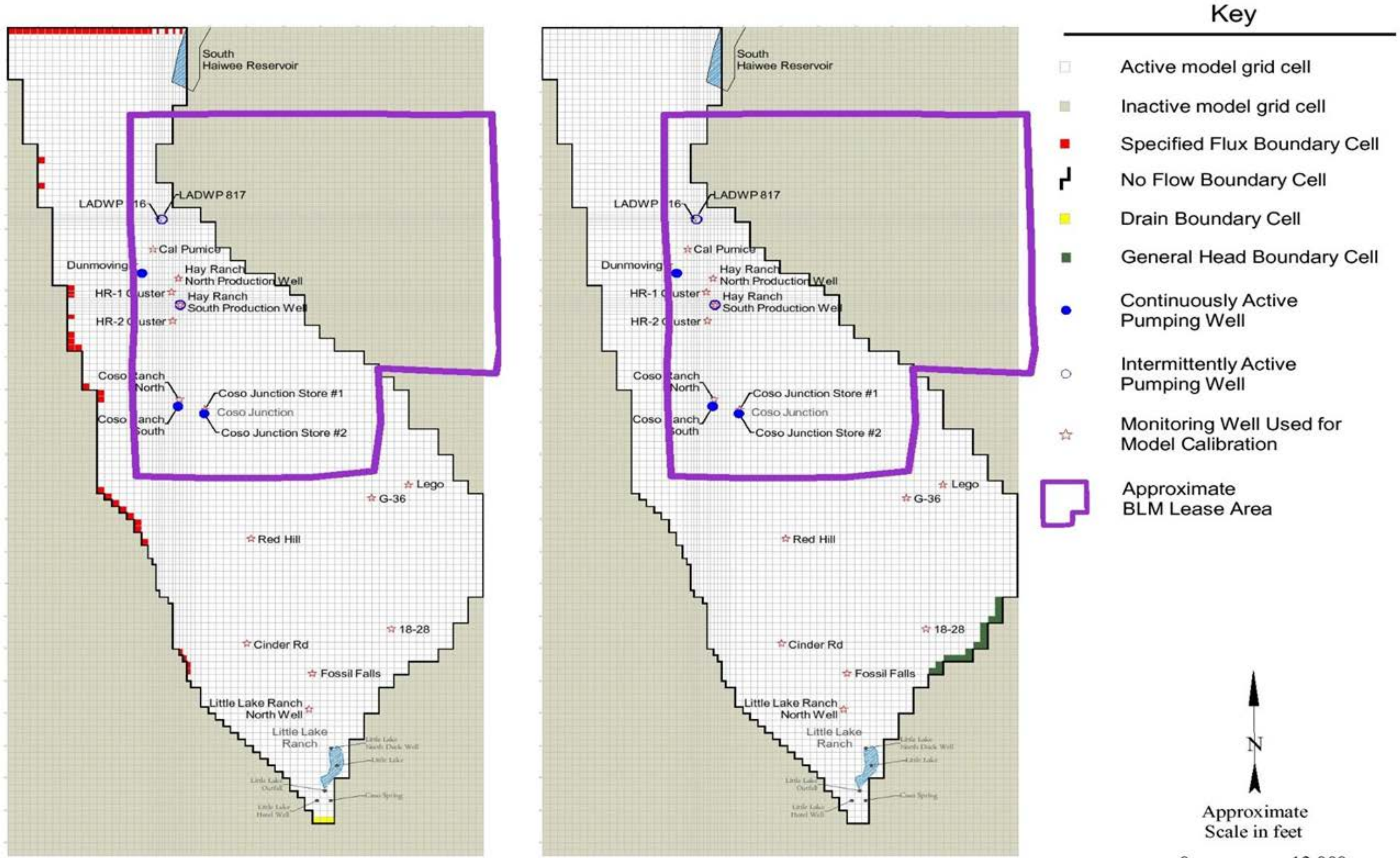
- **Section G2.5**. Sensitivity analyses, discussed in **Section G-3.3.3**, were conducted to evaluate the sensitivity of the steady-state and transient model calibration results to the magnitude of the northern boundary inflow and western boundary inflow.

- **Evapotranspiration** – Surface water evaporation from Little Lake and evapotranspiration from phreatophyte plants around the lake was represented using the MODFLOW Evapotranspiration (ET) package with ET cells specified in model layer 1 over the approximate footprint of the lake. The extinction depth for the ET cells was set to 15 ft below ground surface, the same value as was used in the 2006 model, and consistent with the value used in the USGS model of Owens Valley (Danskin, 1998). Bauer (2002) estimated the surface water evaporation rate from Little Lake to be approximately 500 acre-ft per year, presumably when the lake is at its maximum depth. The relationship between lake level and surface area is unknown, presumably, at lower water levels the lake covers less area and may lose less water to evaporation. MODFLOW reduces the calculated evapotranspiration loss in proportion to the groundwater table depth below ground surface; no evapotranspiration occurs when the groundwater table is at or below the extinction depth (15 ft), half as much evapotranspiration is calculated when the groundwater table is located at half the extinction depth (7.5 ft) below ground surface. The evapotranspiration rate was adjusted during model calibration to yield a total evapotranspiration loss of approximately 500 acre-ft per year in the steady state model, consistent with the 2006 model.

- **General Head Boundary** – Groundwater outflow to Indian Wells Valley from the southeast part of Rose Valley near well 18-28 was simulated using general head boundary (GHB) cells specified in model layer 2. GHB cells in MODFLOW allow groundwater inflow or outflow from the model at a rate dependent on the difference between groundwater elevation in the model and a specified elevation and a conductance assigned to the general head boundary cell; however, the groundwater elevation in the GHB cell is calculated by MODFLOW during a simulation, not fixed like a Constant Head boundary cell. Brown and Caldwell used groundwater elevations measured in the Lego Well in Rose Valley and historical water level elevations measured in the Indian Wells Valley (presented in Bloyd and Robson, 1971) to estimate the flow across this boundary. The conductance and groundwater elevation in the GHB cells were adjusted during this model calibration process to better simulate groundwater elevations observed in the southeast part of Rose Valley.

- **Drain Nodes** – The groundwater outflow to Indian Wells Valley in the Little Lake area was represented using MODFLOW Drain nodes specified in Model Layer 1, at the south end of the model grid near Little Lake (**Figure G-5**). This is a departure from the treatment of this groundwater outflow term in the 2008 model in which General Head Boundary cells were used to represent groundwater discharge from the south end of Rose Valley.

Figure G-5: Model Boundary Conditions – Layers 1 and 2



Layer 1 Boundary Conditions

Layer 2 Boundary Conditions

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G4.2.3 Initial Aquifer Parameters

Initial values for key aquifer parameters including horizontal hydraulic conductivity (Kh), vertical hydraulic conductivity (Kz), water table specific yield (Sy), and aquifer storativity (Ss) were specified based on the final calibrated values used in the 2008 version of the Rose Valley model (GEOLOGICA, 2008). Initial Kh values ranged from 0.55 foot per day (ft/day) in the north end of the model grid (from well V816 north), to 24 ft/day in the central portion of the grid, to 200 ft/day in the southern end of the model domain near Little Lake Ranch. Initial Kz values ranged from 0.05 ft/day in the north end of the model grid (from well V816 north), to 0.019 ft/day in the central portion of the grid, to 20 ft/day in the southern end of the model domain near Little Lake Ranch. A uniform storativity value of 1 x 10^{-7}/ft was used throughout the model domain in accordance with the 2008 version of the model. An initial specific yield value of 0.1 (10%) which was the lowest specific yield value used in groundwater resource development evaluations for the Hay Ranch EIR (RMT, 2008) was used in initial calibration efforts.

G4.3 Model Recalibration

Recalibration of the 2008 version of the numerical model of groundwater flow conditions in Rose Valley was conducted in an iterative process which consisted of calibrating a steady-state model to groundwater elevations observed in Rose Valley at the beginning of November 2007, followed by calibration of a transient model to groundwater elevations observed in wells monitored in the valley between November 2007 and November 2009. The transient model used the same aquifer parameters as the steady-state model, with the exception that it included aquifer storage coefficients that are not used in a steady-state model. The transient model was linked to the steady-state model in that it used the final groundwater elevations from the steady-state model as initial groundwater elevations for the transient simulations. In addition to water level data from the Hay Ranch Monitoring Program (Inyo Co., 2009, 2010), the transient model used time-drawdown data from a 14 day pumping test conducted on the Hay Ranch property in November 2007 (GEOLOGICA, 2008) and 1-1/2 and 6-1/2 day pumping tests conducted on the LADWP property in March 2009 (LADWP, 2009). During the model calibration process, model input parameters were iteratively adjusted until a visual best fit was observed between simulated groundwater elevations and observed groundwater levels during the calibration period, and, the summed squared error between observed and simulated elevations was minimized. Parameters adjusted included:

- Horizontal and vertical hydraulic conductivity;
- Aquifer storativity and specific yield;
- General Head Boundary elevation and conductance;
- Drain elevation and conductance.

G4.3.1 Final Calibrated Model Parameters

Final parameter values are listed in **Table G-3**. The spatial distributions of calibrated parameter values are illustrated on **Figures G-6** and **G-7**. The main changes in aquifer parameter values in the revised model compared to the 2008 model were in the horizontal hydraulic conductivity in the north and central parts of the model grid, vertical hydraulic conductivity in the central part of the grid, storativity values in the central and northern part of the grid, and specific yield throughout the model domain.

Horizontal hydraulic conductivity at the north end of the model grid including, and north of the LADWP property, was set to 0.55 ft/day in the 2008 model, yielding an aquifer transmissivity in that area of approximately 500 ft^2/day. However, a pumping test conducted by LADWP (2009) on their property in March 2009 indicated higher transmissivity in the area on the order of 1,340 ft^2/day. Horizontal hydraulic conductivity in this area was increased to 2 ft/day during the model calibration process, yielding a significantly better fit between observed and simulated steady-state groundwater elevation. An apparent low permeability zone was identified between the Cal Pumice well and LADWP wells 816 and 817, based on the presence of very high groundwater elevation gradients in that area (see **Figure G-3**). Horizontal hydraulic conductivity was decreased in that region in model layers 1 and 2 in an iterative fashion to improve the match between simulated and observed groundwater elevations north of this region.

Table G-3: Summary of Final Calibrated Parameter Values

Parameter	Parameter Value	Units
Northern Boundary Kh	2	ft/day
Northern Boundary Kz	0.02	ft/day
V816 to Pumice Well Kh	0.24	ft/day
V816 to Pumice Kz	0.024	ft/day
Hay Ranch Transition Kh	7.5	ft/day
Hay Ranch Transition Kz	0.75	ft/day
Central Valley Kh L1	50	ft/day
Central Valley L1 Kz	0.001	ft/day
Central Valley Kh L2	12.8	ft/day
Central Valley L2 Kz	0.01	ft/day
Southeastern Kh	100	ft/day
Southeastern Kz	10	ft/day
Volcanics Kh	1	ft/day
Volcanics Kz	0.1	ft/day
Little Lake Kh	112.5	ft/day
Little Lake Kz	11.25	ft/day
Southeast General Head Boundary Elevation	3,140	ft
Southeast General Head Boundary Conductance	367	ft2/day
Little Lake Drain Boundary Elevation	3,110	ft
LittleLake Drain Boundary Conductance	6.60E+05	ft2/day
Northern Boundary Specified Flux	107,088	cfd
Sierra Recharge	500,560	cfd
Northern Sy	0.035	-
Northern Ss	3.50E-06	1/ft
Central Sy	0.1	-
Central Ss	1.50E-06	1/ft
Southern Sy	0.1	-
Southern Ss	3.50E-06	1/ft

Lithologic logging data made available by construction of two sets of clustered monitoring wells on the Hay Ranch property in 2009 (SGSI, 2009a, 2009b, and 2009c) revealed more strongly anisotropic soils in the area than previously estimated. Soils in the upper 200 feet of the soil column were gravelly, while soils below that depth were found to be more fine-grained. In addition, two distinct clay horizons were identified in both clustered boring locations that SGSI concluded would function as aquitards. These two clay aquitards cannot be represented explicitly in the two-layer numerical model. The hydraulic effect of the shallow high permeability gravel horizon overlaying less permeable sands and silts at depth was represented by assigning a higher horizontal hydraulic conductivity (50 ft/day) in the central portion of model layer 1 and lower horizontal hydraulic conductivity (12.8 ft/day) in model layer 2. The hydraulic effect of the two clay aquitards was represented by assigning low vertical hydraulic conductivities to model layers 1 and 2 of 0.001 and 0.01 ft/day, respectively, resulting in vertical anisotropy ratios of 50,000 to 1 and 1,280 to 1. Elsewhere in the model, higher vertical anisotropy ratios of 10 to 1, more typical of natural sediments absent low permeability aquitards, were used.

Figure G-6: Hydraulic Conductivity Distribution – Layers 1 and 2

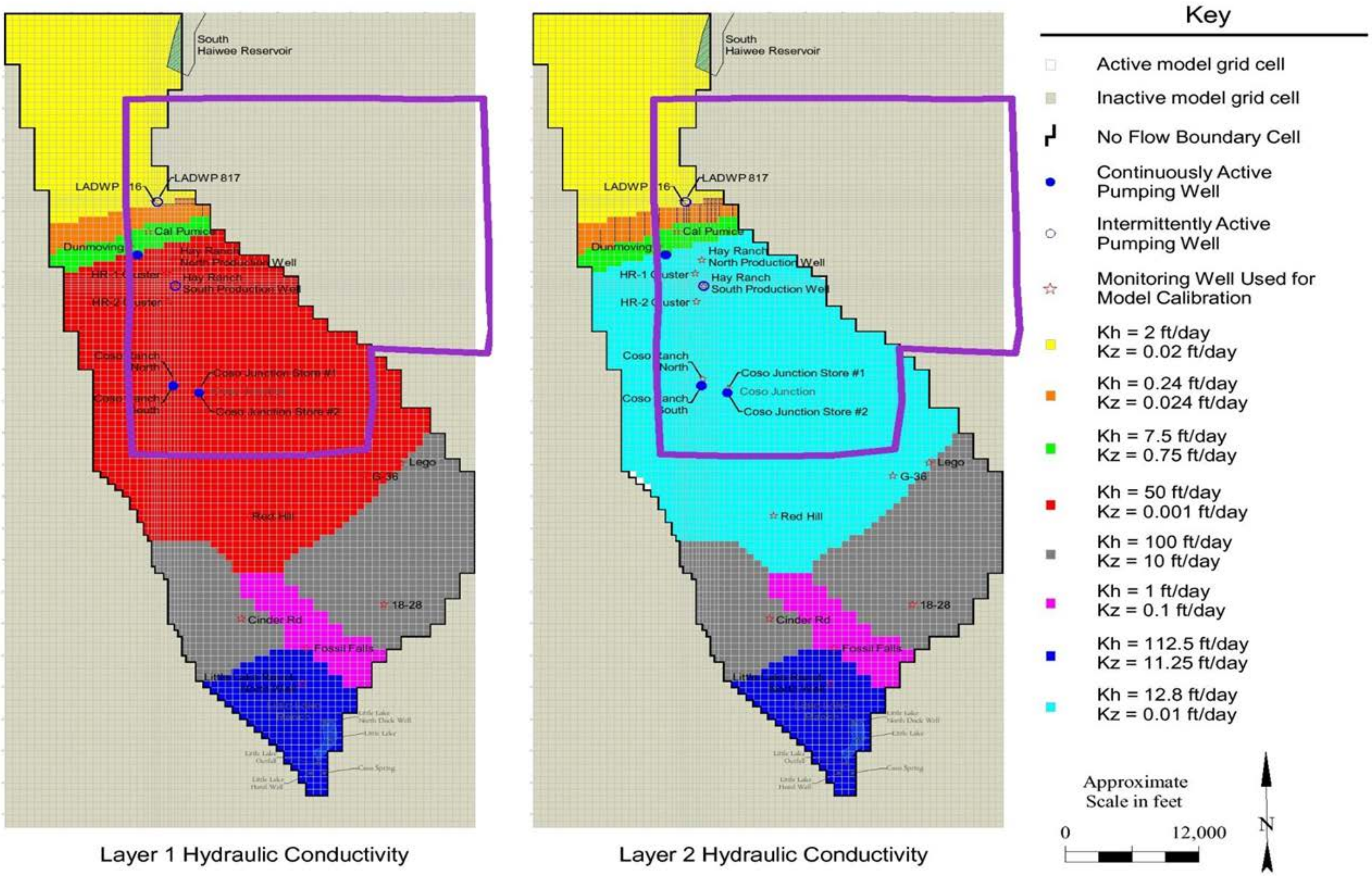

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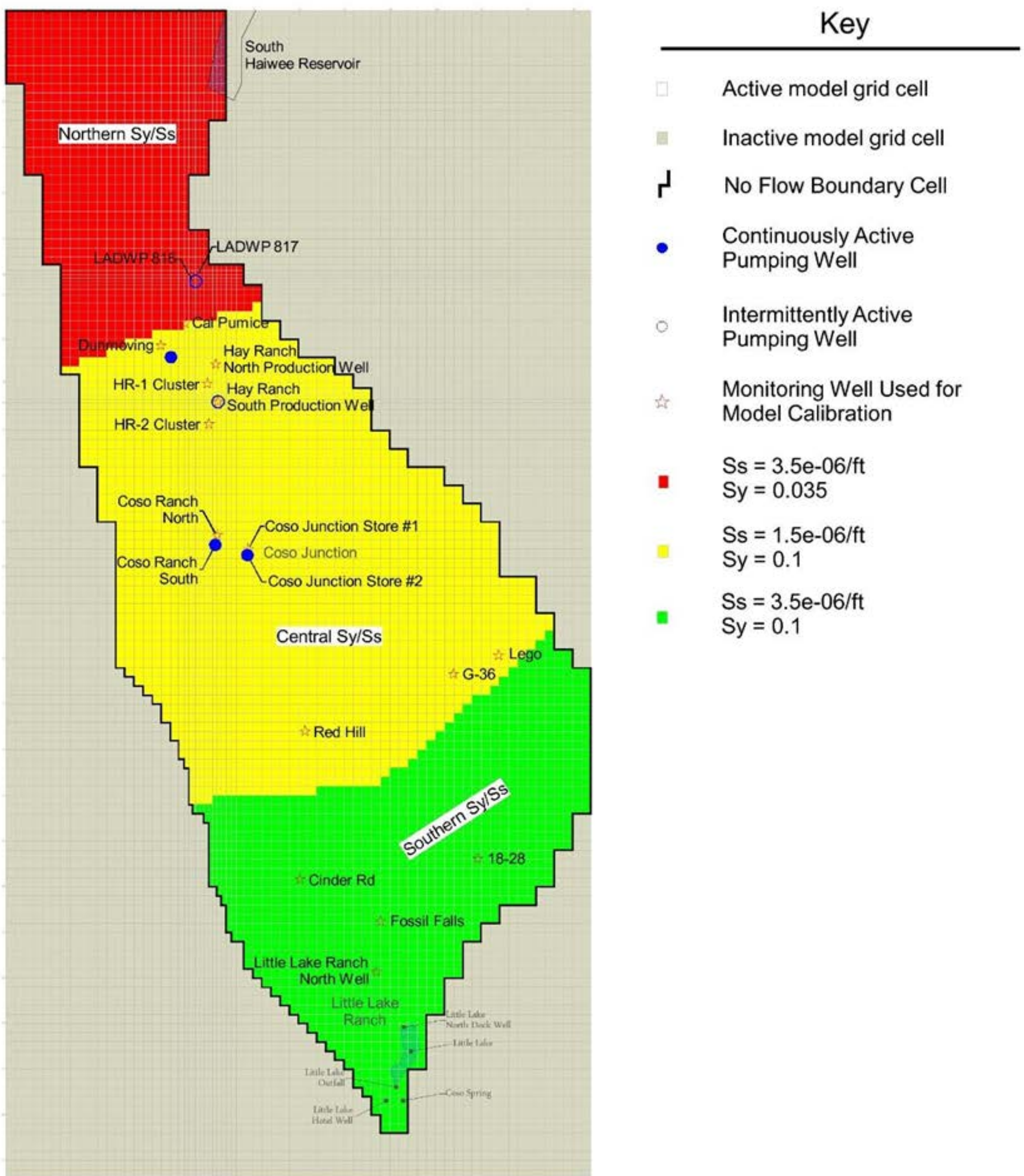
Figure G-7: Storage Property Distribution – Layers 1 and 2



For the 2010 model calibration, the model domain was subdivided into three subregions, north, central, and southern as depicted in **Figure G-7** for the specification of aquifer storage properties. Then specific yield and aquifer storativity were iteratively adjusted during the transient model calibration process until a best fit was obtained between simulated and observed groundwater elevations.

G4.3.3. Calibrated Model Accuracy

The accuracy of the model calibration effort was evaluated by comparison of simulated groundwater elevations and groundwater elevations observed in November 2007.

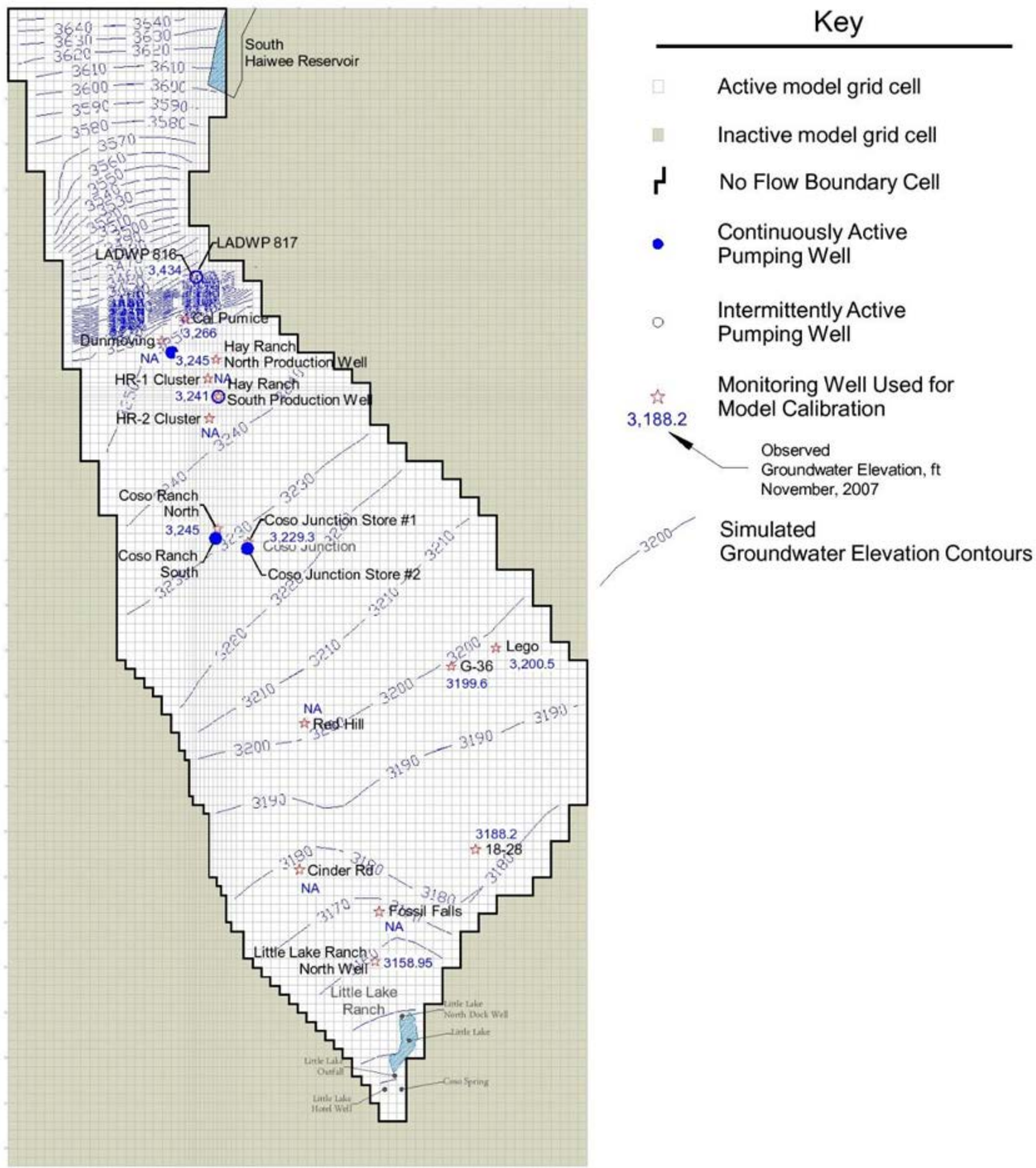
- **Steady-State Model – Figure G-8** presents a plan view map comparing simulated groundwater elevation contours versus groundwater elevations observed in November 2007. **Table G-4** below summarizes simulated versus observed groundwater elevations at 10 selected monitoring well locations for the 2008 and 2010 steady-state model calibrations, respectively.

Table G-4: Steady-State Model Calibration Summary

Well Name	Observed Groundwater Elevation, ft	2008 Model Simulated Groundwater Elevation, ft	2008 Model Calibration Residual Difference	2010 Model Simulated Groundwater Elevation, ft	2010 Model Calibration Residual Difference
LADWP V816	3434	3326.0	108	3431.1	2.9
Cal-Pumice	3266	3247.9	18.1	3253.4	12.6
Hay Ranch North	3245	3243.8	1.2	3244.6	0.4
Hay Ranch South	3241	3242.2	-1.2	3241.2	-0.2
Coso Ranch North	3232.7	3231.0	1.7	3232.1	0.6
Coso Junction #1	3229.3	3227.1	2.2	3228.2	1.8
Navy Lego	3200.5	3203.3	-2.8	3197.3	3.2
Navy G-36	3199.6	3203.3	-3.7	3198.8	0.8
Navy 18-28	3188.2	3182.2	6.0	3182.4	5.6
Little Lake Ranch North	3158.95	3158.1	0.8	3158.7	0.3
Steady-State Calibration Statistics					
Residual Mean			13.0		2.8
Res. Std. Dev.			32.2		3.7
Sum of Squared Residuals			12069		212.3
Abs. Res. Mean			14.6		2.8
Minimum Residual Difference			-3.7		-0.2
Maximum Residual Difference			108		12.6
Range in Target Values			275		275
Std. Dev./Range			0.12		0.013

The calibration residuals for the 2010 model show considerable improvement at the north end of the valley on the LADWP property where the difference between observed and simulated groundwater elevation decreased from 108 ft in the 2008 model to less than 3 ft in the 2010 model. Calibration residuals for the remaining observation wells were generally lower in the 2010 model and except for the Cal-Pumice well, north of the Hay Ranch property, and the Navy 18-28 well in the southeast end of the valley, are less than 4 ft.

Figure G-8: Steady-State Model Calibration Results



- **Transient Model** – Figures G-9-1 through G-9-5 depict simulated versus observed groundwater elevation in fourteen selected monitoring wells in Rose Valley. **Table G-5** summarizes calibration statistics calculated by Groundwater Vistas for the 2010 transient model calibration.

Table G-5: Transient Model Calibration Statistics	
Residual Mean	1.3
Res. Std. Dev.	3.4
Sum of Squared Residuals	18075.7
Abs. Res. Mean	1.7
Minimum Residual Difference	-15.3
Maximum Residual Difference	13.7
Range in Target Values	290.6
Std. Dev./Range	0.012

Figure G-9-1: Transient Calibration Results

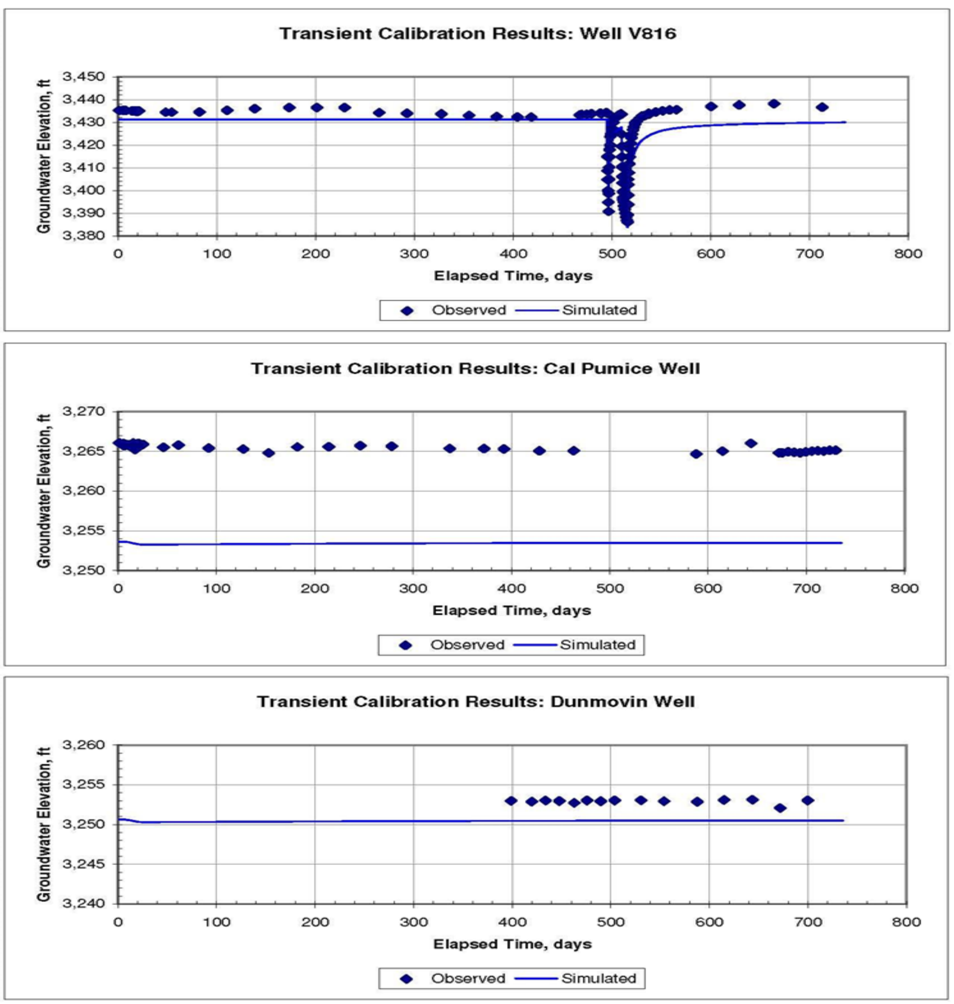
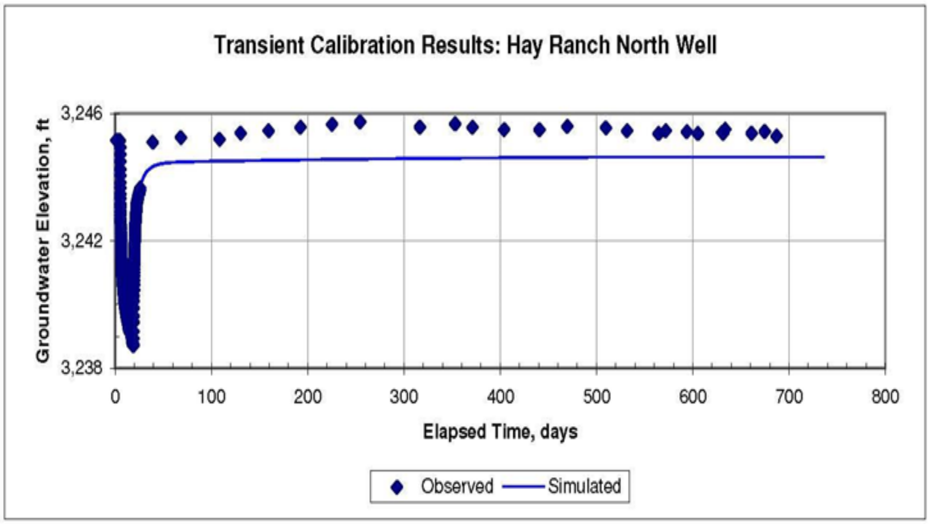
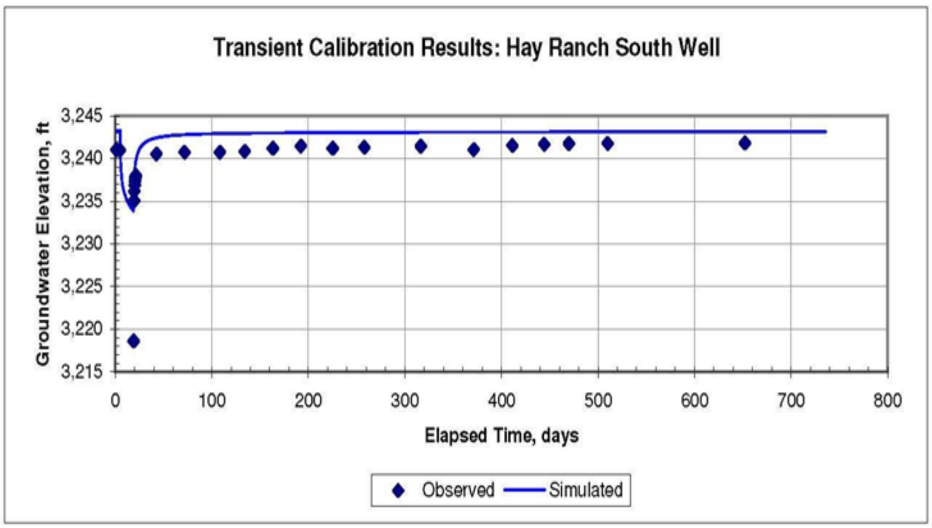


Figure G-9-2: Transient Calibration Results (continued)





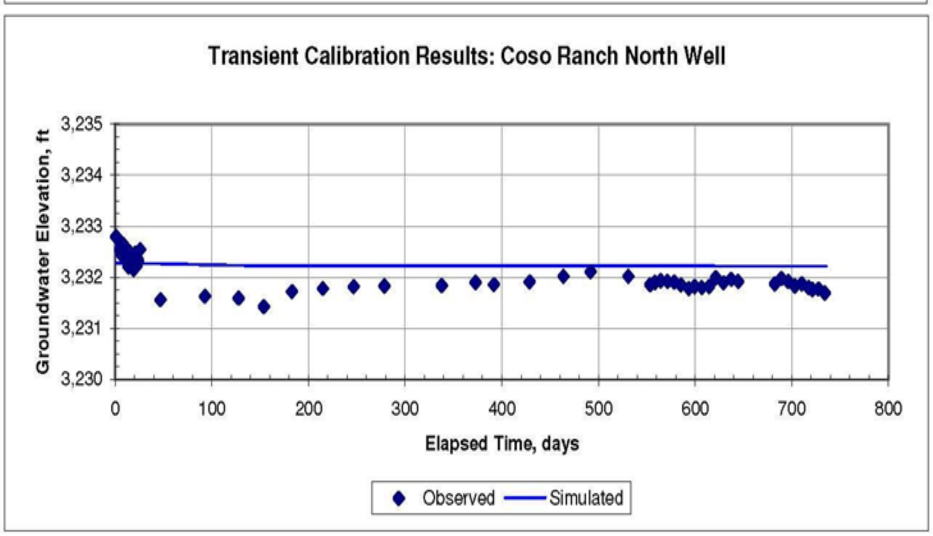
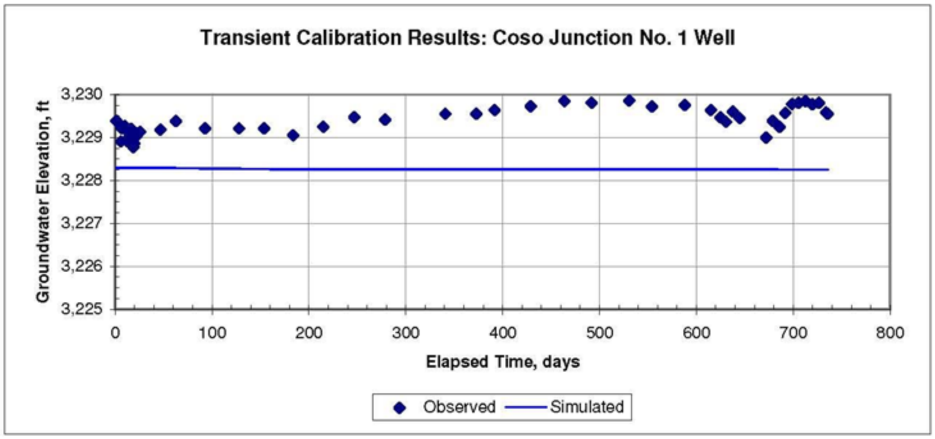
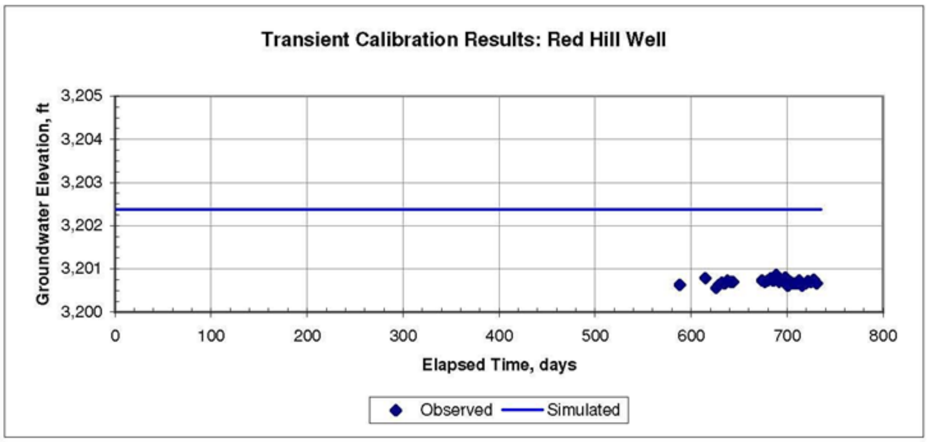


Figure G-9-3: Transient Calibration Results (continued)





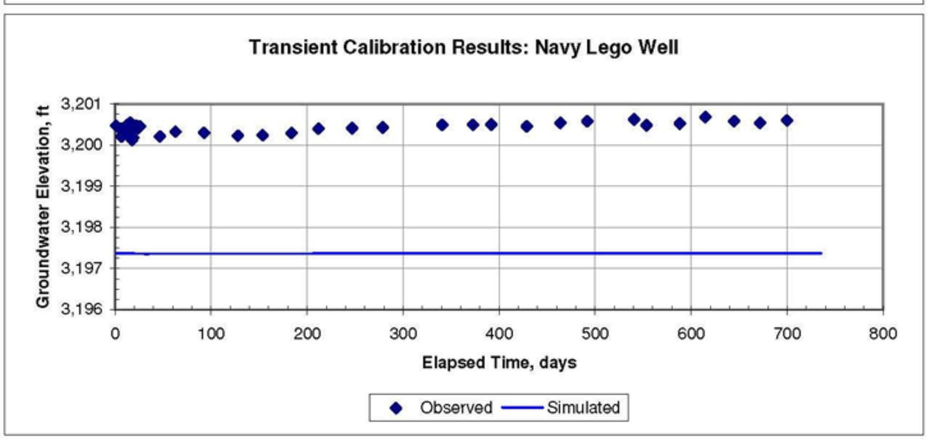
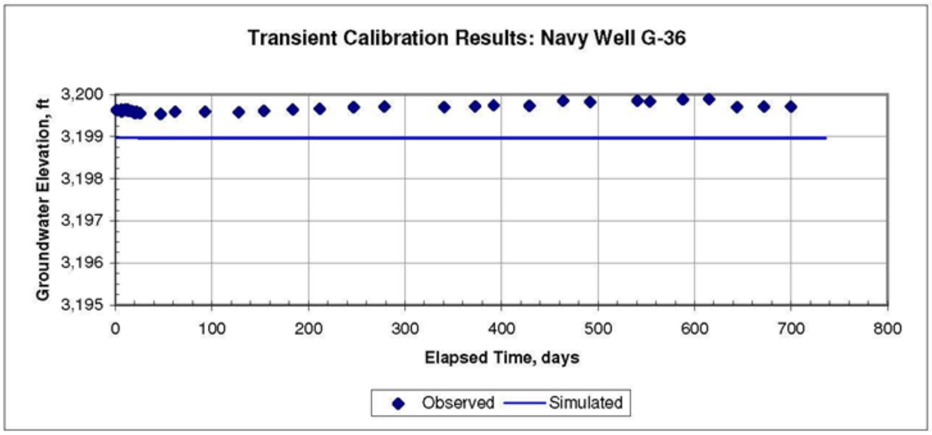
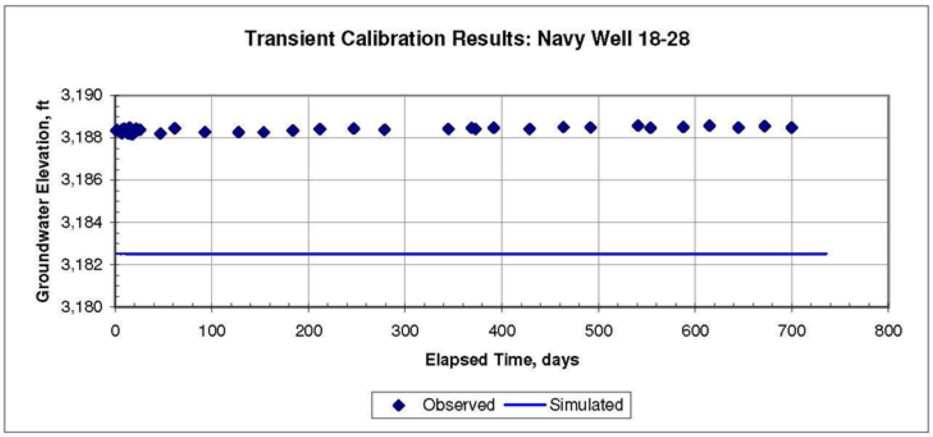


Figure G-9-4: Transient Calibration Results (continued)





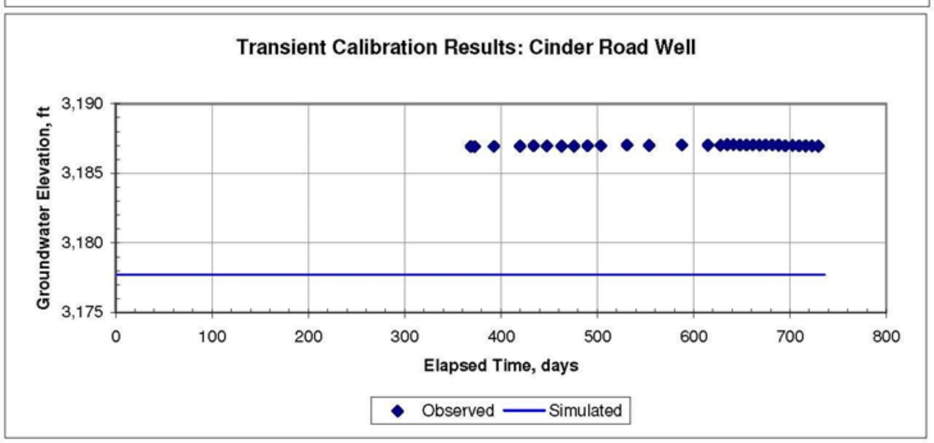
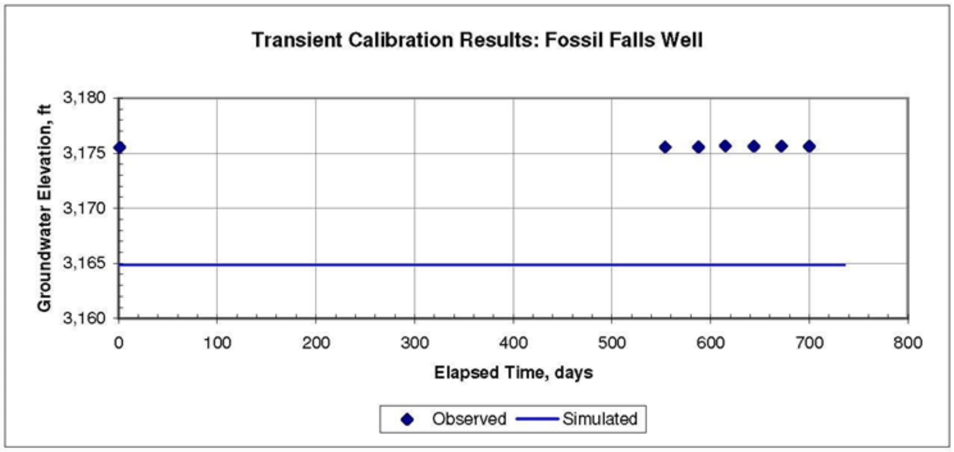
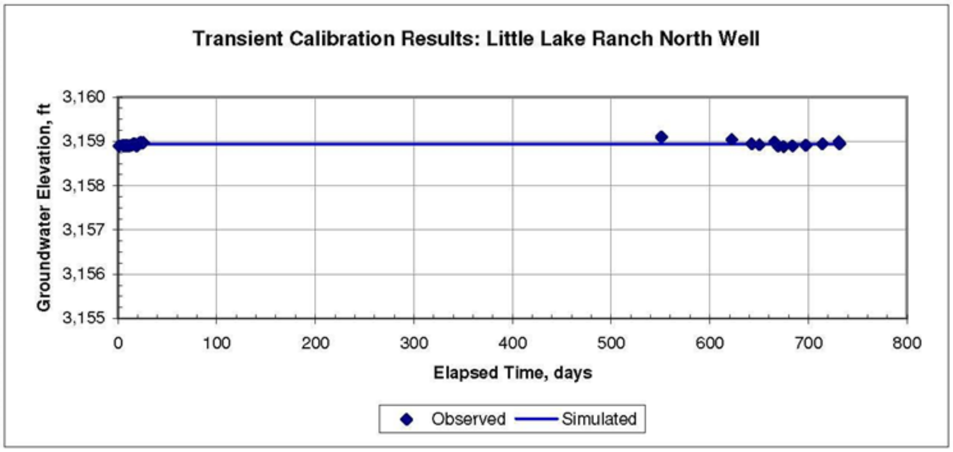


Figure G-9-5: Transient Calibration Results (continued)





As illustrated in **Figure G-9**, the transient model generally provides a good fit between simulated and observed groundwater levels in key areas of the model – the Little Lake Ranch property, the Hay Ranch property, Coso Junction, and the LADWP property. The transient model underestimates groundwater elevation in the southern part of valley, north of the Little Lake Ranch property and south of Coso Junction at the locations of the Cinder Road, Fossil Falls, and Navy 18-28 wells by 6 to 10 ft. This may be an indication of groundwater inflow from outside the valley that is not accounted for in the model.

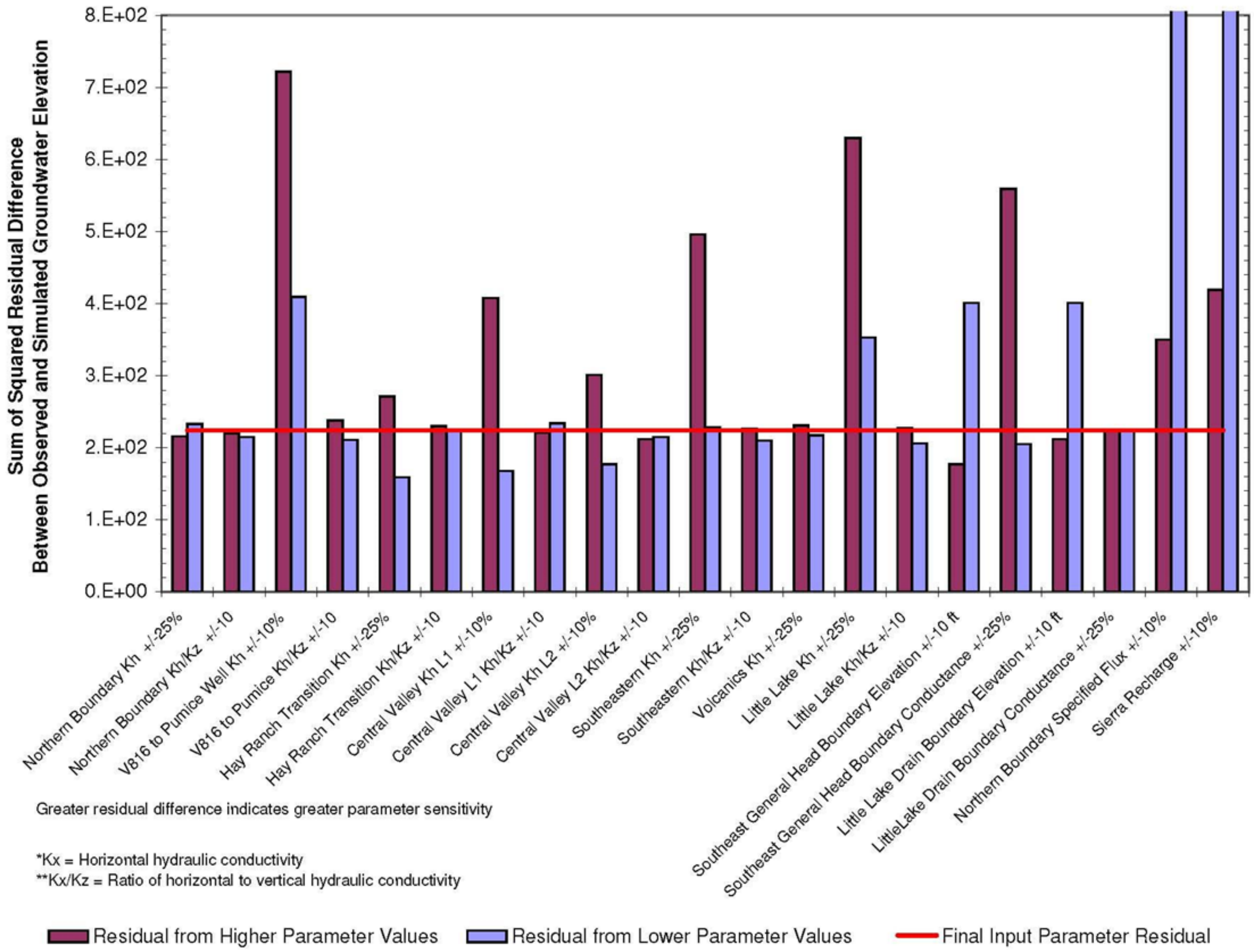
G4.3.3. Parameter Sensitivity Analysis

Input parameter sensitivity analysis was conducted to evaluate the sensitivity of the fit between observed and simulated groundwater elevation values in the steady-state and transient model calibration runs to uncertainty in the model input parameters. Parameters tested, the range of parameter values used for sensitivity analysis, and estimated parameter sensitivity reported as the Sum of Squared Residual Differences between observed and simulated groundwater elevations at selected monitoring wells are summarized in **Table M-6**, and graphically depicted in **Figures G-5** and **G-6** for the steady-state and transient calibration models, respectively.

Table M-6: Summary of Individual Parameter Sensitivity Analysis Results

						Steady-State Model Sensitivity Analysis Results			Transient Model Sensitivity Analysis Results		
		Parameter Values for Sensitivity Analysis				Sum of Residual Squared Differences			Sum of Residual Squared Differences		
Parameter	Final Calibrated Parameter Value	Multiplier	Low Value	High Value	Units	Residual from Lower Parameter Value	Residual from Higher Parameter Value	Residual from Final Parameter Value	Residual from Lower Parameter Value	Residual from Higher Parameter Value	Residual from Final Parameter Value
Northern Boundary Kh	2	+/-25%	1.5	2.5	ft/day	233	216	224	2.34E+04	1.77E+04	1.87E+04
Northern Boundary Kh/Kz	10% (0.02)	+/-10	0.002	0.2	-	215	220	224	1.83E+04	1.79E+04	1.87E+04
V816 to Pumice Well Kh	0.24	+/-10%	0.216	0.26	ft/day	409	722	224	3.76E+04	4.44E+04	1.87E+04
V816 to Pumice Kh/Kz	10% (0.024)	+/-10	0.0024	0.24	-	211	238	224	1.79E+04	1.95E+04	1.87E+04
Hay Ranch Transition Kh	7.5	+/-25%	5.6	9.4	ft/day	159	271	224	1.56E+04	2.11E+04	1.87E+04
Hay Ranch Transition Kh/Kz	10% (0.75)	+/-10	0.075	7.50	-	224	230	224	2.13E+04	1.90E+04	1.87E+04
Central Valley Kh L1	50	+/-10%	45	55.00	ft/day	168	408	224	2.13E+04	3.06E+04	1.87E+04
Central Valley L1 Kh/Kz	0.2% (0.001 ft/day)	+/-10	0.0001	0.010	-	234	221	224	1.98E+04	1.91E+04	1.87E+04
Central Valley Kh L2	12.8	+/-10%	11.52	14.08	ft/day	177	301	224	1.78E+04	2.32E+04	1.87E+04
Central Valley L2 Kh/Kz	0.2% (0.01 ft/day)	+/-10	0.001	0.10	-	215	212	224	1.91E+04	1.87E+04	1.87E+04
Southeastern Kh	100	+/-25%	75.0	125.0	ft/day	228	496	224	3.44E+04	3.70E+04	1.87E+04
Southeastern Kh/Kz	10% (10)	+/-10	1	100.0	-	210	226	224	1.82E+04	1.88E+04	1.87E+04
Volcanics Kh	1	+/-25%	0.75	1.25	ft/day	217	231	224	1.84E+04	1.90E+04	1.87E+04
Little Lake Kh	112.5	+/-25%	84.4	140.6	ft/day	353	630	224	2.81E+04	4.38E+04	1.87E+04
Little Lake Kh/Kz	10% (11.25)	+/-10	1.13	112.5	-	206	227	224	1.75E+04	1.89E+04	1.87E+04
Southeast General Head Boundary Elevation	3,140	+/-10 ft	3,130	3,150	ft	401	177	224	4.74E+04	2.33E+04	1.87E+04
Southeast General Head Boundary Conductance	367	+/-25%	275.3	458.8	ft2/day	205	559	224	2.70E+04	3.95E+04	1.87E+04
Little Lake Drain Boundary Elevation	3,110	+/-10 ft	3,100	3,120	ft	401	212	224	2.92E+04	1.64E+04	1.87E+04
LittleLake Drain Boundary Conductance	6.60E+05	+/-25%	5.0E+05	8.3E+05	ft2/day	223	224	224	1.87E+04	1.87E+04	1.87E+04
Northern Boundary Specified Flux	107,088	+/-10%	96,379	117,797	cfd	890	350	224	5.44E+04	2.53E+04	1.87E+04
Sierra Recharge	500,560	+/-10%	450504	550616	cfd	1320	419	224	9.92E+04	5.25E+04	1.87E+04
Northern Sy	0.035	0.01 - 0.1	0.01	0.1	-	--	--	--	3.05E+04	2.38E+04	1.87E+04
Northern Ss	3.50E-06	+/-10	3.50E-07	3.50E-05	1/ft	--	--	--	1.87E+04	1.87E+04	1.87E+04
Central Sy	0.1	0.01 - 0.2	0.01	0.2	-	--	--	--	1.97E+04	1.87E+04	1.87E+04
Central Ss	1.50E-06	+/-10	1.50E-07	1.50E-05	1/ft	--	--	--	1.96E+04	2.16E+04	1.87E+04
Southern Sy	0.1	0.01 - 0.2	0.01	0.2	-	--	--	--	1.87E+04	1.87E+04	1.87E+04
Southern Ss	3.50E-06	+/-10	3.50E-07	3.50E-05	1/ft	--	--	--	1.87E+04	1.87E+04	1.87E+04

Figure G-10: Summary of Steady-State Model Recalibration Input Parameter Sensitivity Analysis



- **Steady-State Model Sensitivity to Input Parameters** – The steady-state model was found to be most sensitive to specified flux parameters including the flux across the northern boundary of the model (Northern Boundary Specified Flux) and recharge from the Sierra Nevada mountain range (Sierra Recharge on Figure G-10). The steady-state model is relatively highly sensitive to the horizontal hydraulic conductivity (Kh) in the low permeability region between the LADWP property and Pumice Mine well (V816 to Pumice Mine Kh on Figure G-10), central valley horizontal hydraulic conductivity in layer 1, and Little Lake are horizontal hydraulic conductivity, and then the elevations specified for the drain cells and general head boundary cells in the south and southeast portions of the model grid.

- **Transient Model Sensitivity to Input Parameters** – The transient model was also found to be most sensitive to specified flux parameters including the flux across the northern boundary of the model (Northern Boundary Specified Flux) and recharge from the Sierra Nevada mountain range (Sierra Recharge on Figure G-11). The transient model was similarly sensitive to horizontal hydraulic conductivity in generally the same regions as the steady-state model. Neither model was very sensitive to vertical hydraulic conductivity, however, most of the monitoring well data is from wells screened near the water table, or wells that essentially fully penetrate the aquifer, so there is insufficient monitoring data to fully assess this parameter. Likewise, the transient model is relatively insensitive to aquifer storage properties. This is also mostly an artifact of the data available to calibrate the model which consists of three short pumping periods in the LADWP and Hay Ranch wells, with relatively steady water levels in the rest of Rose Valley the remainder of the calibration period (November 2007 to November 2009).

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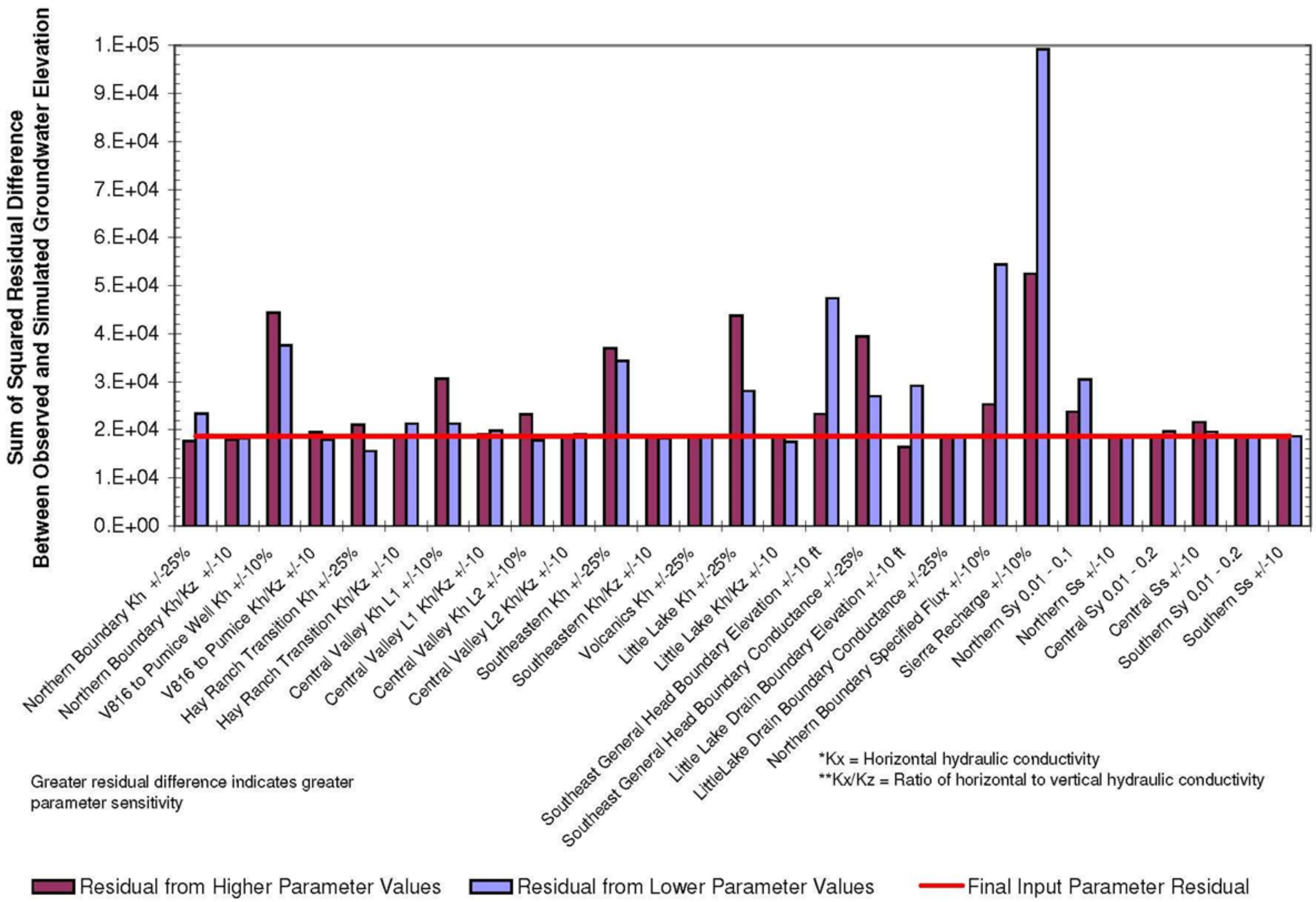
Figure G-11: Summary of Transient Model Recalibration Input Parameter Sensitivity Analysis



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G5. GROUNDWATER DEVELOPMENT IMPACT EVALUATION

This section describes procedures used to evaluate potential impacts of groundwater development associated with development of geothermal resources within the Haiwee Geothermal Leasing Area. Groundwater impacts associated with short-term groundwater extraction for well drilling, dust control, and minor operations and maintenance are unlikely to persist, or extend more than a short distance from wells used to supply these purposes. However, based on the analysis presented in the Hay Ranch Groundwater Extraction Project EIS (RMT, 2008), long-term groundwater extraction to support geothermal reservoir development has significant potential for impacting groundwater resources in Rose Valley. In the course of operation of a typical geothermal flash power plant, high temperature fluids are extracted from the geothermal reservoir, piped through a generator set to generate electricity, and then cooled and condensed for reinjection into the reservoir. During the cooling cycle of a flash steam power plant, a portion of the extracted fluid is lost by evaporation, consequently, more fluid is extracted from the geothermal reservoir on an annual basis than is available to re-inject, leading to a gradual decline in reservoir pressures, and a concomitant loss in electrical generating capacity.

Haizlip (2010) estimated that the water required to provide 100% injection of produced geothermal fluids (aka zero net withdrawal by mass from the reservoir) is equivalent to the fluid lost during power generation under the proposed development scenarios and is approximately 1,450 gallons per minute (gpm), or as much as 2,340 acre-ft per year (ac-ft/yr) for a typical 30 MWe dual flash geothermal power plant[1]. This estimate assumes that 100% of the fluid lost during evaporative cooling would be made-up and reinjected along with the condensate and waste brine by the addition of locally produced. Reinjection of less water than is produced from the geothermal reservoir may result in a gradual reduction in reservoir pressures and/or geothermal fluid yield, and as a consequence result in a gradual reduction in the quantity of steam available to generate power from the initial wells. However, most geothermal reservoirs have experienced pressure decline, most geothermal reservoir pressure decline is managed by a combination of injection and make-up drilling. With new wells and injection management, many geothermal reservoirs have produced for decades without 100% injection.

The rate of pressure decline would presumably be reduced with greater rates of injection. The rate of reduction in geothermal fluid availability with declining reservoir pressure is dependent on reservoir properties, the degree of development relative to the size and sustainable yield of the geothermal reservoir, and the rate of natural recharge of the geothermal reservoir. As these characteristics have not been determined for the Rose Valley geothermal lease area, the water needed to mitigate reservoir decline was estimated to provide zero net withdrawal from the reservoir.

For the Haiwee Geothermal Leasing Area EIS, the assumption was made that up to two 30 MWe dual flash geothermal power plants would be constructed within the Haiwee Action Area. As no specific development plans have been identified as yet, the main purpose of the analysis described below was to assess whether or not groundwater extraction to augment geothermal fluid injection, and thus bolster geothermal reservoir pressures, could be conducted at any location(s) within the Haiwee Action Area. Based on the unique hydrogeologic setting of Rose Valley, and existing groundwater uses, potential impacts from long-term groundwater extraction can be broadly classified into two categories: impacts to existing water supply wells related to possible increased depth to groundwater or reduced well yield; and, impacts to the sensitive surface water features at the Little Lake Ranch property at the south end of the valley.

G5.1. Evaluation Procedures

Transient groundwater flow simulations were conducted to evaluate the impacts of potential long-term groundwater extraction to augment geothermal fluids. Input parameters from the recalibrated transient numerical model of Rose Valley described in Section G3 were used to run a series of simulation scenarios to forecast potential impacts on groundwater elevation and groundwater quantity. Starting groundwater elevations and boundary conditions were set equal to the final values from the transient calibration model representing

[1] Also see Appendix J for annual water consumption of the RFD and other technologies.

groundwater elevations in Rose Valley in November 2009. Pumping from existing domestic, commercial and light industrial supply wells was specified as described for the transient calibration model. Pumping on the LADWP and Hay Ranch properties was not simulated in these analyses. A timeline for the LADWP groundwater development project to capture seepage from the South Haiwee Reservoir has not been established. Pumping for the Hay Ranch Groundwater Extraction Project began in December 2009 (Harrington, 2010) at an initial rate of approximately 700 gpm (1,130 acre-ft/yr); however, a schedule for implementation of the planned operation at 1,859 gpm (3,000 acre-ft/yr) allowed by the Conditional Use Permit for the project has not been established. Consequently, the following discussion pertains to groundwater extraction for the geothermal development project, only.

The cumulative impact of multiple groundwater development projects is more or less additive, that is, if one extraction well causes ten feet of drawdown at a particular location, two wells will likely produce double that amount of drawdown. The timing of cumulative impacts will of course be dependent on the pumping schedule for individual projects, the location of the individual extraction wells relative to sensitive receptors, and the extraction rate of each extraction well. The cumulative impact resulting from augmenting geothermal reservoir pressures, and conducting either or both the LADWP's proposed seepage capture project and the Hay Ranch Groundwater Extraction Project are not evaluated here, but can reasonably be assumed to be greater than the impacts of any individual project.

Because of the unique hydrogeologic conditions that exist in Rose Valley, previous studies (RMT, 2008) found that some amount of groundwater table drawdown resulting from long-term groundwater extraction may persist for a period after pumping is stopped, and, that for locations more distant from the extraction well, the time of maximum drawdown effects may occur after the active pumping period for a project ends. Therefore, drawdown impact forecasts were conducted with varying numbers of extraction wells (one or two) and several different locations (north or south in the Haiwee Action Area) to assess potential impacts of different potential development scenarios. In addition, 200 year long numerical simulations were conducted to assess the magnitude of maximum impacts and their timing relative to the active extraction period.

Two groundwater development scenarios associated with geothermal development were considered:

G1.1.1. Scenario 1 – Extraction to Replace 100% of Lost Fluid

For this scenario, numerical groundwater flow model simulations were conducted to evaluate the potential groundwater resource impacts that might develop in the event that groundwater was extracted to provide water to support injection at rates comparable to 100% of the average annual geothermal fluid loss rate. Extraction was assumed to occur continuously for the 30 year geothermal project lifespan. Several sub-scenarios were evaluated including:

- Extraction from one well at a rate of 2,340 acre-ft/yr to support one 30 MWe dual flash geothermal power plant at the north end of the proposed BLM geothermal lease area, approximately 3 miles from north of Coso Junction (1 plant north);
- As above, but from an extraction well at the south end of the proposed BLM geothermal lease area, approximately 1-1/4 miles south of Coso Junction (1 plant south);
- Extraction from two wells at a total rate of 4,680 acre-ft/yr to support two 30 MWe dual flash geothermal power plants at the north end of the proposed BLM geothermal lease area, approximately 3 miles north of Coso Junction (2 plants north);
- As above, but from two extraction wells located at the south end of the proposed Haiwee Action Area, approximately 1-1/4 miles south of Coso Junction (2 plants south).

G2.1.1. Scenario 2 – Sustainable Extraction at Rate Unlikely to Impact Little Lake

For this scenario, numerical groundwater flow model simulations were conducted to evaluate the groundwater extraction rate that could be sustained for a geothermal project lifespan without causing excessive drawdown or capturing groundwater needed to support surface water features and riparian habitat at the south end of Rose Valley on the Little Lake Ranch property. This criterion was adapted from the Hay Ranch Groundwater Extraction Project Hydrologic Monitoring and Mitigation Plan (HMMP), RMT (2008) which determined that drawdown from groundwater extraction in Rose Valley could not be allowed to cause a greater than 10% reduction in groundwater flow towards the Little Lake Ranch property to avoid causing significant and potentially irreversible impacts to surface water features on the property. For this evaluation, numerical simulations were conducted in iterative fashion to evaluate the maximum groundwater extraction rate that could be sustained for a 30 year project life, without causing a greater than 10% reduction in groundwater flow towards the Little Lake Ranch property. Two sub-scenarios were evaluated including:

- Groundwater extraction at the north end of the Haiwee Action Area, approximately 3 miles north of Coso Junction; and,
- Groundwater extraction at the south end of the Haiwee Action Area, approximately 1-1/4 miles south of Coso Junction.

G5.2. Potential Drawdown Impacts

G5.2.1 Predicted Impacts from Pumping at Full Augmentation Rate

The predicted drawdown impacts of pumping at the full rate needed to augment a geothermal reservoir due to operation of one (1) or two (2) 30 MWe power plants are illustrated in **Figures G-12** and **G-13**, respectively. **Figure G-14** illustrates potential impacts of groundwater development to augment the geothermal reservoir on groundwater flow available to the surface water features at the Little Lake Ranch property at the south end of the valley.

In the north and central parts of Rose Valley, the primary impact to existing or proposed water wells is the reduction in water levels (drawdown) resulting from extraction for geothermal reservoir augmentation. The magnitude of potential impacts depends on the amount of extraction and the location of extraction relative to the property of interest. The drawdown induced by wells operated to support geothermal reservoir augmentation could make some wells unusable without deepening and increase well lift, and thereby increase energy costs for pumping, or reduce well yields. Predicted drawdown near the LADWP property at the north end of the valley may be as little as 10 ft for a single geothermal augmentation well situated at the south end of the Haiwee Action Area, which is predicted to increase to as much as 40 ft if two geothermal augmentation wells were situated at the north end of the Haiwee Action Area.

Predicted drawdown near the Dunmovin community, which has a number of private domestic supply wells, was similarly predicted to range from over 10 ft for a single geothermal augmentation well situated at the south end of the Haiwee Action Area, to greater than 70 ft if two geothermal augmentation wells were situated at the north end of the Haiwee Action Area. Well construction details for wells in the Dunmovin area are not available, but the latter impact scenario would likely impact a number of wells in that area.

Predicted drawdown near Coso Junction, which has several currently active water supply wells, was predicted to range from approximately 20 ft for a single geothermal augmentation well situated at the south end of the Haiwee Action Area, to greater than 50 ft if two geothermal augmentation wells were situated at the south end of the Haiwee Action Area (map not shown). Wells serving the Coso Junction Store (Coso Junction #2) and the Coso Ranch (Coso Ranch South) might not need to be deepened as a result of these impacts, but would likely experience greater pumping costs due to increased lift requirements, and possibly reduced yield.

The effects of simultaneous groundwater extraction on the Hay Ranch property for the Hay Ranch Extraction and Delivery System project to augment geothermal reservoir recovery at the Coso Geothermal Field are not considered in this forecast; however, pumping effects would be additive, consequently greater impacts would occur if both projects extracted groundwater in Rose Valley.

Groundwater extraction to support geothermal reservoir augmentation could also reduce the amount of groundwater available to sustain surface water features on the Little Lake Ranch property. As shown on Figure G-14, all of the scenarios evaluated in which continuous pumping at rates of 1,450 gpm or 2,340 acre-ft/yr from each well for 30 years, result in a reduction in groundwater flow towards Little Lake. The reduction in groundwater flow is greater for two wells (supporting two geothermal power plants) and greater for extraction wells located closer to Little Lake. However, in all cases, the predicted reduction in groundwater flow exceeds the threshold of 10 percent identified as protective of Little Lake surface water features in the Hay Ranch Groundwater Extraction Project Hydrologic Monitoring and Mitigation Plan (HMMP) prepared by MHA (2008). That is, supplying groundwater for 100% injection (zero net withdrawal) requiring operation of one geothermal reservoir augmentation well for the 30 year project life would likely reduce groundwater flow to Little Lake by greater than 10 percent potentially causing adverse impacts to surface water features on the property.

Figure G-12: Potential Drawdown from Pumping One Well for Geothermal Augmentation at 2,340 acre-ft/yr

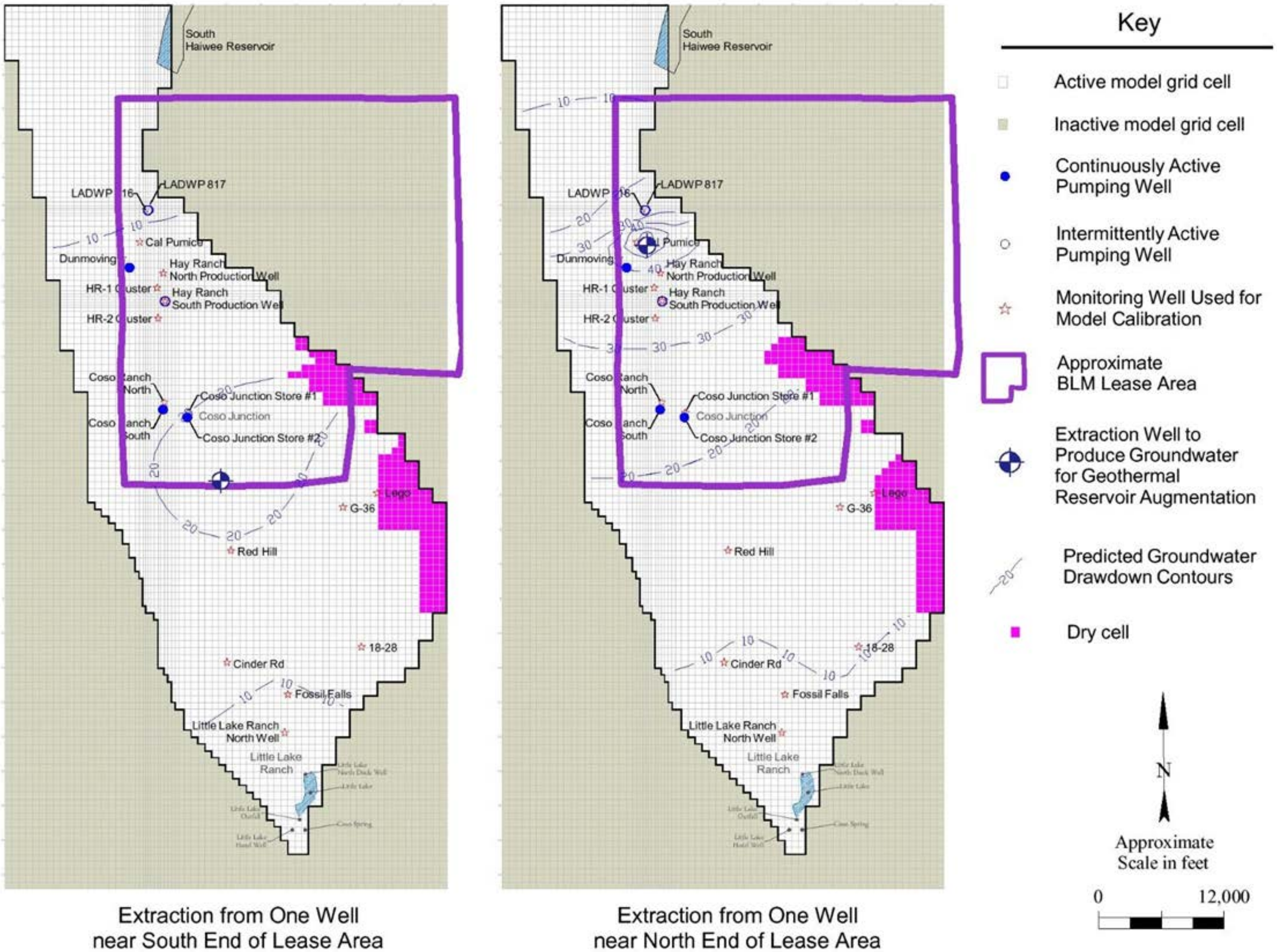
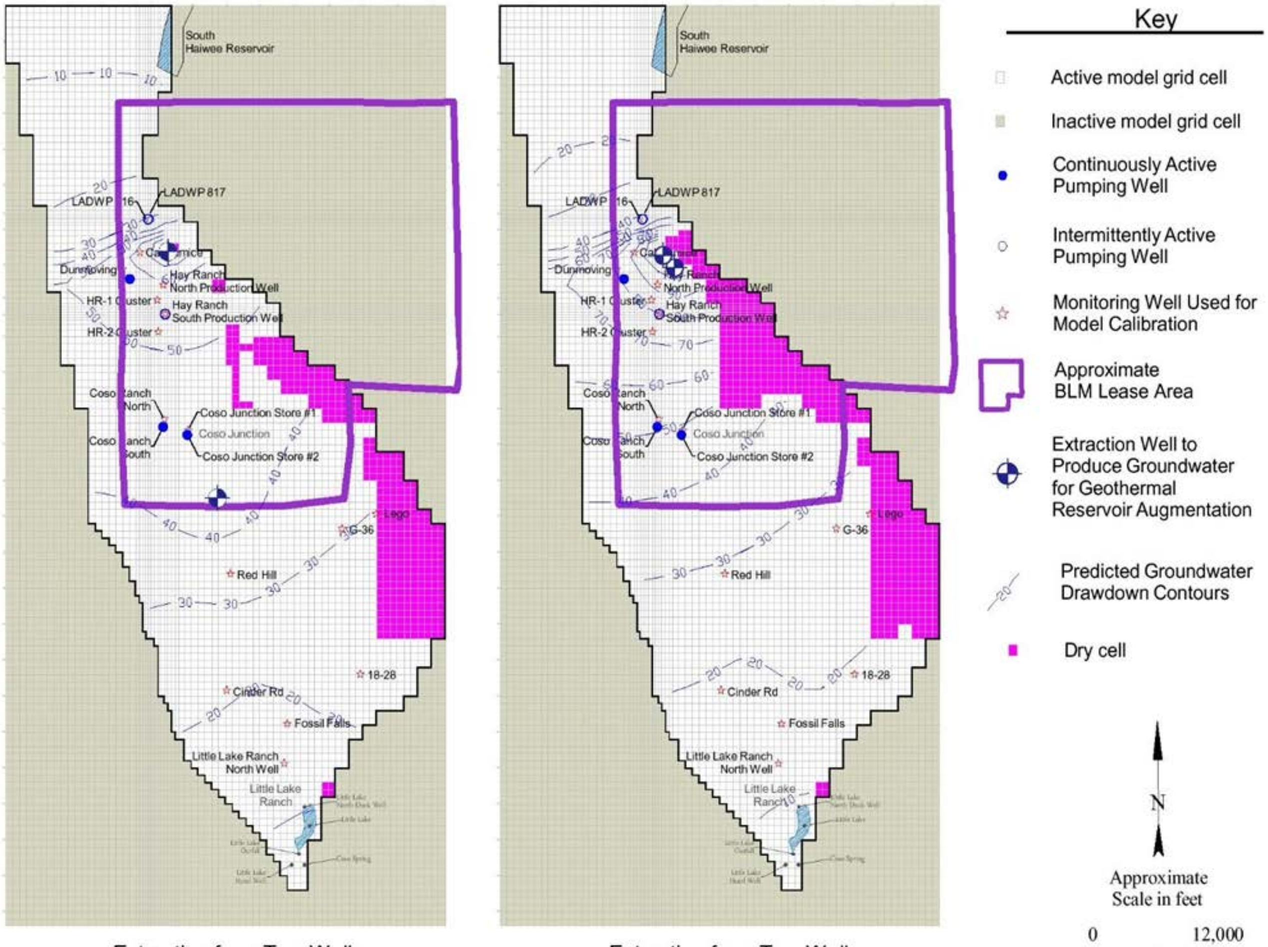


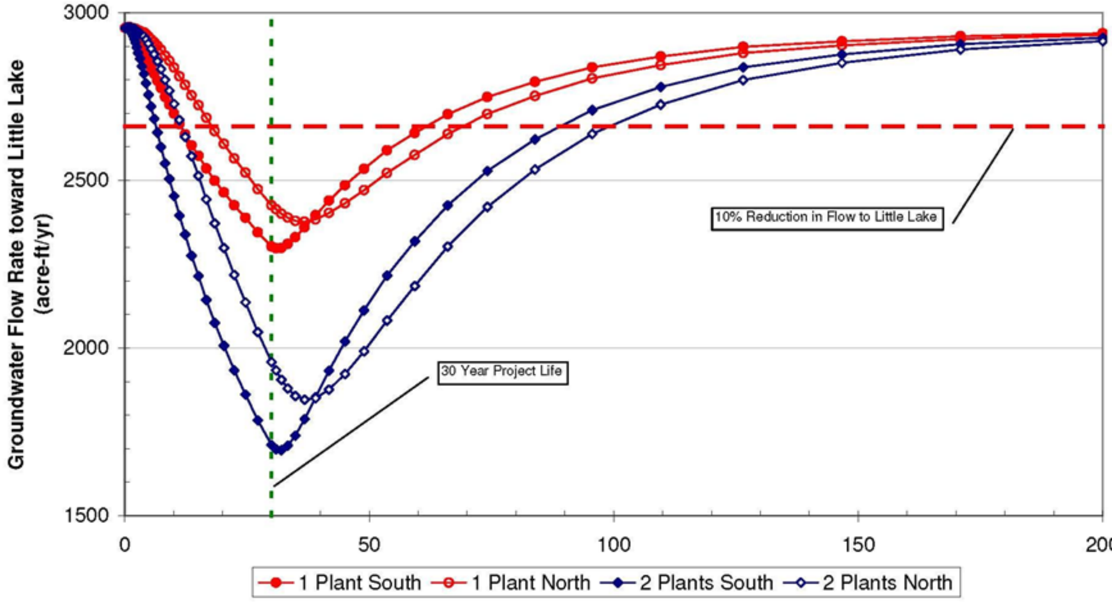
Figure G-13: Potential Drawdown from Pumping Two Wells for Geothermal Augmentation at 4,680 acre-ft/yr



Extraction from Two Wells
North and South Ends of Lease Area

Extraction from Two Wells
near North End of Lease Area

Figure G-14: Potential Reduction in Groundwater Flow to Little Lake from Pumping for 100% Geothermal Augmentation



G5.2.2. Predicted Impacts from Pumping at Reduced Augmentation Rate

For Scenario 2, simulation runs were conducted to forecast the potential impacts of pumping at reduced rates designed to provide some water for geothermal reservoir augmentation but specifically intended to reduce the risk of adverse impacts to surface water features at Little Lake. As discussed in Section G4.1.2, several simulation scenarios were conducted to forecast potential impacts. These evaluations indicated that pumping from a single extraction well located at the northern end of the Haiwee Action Area would have the least potential for impacting Little Lake, while pumping from an extraction well located at the southern end of the Haiwee Action Area would likely have greater impact. The model simulations indicated that pumping at a rate of 625 gpm or 1,000 acre-ft/yr from a well located near the southern end of the Haiwee Action Area could be sustained for 30 years without reducing groundwater flow towards Little Lake by more than 10 percent. However, the same simulation indicated that the maximum predicted drawdown at the Little Lake Ranch North well, located near the north end of the Little Lake Ranch property could exceed 3.5 ft approximately 30 years after the start of pumping at that rate, which exceeds the Maximum Acceptable Drawdown threshold of 0.4 feet established for this well in the Hay Ranch HMMP. A simulation scenario with a single groundwater extraction well located at the northern end of the Haiwee Action Area indicated that a pumping rate of approximately 715 gpm or 1,150 acre-ft/yr could be sustained for 30 years without reducing groundwater flow towards Little Lake by more than 10 percent. However, the same simulation indicated that the maximum predicted drawdown at the Little Lake Ranch North well, located near the north end of the Little Lake Ranch property could exceed 3.5 ft approximately 30 years after the start of pumping at that rate, which also exceeds the Maximum Acceptable Drawdown threshold of 0.4 feet established for this well in the Hay Ranch HMMP. Consequently, lower pumping rates may be required to meet both the groundwater flow and drawdown thresholds established in the Hay Ranch HMMP for protection of surface water features at Little Lake. As was noted in the previous section, the effects of other major groundwater development projects in Rose Valley, including the Hay Ranch Groundwater Extraction and Transfer project and the LADWP's proposed Haiwee Reservoir seepage capture project are not included in this analysis; however, the effects of additional pumping are expected to be additive, with greater impact resulting from higher combined pumping rates or pumping durations.

G6. REFERENCES CITED

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APPENDIX I

LAND UNDER BUREAU OF LAND MANAGEMENT STEWARDSHIP

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APPENDIX I

LANDS UNDER BUREAU OF LAND MANAGEMENT STEWARDSHIP

Fee Ownership

Mount Diablo Meridian,
T. 21 S., R. 37 E.,
sec. 11, lot 1, 2, 9 to 11, inclusive, 14, NW1/4SW1/4NW1/4NE1/4, E1/2NW1/4NW1/4NE1/4, NE1/4NW1/4, SE1/4SW1/4;
sec. 12;
sec. 13;
sec. 14, lots 1 to 3, inclusive, 5 to 10, inclusive, W1/2NE1/4NW1/4, NW1/4SW1/4, S1/2SW1/4, SE1/4SE1/4.
sec. 23, N1/2S1/2, N1/2S1/2S1/2, S1/2SE1/4SE1/4;
sec. 25;
sec. 26, E1/2E1/2;
sec. 35,
sec. 36.

Mount Diablo Meridian,
T. 22 S., R. 37 E.,
sec. 1;
sec. 2, lots 1 and 2 in the NE1/4, lots 1 and 2 in the NW1/4, SW1/4, excluding patent 1084708;
sec. 11;
sec. 12.

Mount Diablo Meridian,
T. 21 S., R. 38 E.,
sec. 7;
sec. 8;
sec. 9;
sec. 10;
sec. 15;
sec. 17;
sec. 18;
sec. 19;
sec. 20;
sec. 21;
sec. 22;
sec. 27;
sec. 28;
sec. 29;
sec. 30;
sec. 31;
sec. 32;
sec. 33;
sec. 34.

HGLA Lands Under BLM Stewardship (cont'd):

Mount Diablo Meridian,
T. 22 S., R. 38 E.,
sec. 5;
sec. 6, lots 3 to 14, inclusive;
sec. 7;
sec. 8.
Containing 22,548 acres more or less.

Mineral Only

Mount Diablo Meridian,
T. 21 S., R. 37 E.,
sec. 11, lots 4 to 7, inclusive, 12, 13, NE1/4NE1/4, E1/2NW1/4NE1/4, E1/2W1/2NW1/4NE1/4, SW1/4SW1/4NW1/4NE1/4, E1/2SE1/4SW1/4, S1/2SE1/4;
sec. 14, lot 11, E1/2NE1/4NW1/4;
sec. 23, S1/2S1/2SW1/4, S1/2SW1/4SE1/4
sec. 26, SW1/4, W1/2E1/2.
Containing 2,288 acres more or less.

Private Lands within HGLA

Township, Range, Section	Inyo County Plan Land Use Designation
T21S R37E Sec 23 N ½	NR-Natural Resources
T21S R37E Sec 23 S ½ of S ½ of SW ¼, S ½ of SW ¼ of SE ¼	RC-Retail Commercial NR-Natural Resources
T21S R37E Sec 26 W ½ of E ½, W ½	NR-Natural Resources
T22S R37E Sec 2 SW ¼	A-Agriculture RC-Retail Commercial RRH-Residential Rural High Density
T22S R38E Sec 6 W ½ of W ½	NR-Natural Resources

Source: Inyo County Plan Land Use and Conservation/Open Space Elements Maps, Diagrams 1 & 22

APPENDIX K

LEASE STIPULATIONS AND PROGRAMMATIC BMPS

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APPENDIX K

STANDARD LEASE STIPULATIONS AND GEOTHERMAL PROGRAMMATIC BEST MANAGEMENT PRACTICES

K.1.0 INTRODUCTION

To ensure leasing decisions remain appropriate in light of continually changing circumstances and new information, the BLM develops and applies criteria for lease stipulations exceptions, waivers, and modifications. An exception, waiver, or modification may not be approved unless, 1) the Authorized Officer determines that the factors leading to inclusion of the stipulation in the lease have changed sufficiently to make the protection provided by the stipulation no longer justified; or 2) the proposed operations would not cause unacceptable impacts. (43 CFR 3101.1-4)

- An **exception** is a one-time exemption for a particular site within the leasehold; exceptions are determined on a case-by-case basis; the stipulation continues to apply to all other sites within the leasehold. An exception is a limited type of waiver.

- A **waiver** is a permanent exemption from a lease stipulation. The stipulation no longer applies anywhere within the leasehold.

- A **modification** is a change to the provisions of a lease stipulation, either temporarily or for the term of the lease. Depending on the specific modification, the stipulation may or may not apply to all sites within the leasehold to which the restrictive criteria are applied.

An exception, waiver, or modification may be approved if the record shows that circumstances or relative resource values have changed or that the lessee can demonstrate that operations can be conducted without causing unacceptable impacts and that less restrictive requirements would meet resource management objectives. This process is more fully explained in the Final Programmatic Environmental Impact Statement for Geothermal Leasing in the Western United States Programmatic Environmental Impact Statement (BLM 2008a), Chapter 2 and is incorporated into this document by reference.

K.2.0 STANDARD STIPULATIONS

In direct response to public comment, consultation, and staff recommendation, the following standard lease stipulations were developed for the HGLA. These stipulations will be required and applied to each of the action alternatives that authorize geothermal leasing (Alternatives A, B, and C) with the two following exceptions: NSO-HGLA-1 shall only apply to Alternatives B and C.

K.2.1 No Surface Occupancy (NSO) Stipulations

NSO-HGLA-1: No surface occupancy or use is allowed on the lands within the identified sensitive resources area within the HGLA.

This stipulation has been removed from the Special Administration Stipulations being considered for HGLA in this FSEIS. Refer to NSO-HGLA-2 below.

<u>NSO-HGLA-2</u>: No surface occupancy or surface use is allowed within any ACEC within the HGLA.

The locations of the ACECs are detailed in the DRECP LUPA (BLM 2015).

<u>Purpose</u>: This stipulation is for the protection of cultural and historical resources found within the Rose Springs ACEC.

<u>Exception</u>: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

<u>Modification</u>: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

<u>Waiver</u>: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

K.2.2 CONTROLLED SURFACE USE (CSU) STIPULATIONS

<u>CSU-HGLA-1</u>: The use of all lands within the HGLA shall be controlled with regard to the following set of stipulations. The HGLA is within the Mount Diablo Meridian and is generally defined as lands within the following sections:

Township 21 South, Range 37 East, Sections 11-14, 23-26, 35-36
Township 21 South, Range 38 East, Sections 7-10, 15, 17-22, 27-34
Township 22 South, Range 37 East, Sections 1-2, 11-12
Township 22 South, Range 38 East, Sections 5-8

<u>Purpose</u>: To conserve the Mojave ground squirrel (*Xerospermophilus mojavensis*) (MGS) and its habitat. Potential MGS habitat is defined as any area where MGS is likely to occur based on compatible vegetation, soil, elevation, climate, and region. Known MGS habitat is defined as those areas where MGS have been observed. The HGLA site contains potential and known habitat for the MGS. This habitat is identified by creosote bush scrub with a diverse mix of sub-shrubs and herbaceous plants, with shrubs in the Chenopodiaceae (Goosefoot Family) such as spiny hopsage (*Grayia spinosa*), winterfat (*Krascheninnikovia lanata*), and saltbush (*Atriplex* species) being favored.

1) In areas where potential habitat for the MGS exists, presence shall be assumed and spring trapping surveys are to be conducted prior to any ground disturbing activity on undisturbed ground. Such surveys shall be conducted according to the California Department of Fish and Wildlife (CDFW) protocol i.e. the trapping methodologies outlined in the *California Department of Fish and Game Mojave Ground Squirrel Survey Guidelines* (2010).

2) If MGS are detected using trapping surveys, the proponent must obtain a 2081 Incidental Take Permit from CDFW prior to proceeding with any ground disturbing activity.

3) If trapping that follows CDFW protocol does not detect MGS, or if identified MGS habitat does not exist within the area of proposed disturbance, mitigation and a permit are not necessary for the year in which the ground-disturbing activity will occur.

4) If ground-disturbing activities do not begin within the year that trapping was conducted, presence of the species shall be assumed, and the procedure identified in a) above shall be followed.

Exception: An exception to this stipulation may be granted by the Authorized Officer after coordination with CDFW if the operator submits a plan that demonstrates that impacts from the proposed action can be fully mitigated.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

CSU-HGLA-2: The use of all lands within the HGLA shall be controlled with regard to the following set of stipulations. The HGLA is within the Mount Diablo Meridian and is defined as lands within the following sections:

Township 21 South, Range 37 East, Sections 11-14, 23-26, 35-36
Township 21 South, Range 38 East, Sections 7-10, 15, 17-22, 27-34
Township 22 South, Range 37 East, Sections 1-2, 11-12
Township 22 South, Range 38 East, Sections 5-8

Purpose: to protect federally listed threatened and endangered species, or other special status and state listed species, because the lease area may contain plants or animals determined to be threatened or endangered, or other special status species and their habitats

a) BLM may require modifications to exploration and development proposals to further its conservation and management objective to avoid activities that will contribute to a need to list such species or their habitat.

b) BLM will disapprove or require modifications to a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of designated or proposed critical habitat.

c) BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its statutory obligations under the Endangered Species Act as amended, 16 USC 1531 et seq., including completion of any required procedure for conference or consultation.

d) The holder shall comply with the Biological Opinion for listed species and Conference Opinion for proposed species associated with this project issued by the US Fish and Wildlife Service (USFWS). Failure to comply with the requirements of the Biological Opinion or Conference Opinion shall be cause for lease suspension or termination as provided in 43 CFR 3213.17 and 43 CFR 3200.4.

e) Unless otherwise agreed to in writing by the Authorized Officer, power lines shall be constructed in accordance with standards outlined in *Suggested Practices for Avian Protection on Power Lines: State of the Art in 2006* (APLIC 2006). The holder shall assume the burden and expense of proving that pole designs not shown in the above publication are "eagle safe." Such proof shall be provided by a raptor expert approved by the Authorized Officer. The BLM reserves the right to require modifications or additions to all power line structures placed on the right-of-way, should they be necessary, to ensure the safety of large perching birds. Such modifications and/or additions shall be made by the holder without liability or expense to the United States Government.

f) Bald and/or golden eagles may be found to use the project area. The BLM will 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 under applicable requirements of the Bald and Golden Eagle Protection Act (BGEPA), including completion of any required coordination with the USFWS. The BLM hereby notifies the applicant that compliance with the BGEPA is a dynamic and adaptable process which 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 BGEPA will be developed with the USFWS and coordinated with the BLM. The BLM will require the applicant to prepare a Bird and Bat Conservation Strategy (BBCS) that defines mitigation and conservation measures relative to avian and bat species in the area.

Exception: An exception to this stipulation may be granted by the Authorized Officer in coordination with the USFWS if the operator submits a plan that demonstrates that impacts from the proposed action are discountable or can be fully mitigated.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

CSU-HGLA-3: The use of all lands within the HGLA shall be controlled with regard to the following set of stipulations. The HGLA is within the Mount Diablo Meridian and is defined as lands within the following sections:

Township 21 South, Range 37 East, Sections 11-14, 23-26, 35-36
Township 21 South, Range 38 East, Sections 7-10, 15, 17-22, 27-34
Township 22 South, Range 37 East, Sections 1-2, 11-12
Township 22 South, Range 38 East, Sections 5-8

Purpose: to consider effects to historic properties and cultural resources consistent with the National Historic Preservation Act (NHPA), Archaeological Resources Protection Act (ARPA), National Environmental Policy Act (NEPA), Federal Land Policy and Management Act (FLPMA), American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, E.O. 13007, and other statutes, regulations, and policies.

a) All fieldwork required after a proposed leasing development has been submitted to the BLM will be performed under the terms of a CRUP and FA issued by the BLM.
b) A Class I records search and literature review must be undertaken prior to submission of a FA permit request to BLM. The Class I shall be utilized to develop a research design and work plan for all cultural resource studies in the project development area including those portions of the development that extend outside the area to be leased.
c) A new Class III inventory, subject to conditions and the establishment of a proposed Area of Potential Effects, must be prepared after an authorization to proceed by BLM has been granted.
d) BLM will require the development of a geo-archaeological study of the entire direct effects APE and may require the development of a separate historic-built environment study.
e) Any technical reports generated for the project will require a BLM-mandated peer review. Encountered resources may have to undergo field testing to determine if the find is a historic property or not.
f) Before, during or after the fieldwork is taking place, BLM will consult with tribal stakeholders to identify any resources in the project area that have cultural or religious significance to the Tribes or Tribal Organizations. The BLM may require the development of an ethnographic assessment for the project if the Tribes or Tribal Organizations indicate that they have additional information that should be considered in the Section 106 review process.
g) Historic properties encountered during the Class III or the ethnographic assessments of the project will be avoided, where possible, during construction, operations, and decommissioning. If technical research suggests a resource is not a historic property, BLM may decide at its discretion that the resource must be nonetheless avoided.
h) Avoidance of impacts through project design will be given priority over other treatments associated with potential adverse effects. Avoidance measures include moving project elements away from site locations or into areas bearing previous development impacts or restricting travel to existing roads.
i) When adverse effects to historic properties from any proposed renewable energy project application within the developmental area are identified, the BLM will execute a project-specific MOA pursuant to 36 C.F.R. § 800.6 to fulfill the intent of the DRECP PA. Historic properties will be treated and managed in accordance with process defined under the MOA. Any data recovery as treatment of adverse effects will be preceded by approval of a detailed research design.
j) The BLM will identify all mitigation measures for historic properties that will be adversely affected by a specific project in an Historic Properties Treatment Plan (HPTP) that will be included as an appendix to the MOA. The Applicant is responsible for implementing all of the terms of the MOA, with BLM oversight.
k) The BLM, in consultation with the SHPO, the ACHP (if participating), and project-specific consulting parties, will develop a comprehensive plan to manage post-review discoveries and unanticipated effects during project construction. The plan will be attached to any project-specific MOA or PA as an appendix, and implemented by the Applicant, with BLM oversight.
l) If an area exhibits a high potential for containing subsurface cultural resources, but no resources were observed during a Class III inventory, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area.
m) If long-term management of historic properties is required, BLM shall ensure that a Historic Properties Management Plan (HPMP) will be developed for all projects where historic properties

require long term management. The HPMP will be developed in consultation with the SHPO, the ACHP (if participating), and project-specific consulting parties. The HPMP will identify how historic properties will be managed through project Operations and Maintenance, and Decommissioning. The Applicant is responsible for implementing the terms of the HPMP, with BLM oversight.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action or elements of the proposed action is unlikely to impact a historic property.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

K.2.3 TIMING LIMITATION (TL) STIPULATIONS

TL-HGLA-1: The use of all lands within the HGLA shall be controlled with regard to the following set of stipulations. The HGLA is within the Mount Diablo Meridian and is defined as lands within the following sections:

Township 21 South, Range 37 East, Sections 11-14, 23-26, 35-36
Township 21 South, Range 38 East, Sections 7-10, 15, 17-22, 27-34
Township 22 South, Range 37 East, Sections 1-2, 11-12
Township 22 South, Range 38 East, Sections 5-8

Purpose: To conserve the desert tortoise (*Gopherus agassizii*) and its habitat, the following stipulations apply:

a) The HGLA is situated in the northern extent of the desert tortoise's range. Prior to ground disturbance, desert tortoise protocol surveys shall be conducted according to guidelines set forth by the U.S. Fish and Wildlife Service.

b) The lease holder shall retain a desert tortoise Authorized Biologist approved by USFWS who would be responsible for ensuring compliance with desert tortoise stipulations prior to the initiation of and during ground-disturbing activities, including installation of desert tortoise exclusion fencing. The Authorized Biologist shall conduct clearance surveys within the desert tortoise exclusion fence, and other duties such as tortoise handling, artificial burrow construction, egg handling and other procedures as necessary in accordance with the *Guidelines for Handling Desert Tortoise during Construction Projects* (Desert Tortoise Council 1994) or the most current guidance provided by USFWS.

c) The Authorized Biologist shall be present on the project site from March 15 through October 31 (active season) during ground-disturbing activities in areas that have not been enclosed with tortoise exclusion fencing. The Authorized Biologist will be on-call from November 1 to March 14 (inactive season) and shall check construction areas that have not been enclosed with tortoise exclusion fencing immediately before construction activities begin at all times.

d) The lease holder shall incorporate desert tortoise exclusion fencing, approved by USFWS, into any permanent fencing surrounding the proposed facility prior to the initiation of ground disturbing activities to avoid potential harm to desert tortoise in the project area. Tortoise exclusion fencing should be constructed in accordance with the *Desert Tortoise Exclusion Fence Specifications* (USFWS 2005) or the most current guidance provided by USFWS and CDFW.

e) The lease holder shall install desert tortoise exclusion fencing around temporary project disturbance areas such as staging areas, storage yards, excavations, and linear facilities during construction. Construct fences in late winter or early spring to minimize impacts to tortoises and accommodate subsequent tortoise surveys.

f) Within 24 hours prior to the initiation of construction of tortoise exclusion fence, the Authorized Biologist shall survey the fence alignment to ensure it is cleared of desert tortoises. Following construction of the tortoise-exclusion fence, the Authorized Biologist shall conduct clearance surveys within the fenced area to ensure as many desert tortoises as possible have been removed from the site following the guidance in the approved desert tortoise translocation plan.

g) The lease holder shall install and regularly maintain exclusion fencing to prevent desert tortoise passage into the project area.

h) Heavy equipment shall only be allowed to enter the project site following the completion of desert tortoise clearance surveys of the project area by the Authorized Biologist. The Authorized Biologist shall monitor initial clearing and grading activities to ensure any tortoises missed during the initial clearance survey are moved from harm's way following the guidance in the approved desert tortoise translocation plan.

i) Following installation, the permanent fencing should be inspected quarterly and after major rainfall events to ensure fences are intact and there is no ground clearance under the fence that would allow tortoises to pass. The lease holder shall ensure that any damage to the permanent or temporary fencing is immediately blocked to prevent tortoise access and permanently repaired within 72 hours between March 15 and October 31, and within 7 days between November 1 and March 14.

j) The Authorized Biologist shall inspect any construction pipe, culvert, or similar structure with a diameter greater than 3 inches, stored less than 8 inches above ground and within desert tortoise habitat (i.e., outside the permanently fenced area) for one or more nights, before the material is moved, buried or capped. As an alternative, all such structures may be capped before being stored outside the fenced area or placed on pipe racks. These materials would not need to be inspected or capped if they are stored within the permanently fenced area after desert tortoise clearance surveys have been completed.

k) The lease holder shall ensure vehicular traffic does not exceed 25 miles per hour within the delineated project areas or on access roads in desert tortoise habitat. On unpaved roads the speed limit should be 10 miles per hour to suppress dust and protect air quality.

l) Any time a vehicle or construction equipment is parked in desert tortoise habitat outside the permanently fenced area, the Authorized Biologist or drivers of the vehicle shall inspect the ground under the vehicle for the presence of desert tortoise before it is moved. If a desert tortoise is observed, it should be left to move on its own. If it does not move within 15 minutes, the Authorized Biologist may remove and relocate the animal to a safe location.

m) The lease holder shall design culverts to allow safe passage of tortoises.

n) If desert tortoise relocation is determined to be an appropriate conservation measure, the lease holder shall develop and implement a Desert Tortoise Translocation Plan for approval by CDFW, USFWS and BLM. The Plan shall designate a relocation site as close as possible to the disturbance site that provides suitable conditions for long term survival of the relocated desert tortoise and outline a method for monitoring the relocated tortoise.

o) If desert tortoises are observed within the HGLA, consult with USFWS and CDFW to determine the need for and/or feasibility of conducting relocation or translocation as minimization or mitigation for project impacts. Development and implementation of a translocation plan may require, but not be limited to, additional surveys of potential recipient sites; disease testing and health assessments of translocated and resident tortoises; and consideration of climatic conditions at the time of translocation. Because of the potential magnitude of the impacts to desert tortoise from proposed renewable energy projects, USFWS and CDFW must evaluate translocation efforts on a project by project basis in the context of cumulative effects.

p) If the desert tortoise protocol surveys indicate that there are no desert tortoises, and/or desert tortoise habitat, within the project area, the lease holder may apply for a waiver to one or more of the above stipulations.

<u>Exception</u>: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

<u>Modification</u>: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

<u>Waiver</u>: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

K.2.4 SPECIAL ADMINISTRATION (SA) STIPULATIONS

<u>SA-HGLA-1</u>: The BLM Authorized Officer for the administration of this lease is the Field Manager, Ridgecrest Field Office, Ridgecrest, CA; Phone 760-384-5400.

Exception: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

SA-HGLA-2: Unitization Stipulation: This has been removed from the Special Administration Stipulations being considered for HGLA in this DSEIS.

SA-HGLA-3: The lease holder shall construct, operate, and maintain the facilities, improvements, and structures within this geothermal lease area in strict conformity with the approved Plan of Development (POD), as amended or supplemented by approval of the Authorized Officer. All exploration, development, construction, and reclamation activities shall conform as closely as possible to the latest edition of the BLM/U.S. Forest Service publication: The Gold Book – *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (Available Online at https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/operations-and-production/the-gold-book)*. Any surface disturbing activity, additional construction, or use that is not in accord with the approved Plan of Development shall not be initiated without the prior written approval of the Authorized Officer. A copy of the lease, including all stipulations and approved Plan of Development, shall be available at all times onsite during construction, operation, and decommissioning. Noncompliance with the above will be grounds for immediate temporary suspension of activities if it constitutes a threat to public health or safety or the environment.
Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.
Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

SA-HGLA-4: Actions and activities of the lease holder within the HGLA will be governed by all mitigation measures and best management practices (BMPs) detailed in the *Best Management Practices and Guidance Manual: Desert Renewable Energy Projects*, September 2010, as directed by the Authorized Officer, as well as applicable Conservation Management Actions (CMA) and BMPs listed in the DRECP.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

Modification: A modification to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

SA-HGLA-5: Actions and activities of the lease holder within the HGLA will be governed by all mitigation measures and best management practices as detailed in the *Geothermal Resources Leasing Programmatic EIS*, October 2008, as directed by the Authorized Officer.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

Modification: A modification to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.
Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

SA-HGLA-6: The leaseholder will be liable for all fire suppression costs resulting from fires caused during construction, operations, or decommissioning. The lease holder shall comply with all guidelines and restrictions imposed by agency fire control officials.

Exception: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

SA-HGLA-7: The three noncompetitive lease applications (CACA 043998, CACA 044082, CACA 043993) within the HGLA were pending on August 8, 2005. Therefore, all geothermal leases will be issued subject to the revised regulations at *43 CFR 3200.8 (b)(1)* and *(b)(3)*. The lease applicant must make its election and provide written notice to the BLM of their preference for payment of royalties on production before the lease may be issued.

Exception: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

<u>SA-HGLA-8</u>: Potential geothermal lessees should be aware of the revised due diligence requirements contained in the federal regulations at *43 CFR § 3207*. Leases are typically issued for an initial term of 10 years and may be extended if diligent work requirements have been satisfied and the BLM believes that the lessee has made satisfactory progress in complying with the lease terms and stipulations.

<u>Exception</u>: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

<u>Modification</u>: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

<u>Waiver</u>: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

<u>SA-HGLA-9</u>: The BLM may, after giving 30 days written notice, terminate a lease if it has been determined that there has been a violation of any of the requirements of *43 CFR § 3200.4*, including but not limited to compliance with the terms and conditions of the lease, including any and all lease stipulations, and the nonpayment of required annual rentals or royalties and fees (*43 CFR § 3213.17*.)

<u>Exception</u>: This stipulation will only be granted an exception by the Authorized Officer under extraordinary circumstances.

<u>Modification</u>: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

<u>Waiver</u>: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

<u>SA-HGLA-10</u>: The consumptive use of water within the HGLA shall be controlled in accordance with applicable Inyo County, State of California Regulations, and with regard to the following set of stipulations. The HGLA is within the Mount Diablo Meridian and is defined as lands within the following sections:

Township 21 South, Range 37 East, Sections 11-14, 23-26, 35-36
Township 21 South, Range 38 East, Sections 7-10, 15, 17-22, 27-34
Township 22 South, Range 37 East, Sections 1-2, 11-12
Township 22 South, Range 38 East, Sections 5-8

<u>Purpose</u>: to protect and conserve the water resources that may be present within the HGLA and the Rose Valley Basin. The following stipulations are the governing rules for groundwater use.

d) Groundwater extraction for consumptive use during geothermal exploration, development, and project operations activities may be allowed, with the expressed approval of the Authorized Officer, for some leases to the extent that groundwater extraction and water loss to the Rose Valley Aquifer, in combination with all other authorized groundwater uses, does not exceed the safe yield, as defined in item g) below, in the Rose Valley Aquifer, and does not cause a decline of 10 percent or more to the average annual flow of water flowing into the surface features at Little Lake, when combined with all other approved uses.

e) Water produced or used for the construction, operation, maintenance, or remediation of the project shall be solely for the beneficial use of the renewable energy project or its associated mitigation and remediation measures, as specified in approved plans and permits.

f) The siting, construction, operation, maintenance, and remediation of all wells shall conform to specifications contained in the California Department of Water Resources Bulletins #74-81 and #74-90.

g) A water supply assessment shall be prepared and must be approved by the Authorized Officer prior to the development or use of any water resources. This assessment shall identify the groundwater basin(s) and the surface water basin(s) related to water delivery and supply, as well as the aquifer(s) contained within them. An assessment of the geothermal reservoir is expressly required. A water budget for each aquifer identified shall be established based on the best available data and practices for the identified basin(s). This water budget shall classify and describe all water inflow and outflow to the identified basin(s) or system using the following basic hydrologic formula or a derivation: $P - R - E - T - G = \Delta S$, where P is precipitation and groundwater inflow, R is surface runoff or outflow, E is evaporation, T is transpiration, G is groundwater outflow, and ΔS is the change in storage. The volumes involved in this calculation shall be in units of acre-feet per year. Safe Yield is defined as that amount, such that $P - R - E - T - G$ is greater than or equal to zero.

h) A Water Monitoring, Management, and Mitigation Plan shall be prepared and must be approved by the Authorizing Officer prior to the development or use of any water resources. The quality and quantity of all surface water and groundwater used for the project shall be monitored using this plan. The plan shall detail the management and use of all project-related water resources. The plan shall also detail any mitigation measures that may be required as a result of the project.

i) Any wastewater generated in association with temporary, portable sanitary facilities shall be periodically removed by a licensed hauler and disposed into an existing municipal sewage treatment facility.

j) Temporary, portable sanitary facilities provided for construction crews should be adequate to support expected onsite personnel and should be removed at completion of construction activities.

k) Lessee shall comply with local requirements for permanent, domestic water use and wastewater treatment.

l) Lessee shall identify the source(s) of project water, and provide analysis proving that adequate quantity and quality of water are available from identified source(s) for the life of the geothermal project.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan that demonstrates that impacts from the proposed action are minimal or can be adequately mitigated.

Modification: This stipulation will only be granted a modification by the Authorized Officer under extraordinary circumstances.

Waiver: This stipulation will only be granted a waiver by the Authorized Officer under extraordinary circumstances.

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APPENDIX L

CONTEXTUAL MAPPING

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APPENDIX L

CONTEXTUAL MAPPING

This appendix provides supplemental figures discussed in Chapter 1 and Chapter 2 of this DSEIS. Figure L-4 has been revised to reflect the land allocations identified in the DRECP LUPA (BLM 2016). All others are identical to those contained in Chapter 2 and Chapter 3 of the DEIS (BLM 2012), and are provided for reference.

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FIGURE L-1 Regional Setting with Vicinity Projects

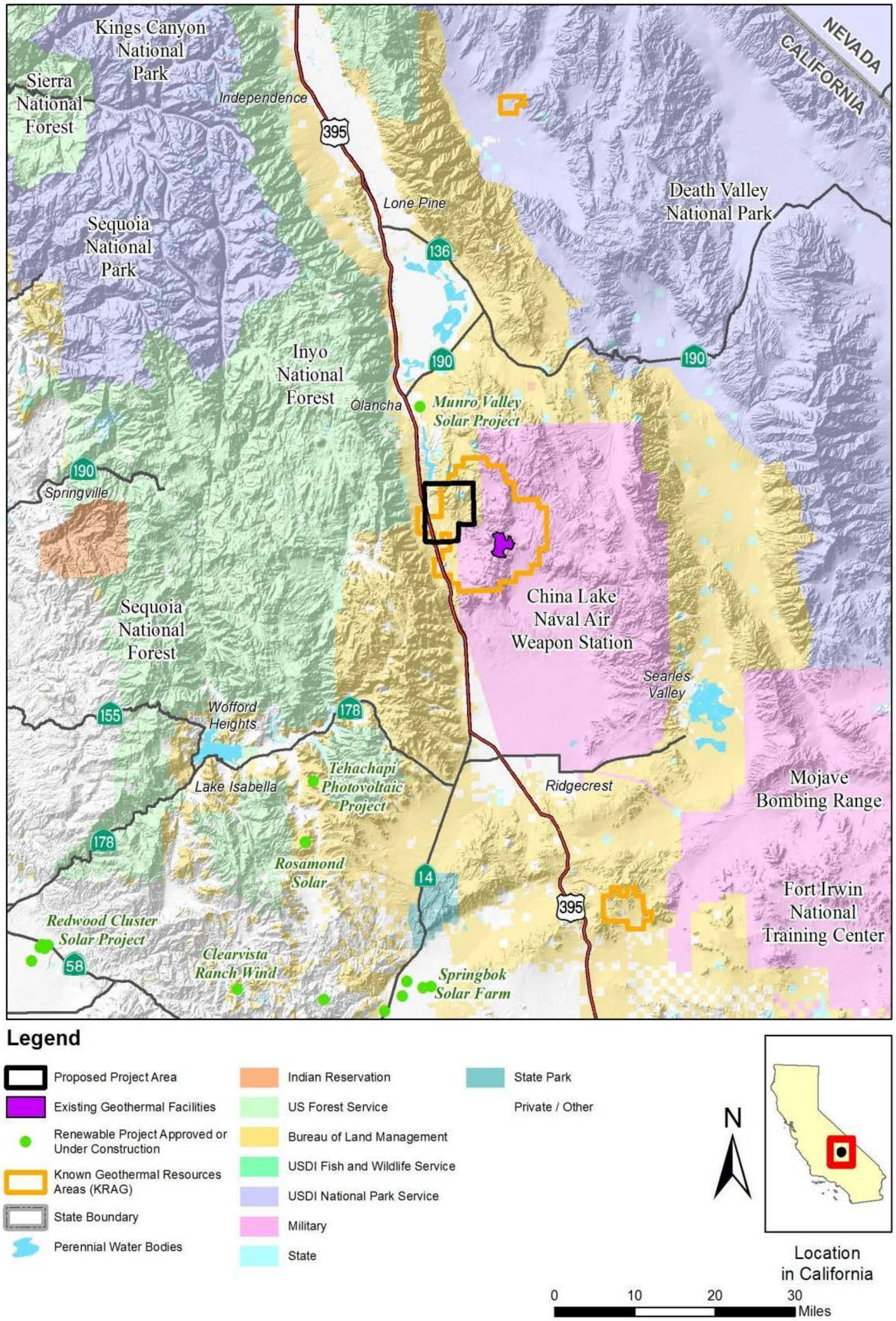


Figure L-2 Aerial View

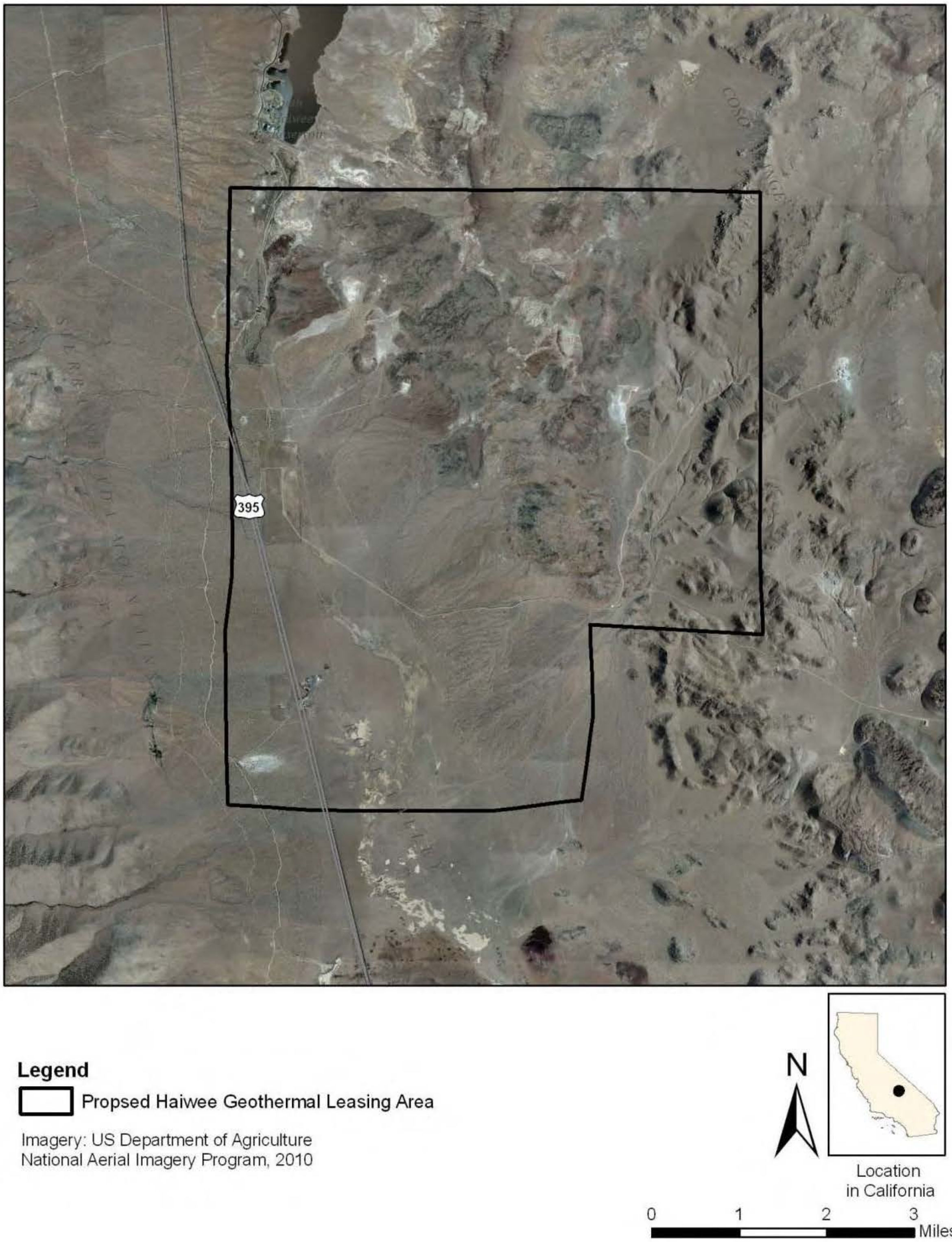


FIGURE L-3 Designated Routes and Pending Geothermal Lease Applications

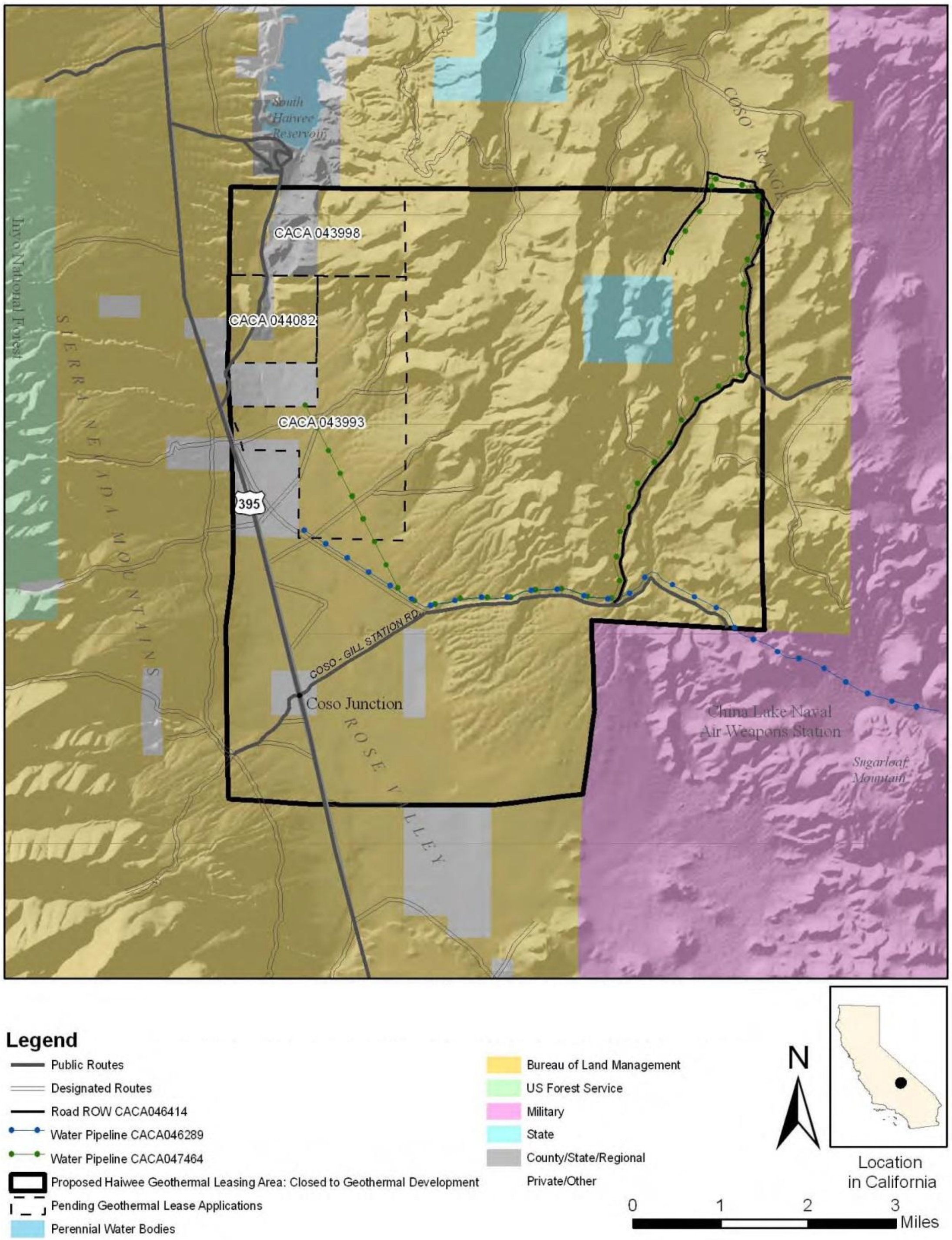


Figure L-4 Land Status

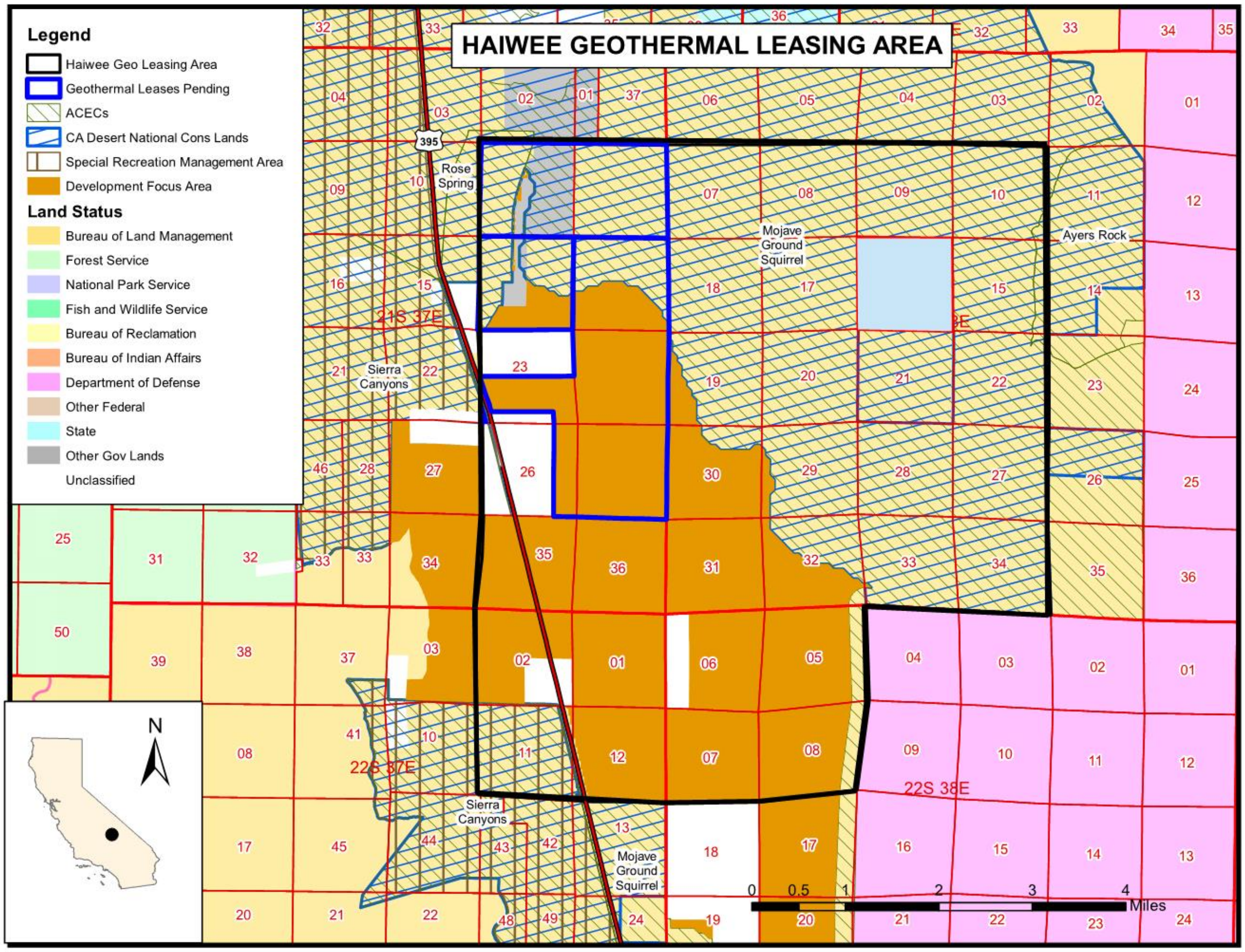
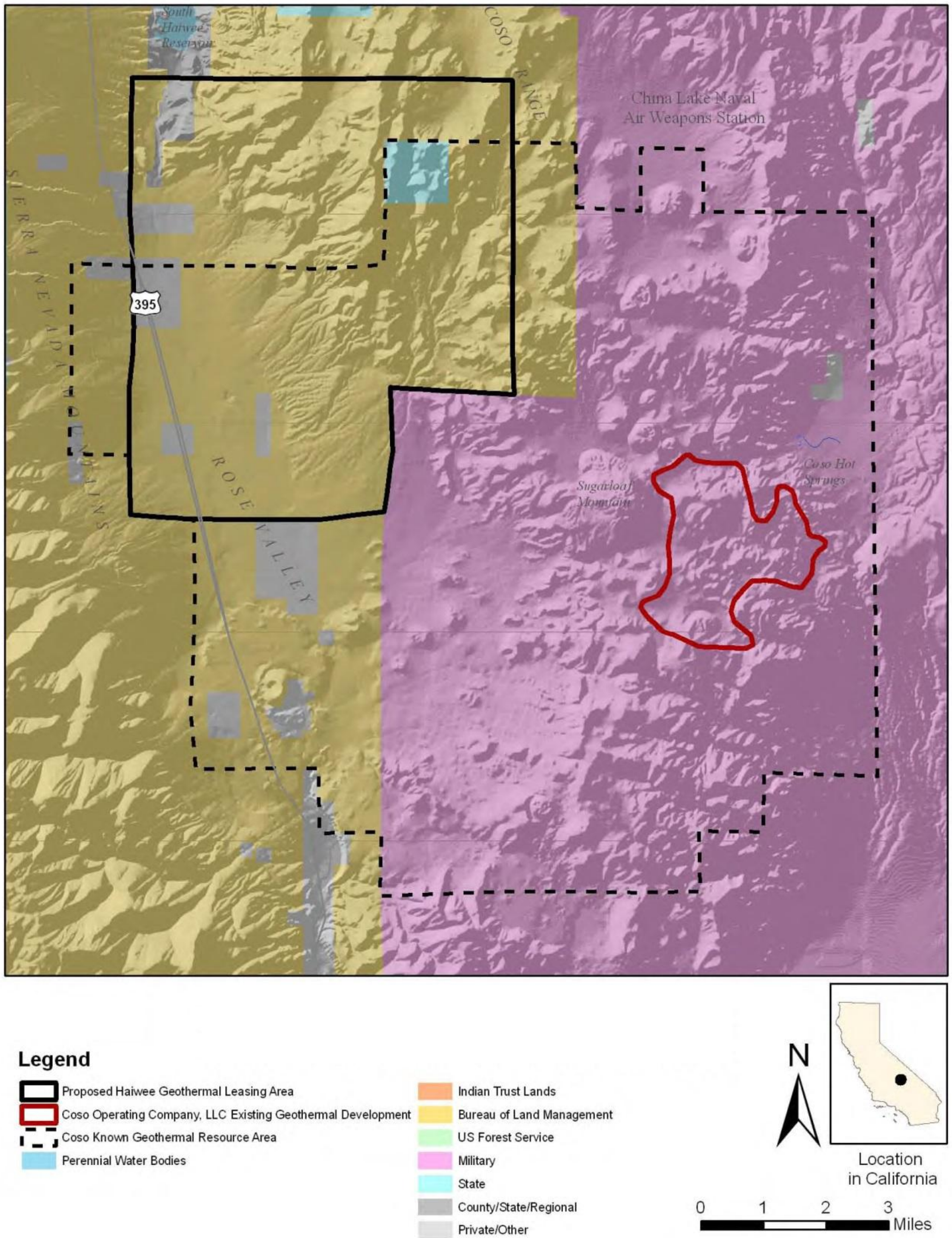


Figure L-5 The Haiwee Geothermal Leasing Area (HGLA) and the Coso Known Geothermal Resources Area (KGRA)



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APPENDIX M

ALTERNATIVES MAPPING

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APPENDIX M

ALTERNATIVES MAPPING

This appendix provides supplemental figures discussed in Chapter 2 of this FSEIS and throughout the document. These figures show the alternatives analyzed in detail in Chapters 3 and 4 and have been revised from the DEIS (BLM 2012) to reflect the land allocations identified in the DRECP LUPA (BLM 2016).

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FIGURE M-1 Alternative A (Preferred Alternative)

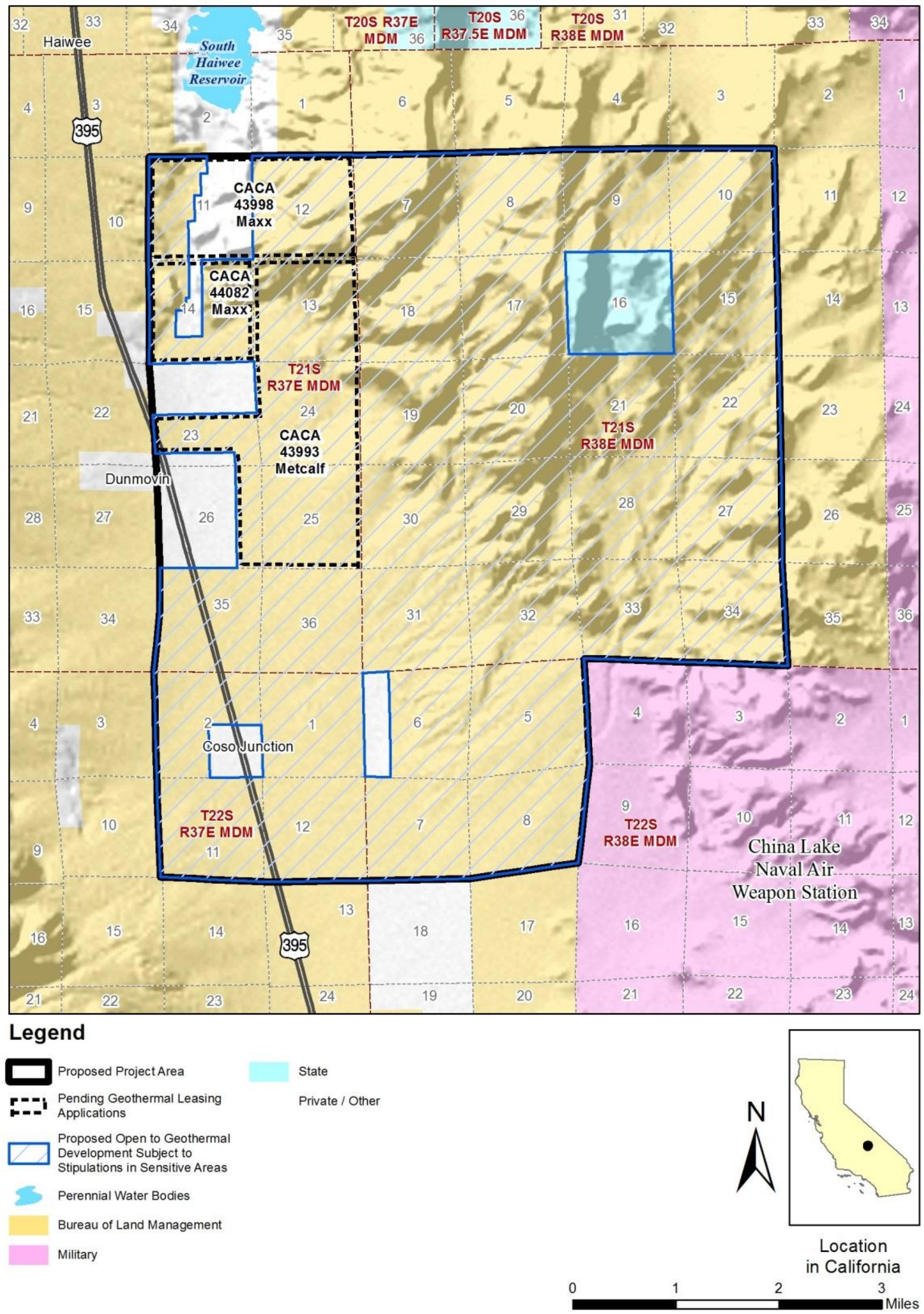


Figure M-2 Alternative B

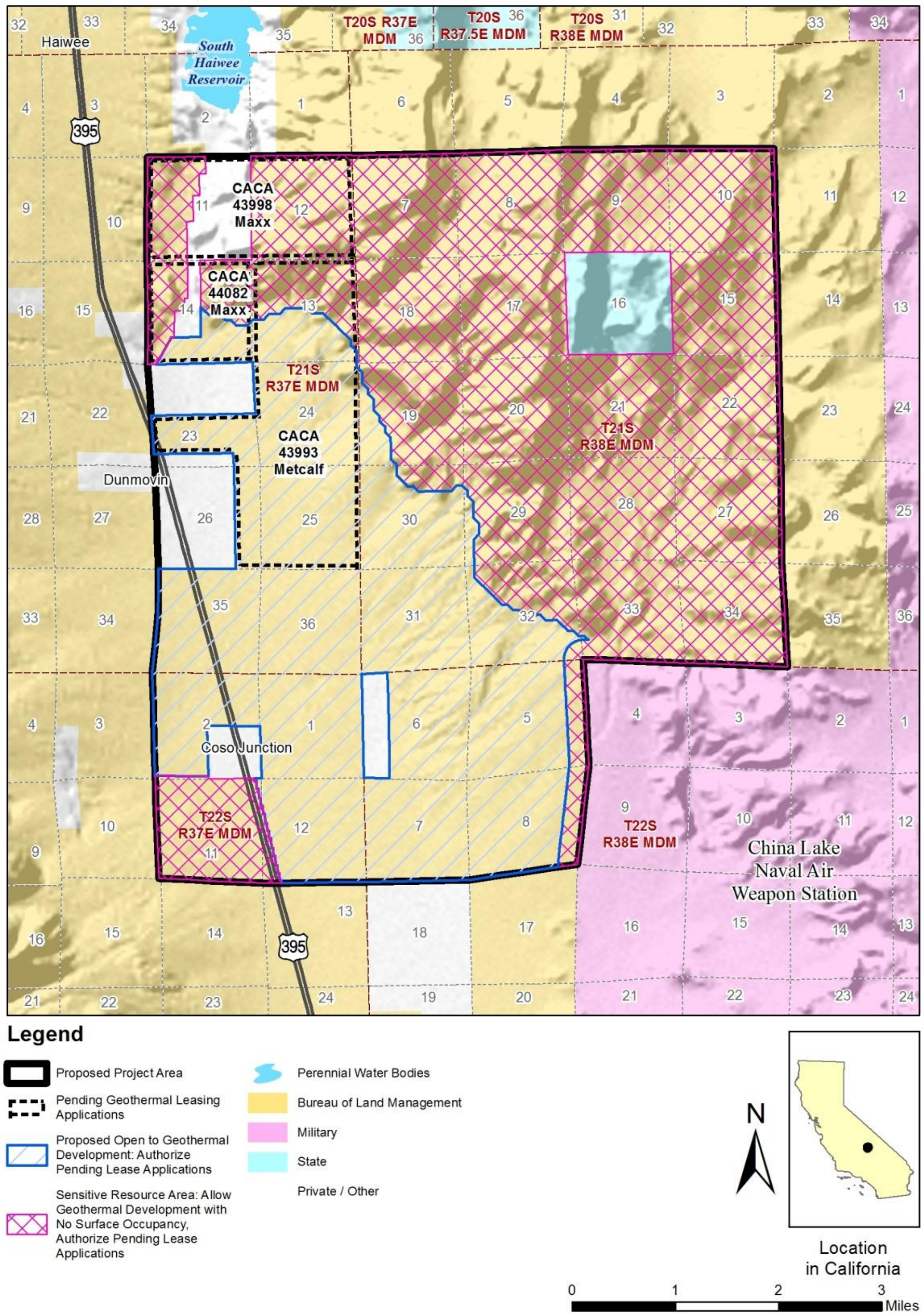


FIGURE M-3 Alternative C

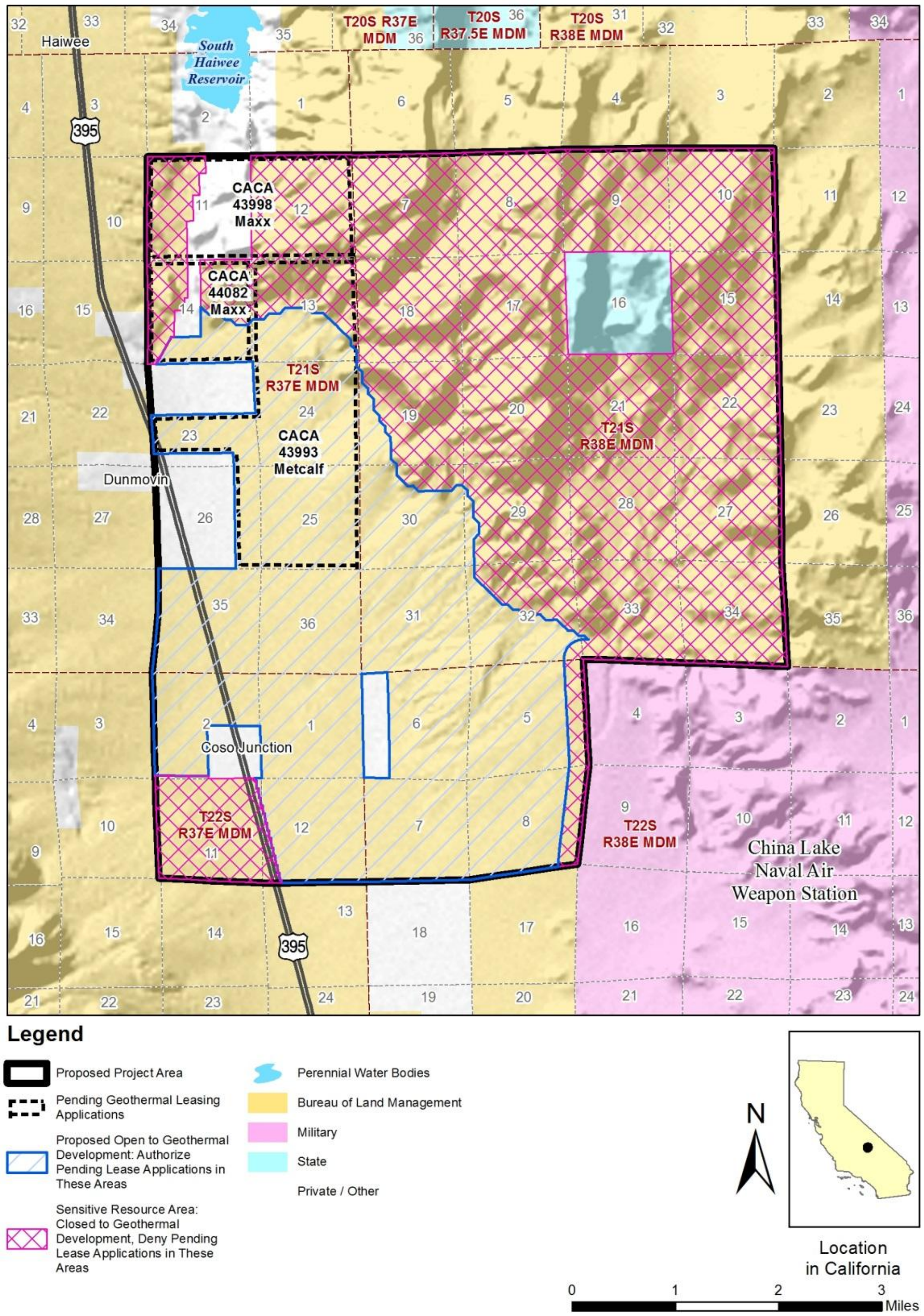
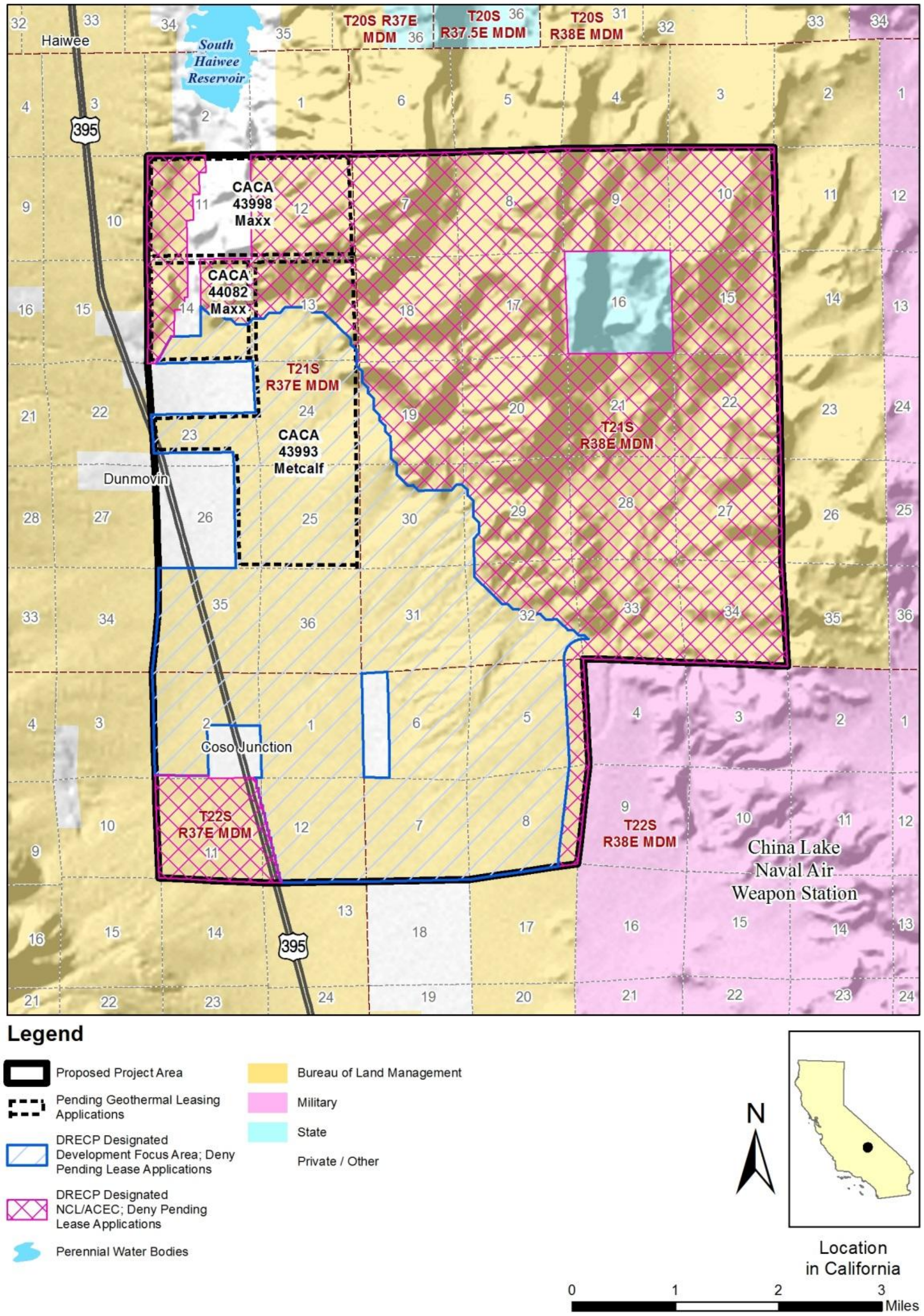


FIGURE M-4 Alternative D



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APPENDIX N

SUPPLEMENTAL AIR QUALITY DATA

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This appendix provides supplemental tables as discussed in Section 3.2 and Section 4.2 of this FSEIS that have changed from the DEIS (BLM 2012). Also refer to Section 3.2, Section 4.2 and Appendix F of the DEIS.

Table N-1 Monthly Average Temperatures and Precipitation – Haiwee Meteorological Station

MONTH	TEMPERATURE, FAHRENHEIT (ºF)				PRECIPITATION, INCHES	
	Maximum	Standard Deviation	Minimum	Standard Deviation	Measurement	Standard Deviation
January	52.0	5.09	29.1	4.38	1.08	1.44
February	56.7	4.44	32.7	3.78	1.30	1.51
March	63.1	4.74	37.2	3.26	0.86	1.07
April	70.5	4.45	51.4	4.08	0.34	0.52
May	79.6	4.56	51.4	3.68	0.22	0.36
June	89.1	3.74	59.2	3.19	0.09	0.21
July	95.6	2.99	65.8	3.40	0.23	0.49
August	93.9	2.97	63.9	2.99	0.29	0.56
September	87.2	3.07	57.3	3.45	0.27	0.53
October	75.8	4.04	47.2	3.27	0.29	0.72
November	62.0	3.85	36.0	3.06	0.5	0.97
December	52.7	3.95	30.1	2.98	0.99	1.14
Annual	**73.2**	**1.86**	**46.1**	**2.10**	**6.5**	**3.55**

Source: http://www.wrcc.dri.edu/CLIMATEDATA.html.

Table N-2 Representative Air Quality Data for the HGLA (2012-2016)

AIR QUALITY INDICATOR	2012	2013	2014	2015	2016
Ozone (O_3) **[(1)]**					
Peak 1-hour value (ppm)	0.082	0.08	0.08	0.076	0.085
Days above state standard (0.09 ppm)	0	0	0	0	0
Peak 8-hour value (ppm)	0.077	0.074	0.075	0.073	0.078
Days above state standard (0.070 ppm)	7	3	3	3	5
Days above federal standard (0.070 ppm)[(2, 6)]	7	3	3	3	5
Particulate matter less than or equal to 10 µm in diameter (PM_{10})[(3)]					
Peak 24-hour value (µg/m^3)	485	276	309	384.6	530.8
Days above state standard (50 µg/m^3)	*	*	*	*	*
Days above federal standard (150 µg/m^3)	3	6	3	3	4
Annual Average value (ppm)	18.5	19.7	20.6	19.1	24.4
Particulate matter less than or equal to 10 µm in diameter (PM_{10})[(7)]					
Peak 24-hour value (µg/m^3)	173	162	673	122.2	266.7
Days above state standard (50 µg/m^3)	*	*	*	*	*
Days above federal standard (150 µg/m^3)	1	2	3	0	1
Annual Average value (ppm)	15.5	18.8	30	16.7	18.5
Particulate matter less than or equal to 2.5 µm in diameter ($PM_{2.5}$)[(4)]					
Peak 24-hour value (µg/m^3) [(5)]	99	93.6	161	130.2	56.8
Days above federal standard (35 µg/m^3)	4	8	7	3	4
Annual Average value (ppm)	6.6	7.8	7.8	6.7	6.1
Hydrogen Sulfide (H_2S)[(7)]					
Peak 1-hour value (ppm)	0.008	0.005	0.004	0.006	0.004
Days above state standard (0.03 ppm)	0	0	0	0	0

Source: CARB 2016a. ADAM Air Quality Data Statistics. http://www.arb.ca.gov/adam/topfour/topfourdisplay.php

Notes: [(1)] Data from the Death Valley monitoring station, 55 miles from the project area.

[(2)] The federal ozone standard was revised downward in 2015 to 0.070 ppm.

[(3)] Data from the Olancha monitoring station.

[(4)] Data from the Keeler monitoring station.

[(5)] The federal $PM_{2.5}$ standard was revised downward in 2007 to 35 ⌠g/m^3.

[(6)] The federal eight-hour ozone standard was previously defined as 0.08 ppm (1 significant digit). Measurements were rounded up or down to determine compliance with the standard; therefore a measurement of 0.084 ppm is rounded to 0.08 ppm. The 8-hour ozone ambient air quality standards are met at an ambient air quality monitoring site when the average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to the standard.

[(7)] Data from the Coso Junction monitoring station.

ppm = parts per million; ⌠g/m^3 = micrograms per cubic meter; * = not available

APPENDIX O

SUPPLEMENTAL WATER RESOURCES DATA

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This appendix provides a supplemental table as discussed in Section 3.6 of this FSEIS that has changed from the DEIS (BLM 2012). Also refer to Section 3.6, Section 4.6, Appendix C, and Appendix G of the DEIS.

Table O-1 Baseline, Estimated Average November 2007, and Average September 2017 Groundwater Elevations

GROUNDWATER ELEVATION, FEET amsl(5)				
Well	**Baseline Groundwater Elevation (1)**	**November 2007 (2)**	**November 2009 (3)**	**September 2017 (4)**
Enchanted Village	-	NM	3,755.5	3,754.8
LADWP 816	-	3,435.2	3,430.8	3,445.1
Dunmovin	-	NM	3,253.0	NM
Cal Pumice	-	3,266.0	3,265.4	3,263.0
Hay Ranch North	-	3,245.0	3,245.3(3)	NM
HR-1A	-	NM	3,244.3	3,233.0
HR-1B	-	NM	3,243.1	3,220.5
HR-1C	-	NM	3,245.6	3,226.0
HR-2A	3,240.9	NM	3,241.1	3,231.8
HR-2B	-	NM	3,238.5	3,221.0
HR-2C	-	NM	3,242.6	3,227.5
Hay Ranch South	-	3,240.9	3,241.8	NM
Coso Junction Ranch	3,230.7	3,232.7	3,232.2	3,227.7
Coso Junction Store #1	3.227.6	3,229.3	3,229.8	3,225.5
Red Hill	3,200.7	NM	3,200.8	3,199.8
Lego	3,199.2	3,200.5	3,200.6	3,198.2
G-36	3,198.4	3,199.6	3,200.0	3,197.3
Cinder Road	3,186.9	NM	3,187.0	3,185.9
18-28 GTH	3.187.7	3,188.2	3,188.5	3,187.7
Fossil Falls	-	NM	3,175.6	3,174.8
Little Lake Ranch North	3,158.9	3,158.95	3,158.9	3,158.1
Little Lake Ranch Dock	-	NM	3,147.9	3,147.3
Little Lake Surface	-	NM	3,147.4	3,146.5
Little Lake Ranch Hotel	-	NM	3,138.3	3,138.0

Source: Geologica 2010.

Notes: NM = not measured; amsl = above mean sea level

(1) Baseline groundwater elevations set January 2010 and March 2011 and approved by Inyo County Water Department.

(2) MHA (2008) Table 3.2-2

(3) Average November 2009 groundwater elevation estimated by Geologica from groundwater elevation hydrographs presented at the Inyo County Water Department's Hay Ranch Monitoring Website, http://www.inyowater.org/coso/default.html accessed December 4, 2009.

(4) Average September 2017 groundwater elevation estimated by Geologica from groundwater elevation hydrographs presented at the Inyo County Water Department's Hay Ranch Monitoring Website,http://www.inyowater.org/projects/groundwater/coso-hay-ranch-project/ accessed November 17, 2017

(5) amsl=above mean sea level.

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APPENDIX P

SUPPLEMENTAL VISUAL RESOURCES DATA

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This appendix provides supplemental tables and figures as discussed in Section 3.10 and Section 4.10 of this FSEIS that have changed from the DEIS (BLM 2012). Also refer to Section 3.10 and Section 4.10 of the DEIS.

Table P-1 Sensitive Viewpoints

VIEWPOINT	USER TYPE/ATTITUDE	DURATION OF VIEW	USE VOLUME	VISUAL SENSITIVITY	COMMENTS
Communities*	High	Long	Moderate	High	Includes Olancha, Haiwee, Dunmovin, Coso Junction and Little Lake
Travel Corridors					
US 395	High	Short	High	High	State Identified Eligible Scenic Highway*
Coso-Gill Station Road	Moderate/Low	Short	Low	Low	
Unimproved/4WD Roads	Moderate/Low	Short	Low	Low	
Mine Haul Roads	Low	Short	Low	Low	
Recreation and Preservation Viewpoints					
Little Lake Overlook*	High	Long	Low	High	California Watchable Wildlife Site
Fossil Falls*	High	Long	Low	High	One of the Ridgecrest Field Office’s ‘Top 10 Points of Interest’; campground and trail at site.
Sacatar Trail Wilderness*	High	Long	Low	High	Access from the east is via the Sacatar Trail.
Coso Range Wilderness*	High	Long	Low	High	
South Sierra Wilderness*	High	Long	Low	High	
Haiwee Trail*	High	Long	Low	High	Trail accesses Kern River Wild and Scenic River and South Sierra Wilderness.

VIEWPOINT	USER TYPE/ATTITUDE	DURATION OF VIEW	USE VOLUME	VISUAL SENSITIVITY	COMMENTS
Pacific Crest Trail*	High	Long	Low	High	
Kennedy Meadows Campground*	High	Long	Low	High	Campground provides access to the Pacific Crest Trail.
Kern River Wild and Scenic River	High	Long	Low	High	
South Haiwee Reservoir	N/A	N/A	N/A	N/A	The reservoir has been closed to public access.
Cultural Resource Viewpoints					
Ayers Rock Petroglyph Site	Moderate	Long	Low	Moderate	
Coso Hot Springs*	High	Long	Low	High	
Fossil Falls Archeological District*					See Recreation and Preservation Viewpoints
Ayers Rock ACEC	Moderate/Low	Long	Low	Low	Designated for important and irreplaceable cultural resources, especially archaeological.
Sierra Canyons ACEC	Moderate/Low	Long	Low	Low	Designated for important and irreplaceable cultural resources, Including archaeological.
Rose Spring ACEC	Moderate/Low	Long	Low	Low	Designated for important and irreplaceable cultural resources, especially archaeological.

*High sensitivity viewpoints included in the visibility analysis.

Table P-2 Contrast Levels and VRM Class Conformance

VRM CLASS	VISUAL CONTRAST		
	Strong	**Moderate**	**Weak**
Class I*	N/A	N/A	N/A
Class II	No	No	Yes
Class III	Yes	Yes	Yes
Class IV*	N/A	N/A	N/A

*Indicates VRM Classes that are not present within the HGLA, and therefore not analyzed for visual contrast.

Figure P-1 HGLA VRM Classes and Scenic Quality Rating Units

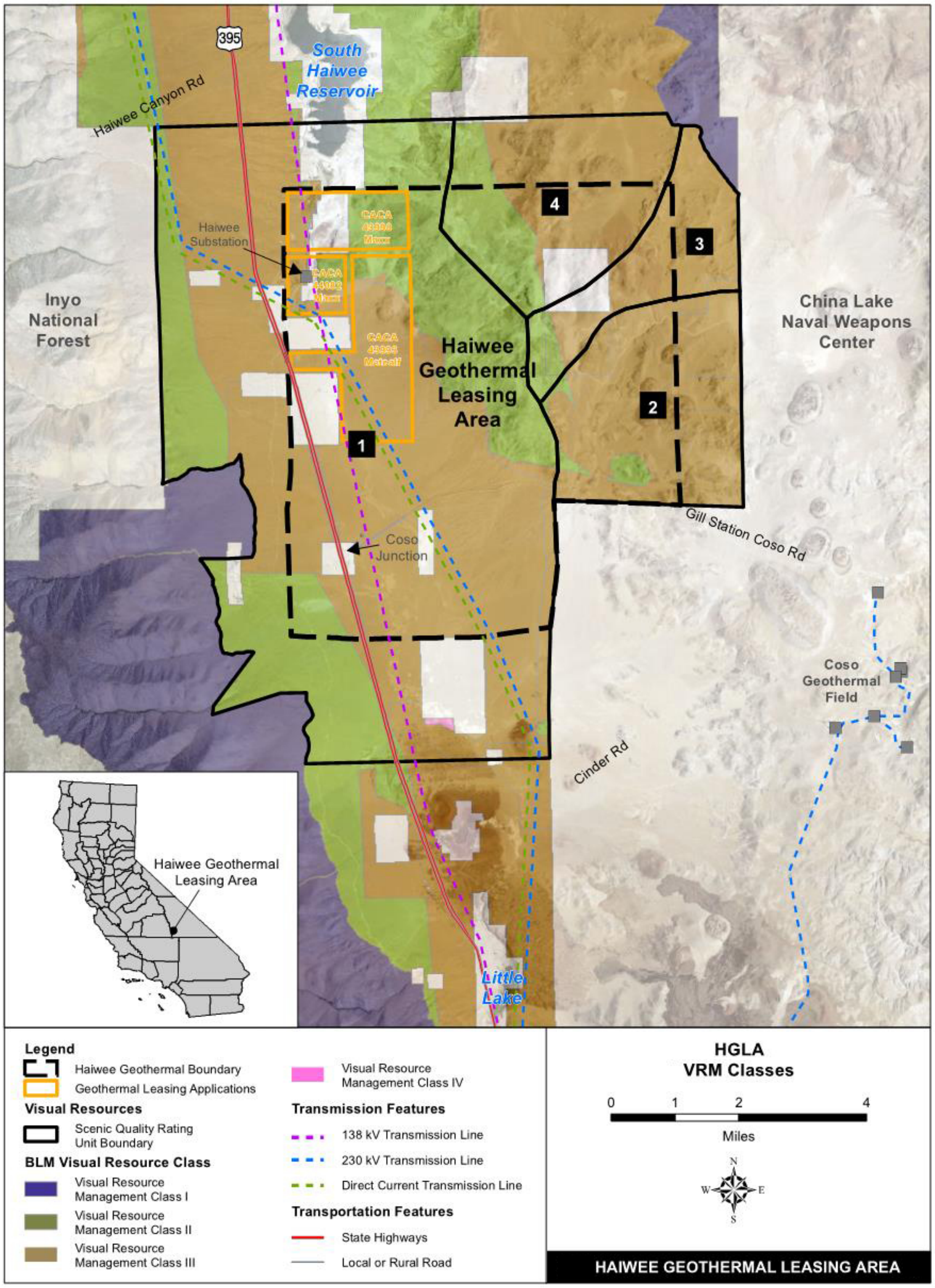
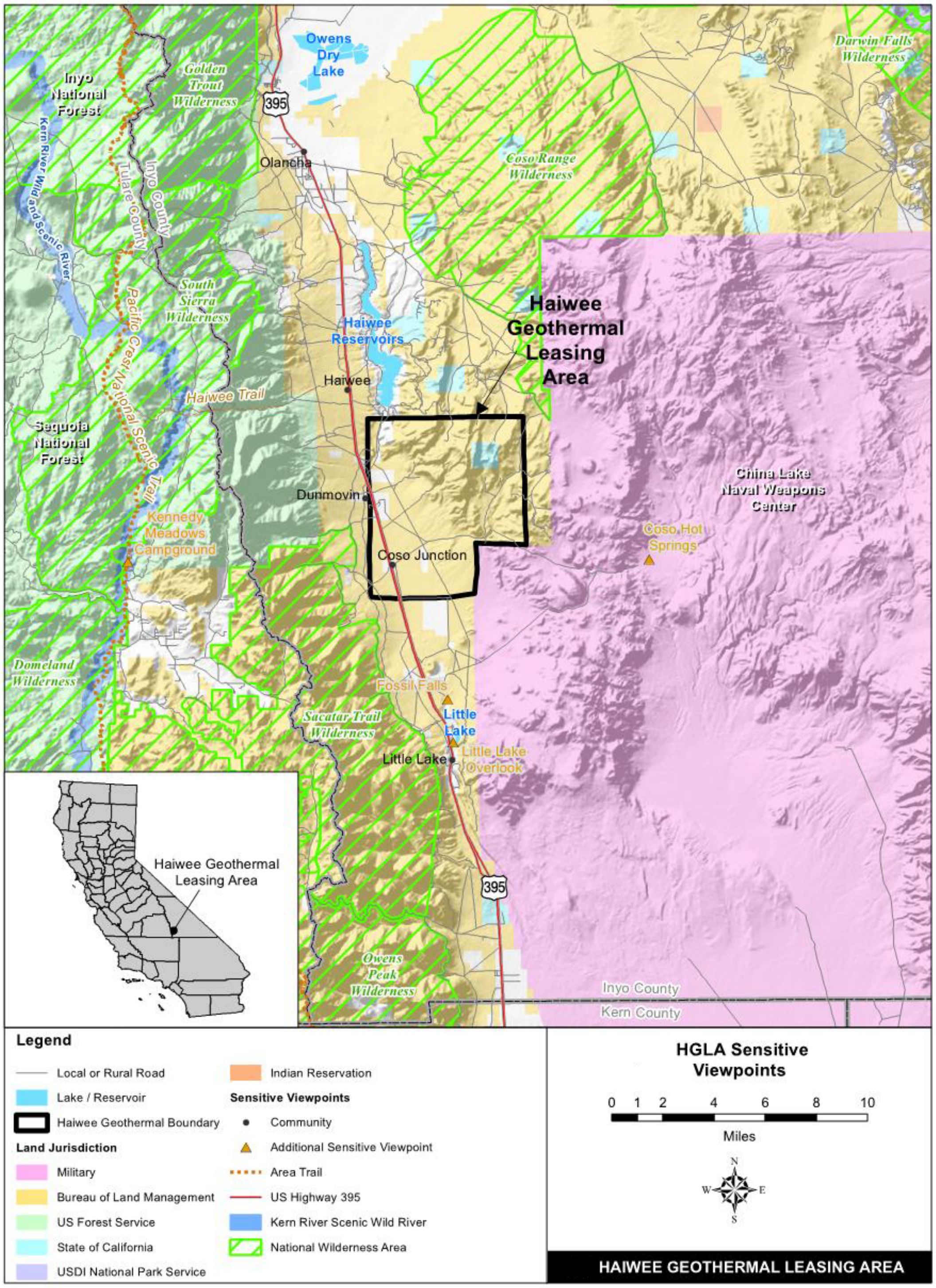


Figure P-2 HGLA Sensitive View Points



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APPENDIX Q

SUPPLEMENT LAND AND REALTY DATA

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This appendix provides a supplemental table as discussed in Section 3.11 of this FSEIS that has changed from the DEIS (BLM 2012). Also refer to Section 3.11 and Section 4.11 of the DEIS.

Table Q-1 Current Land Use Authorizations within the HGLA

HOLDER	SERIAL#	DESCRIPTION
Coso Energy Developers	CACA 13510	Power Transmission Line – 50 feet
Coso Energy Developers	CACA 18885	Telephone Line – 10 feet
Southern California Edison	CACA 21596	115 kV Power Transmission Line – 80 feet
Southern California Edison	CACA 26242	12 kV Power Transmission Line – 10 feet
Verizon California LLC	CACA 26398	Fiber Optic Line – 10 feet
Coso Operating Co.	CACA 46289	Pipeline
Deep Rose, LLC	CACA 47464	Water Pipeline
Maxx Management Corp	CACA 43998	Pending Geothermal Lease
Maxx Management Corp	CACA 44082	Pending Geothermal Lease
Terry K Metcalf	CACA 43993	Pending Geothermal Lease
CA Dept. of Public Works	CALA 0 88333	Material Sites
LADWP	CALA 0 88876	500 kV Power Transmission Line – 250 feet
CA Dept. of Public Works	CALA 0 93471	Federal Highway
Verizon California Inc.	CALA 0 125334	Fiber Optic Line – Variable Widths
City of Los Angeles	CALA 0 155168	34.5 kV Power Transmission Line – 50 feet
CA Dept. of Public Works	CALA 0 164238	Material Site
LADWP	CARI 231	Aqueduct – 100 feet
CA Dept. of Public Works	CARI 2641	Federal Highway
Southern California Edison	CARI 2861	12 kV Power Transmission Line – 25 feet
Southern California Edison	CARI 4354	12 kV Power Transmission Line – 25 feet

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APPENDIX R

SUPPLEMENTAL CULTURAL DATA

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As noted in Section 3.8.3.10 of this FSEIS, there are 23 prehistoric archeological sites and four archaeological sites with historic-era components within the HGLA study area as listed below.

Prehistoric archaeological sites: There are 23 prehistoric archeological sites within the HGLA study area. These are listed in Appendix S of this DSEIS.

- CA-INY-134 Ayer's Rock (NRHP #03000116)
- CA-INY-1791 (BLM #250)
- P14-1792 (BLM #251)
- CA-INY-1799 (BLM #254)
- CA-INY-1897 (BLM #311)
- P14-1910 (BLM #327)
- CA-INY-1993 (BLM #355)
- P14-2137 (BLM #355)
- CA-INY-2246
- CA-INY-2248 (BLM #261, also listed in CRHR)
- CA-INY-2284 (BLM #390)
- CA-INY-2323 (BLM #63, also listed in CRHR)
- CA-INY-2333 (BLM #306)
- CA-INY-2334
- CA-INY-3002 (also eligible CRHR)
- P14-3665 (BLM #286)
- CA-INY-3669
- CA-INY-3618 (also listed in CRHR)
- BLM #8884
- BLM #8885
- BLM #9112
- Fossil Falls Archaeological District (NRHP #80004492)
- Coso Rock Art District (NRHP #99001178)

Archaeological sites with Historic-era Components:

P14-372 (BLM #372, the Rose Spring Site)

- CA-INY-1806 (BLM #265, 366)
- CA-INY-2329 (determined eligible for NRHP as part of a District, also listed in CRHR)
- Coso Hot Springs (NRHP #78000674)

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APPENDIX S

SUPPLEMENTAL ENERGY AND MINERAL RESOURCES DATA

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As of December 2017, there are 23 active mining claims recorded with the BLM within the HGLA. Table S-1 below was revised from the DEIS (BLM 2012) and summarizes all active and recorded mining claims.

Table S-1 Active Recorded Mining Claims within the HGLA

CLAIM NAME	TYPE	DATE RECORDED	DATE OF LOCATION	DATE OF LATEST ASSESSMENT	SERIAL# (FULL)
MAKAYLA PUMICE NO 1	PLACER	08/21/2000	06/26/2000	8/17/2009	CAMC277668
MAKAYLA PUMICE NO 2	PLACER	08/21/2000	06/26/2000	8/17/2009	CAMC277669
MARGIE 1	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277670
MARGIE 2	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277671
MARGIE 3	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277672
MARGID 4	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277673
MARGIE 5	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277674
MARGIE 6	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277675
MARGIE 7	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277676
MARGIE 8	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277677
MARGIE 9	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277678
MARGIE 10	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277679
MARGIE 11	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277680
MARGIE 12	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277681
MORIAH 1	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277682
MORIAH 2	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277683
MORIAH 3	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277684
MORIAH 4	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277685
MORIAH 5	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277686
MORIAH 6	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277687
MORIAH 7	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277688
MORIAH 8	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277689
MORIAH 9	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277690
MORIAH 10	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277691
MORIAH 11	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277692
MORIAH 12	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277693
MORIAH 13	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277694
MORIAH 14	PLACER	08/21/2000	06/21/2000	07/07/2014	CAMC277695
DB 197	LODE	11/27/2007	09/08/2007	8/27/2009	CAMC291086
DB 198	LODE	11/27/2007	09/08/2007	8/27/2009	CAMC291087
DB	LODE	11/27/2007	09/08/2007	8/27/2009	CAMC291088

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APPENDIX T

SUPPLEMENTAL RECREATION DATA

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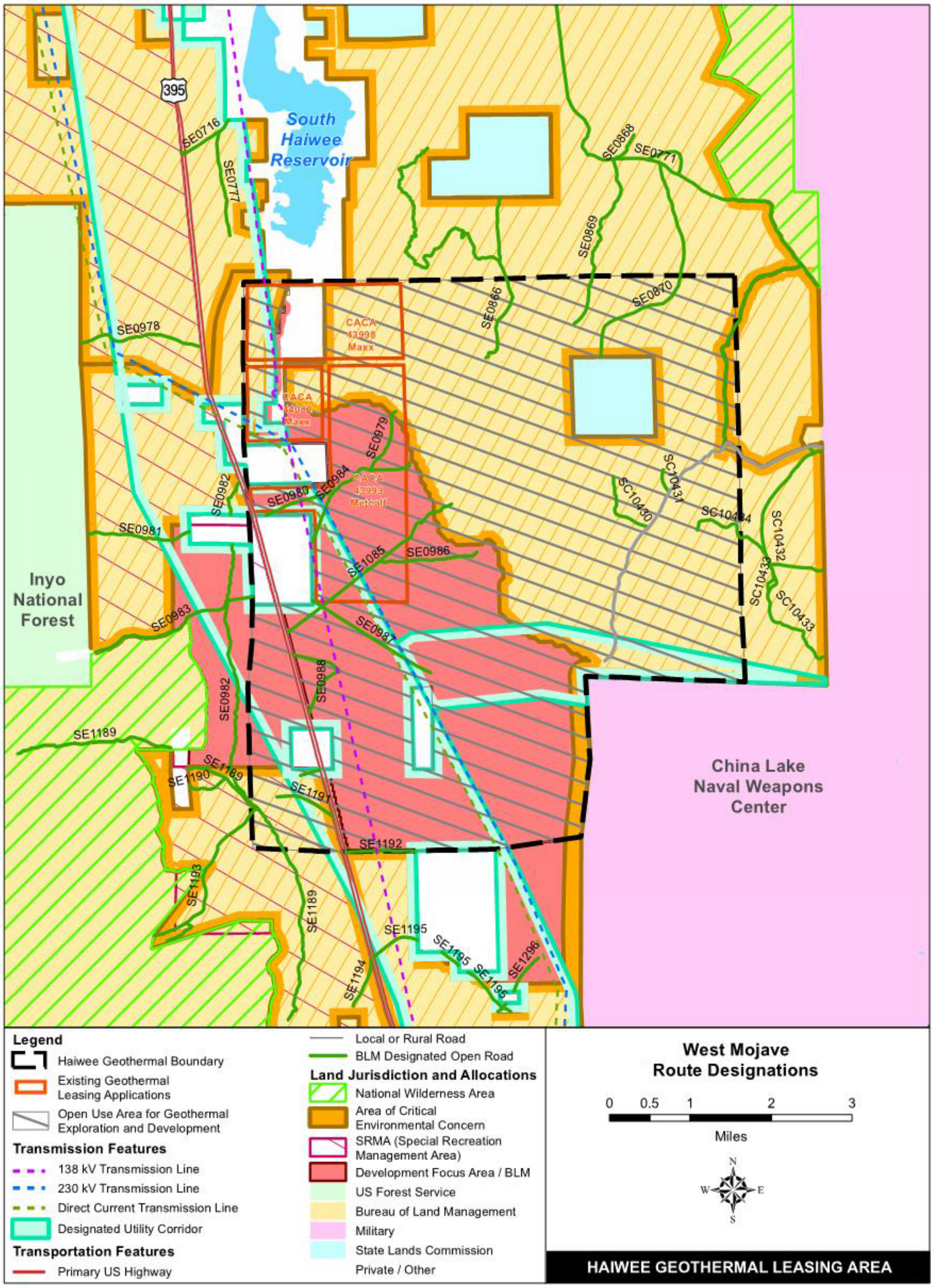
This appendix provides supplemental figures and tables as discussed in Section 3.16 and Section 4.16 of this FSEIS that have changed from the DEIS (BLM 2012). Also refer to Section 3.16 and Section 4.16 of the DEIS. Recreational uses and visitation rates to the Ridgecrest SRMA between October 1, 2016 and September 30, 2017 are summarized in Table T-1 below and reference in Section 3.16.3 of this DSEIS.

Table T-1 Ridgecrest Special Recreation Management Area: Recreational Use and Visitation

ACTIVITY	NUMBER OF PARTICIPANTS	VISITOR DAYS
Ridgecrest SRMA, ID: LLCAD05000-01 Site: Dispersed-Ridgecrest, ID: 00000.000		
Bicycling - Mountain	8,240	1,373
Camping	4,464	8,689
Driving for Pleasure	28,898	7,249
Hiking/Walking/Running	12,360	2,060
Horseback Riding	8,240	1,373
Hunting – Upland Bird	6,180	2,060
Nature Study	6,180	1,030
OHV - ATV	4,120	1,030
OHV – Cars/Trucks/SUVs	29,019	4,926
OHV - Motorcycle	12,360	2,060
Photography	6,180	515
Racing – Horse Endurance	352	381
Rockhounding/Mineral Collection	4,120	1,030
Target Practice	4,120	687
Viewing - Wildlife	4,120	1,373
Viewing – Scenery/Landscapes	58	10

Source: BLM 2017.

Figure T-1 West Mojave Route Designation Program Map



APPENDIX U

SUPPLEMENTAL TRAFFIC/TRANSPORTATION DATA

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This appendix provides supplemental tables as discussed in Section 3.18 and Section 4.18 of this FSEIS that have changed from the DEIS (BLM 2012). Also refer to Section 3.18 and Section 4.18 of the DEIS.
Historic and recent traffic volumes were revised as noted in Section 3.18.2.2 of this FSEIS. Data for 2016 is provided in Table U-1 and Historic data from 2007 to 2015 is provided in Table U-2.

Table U-1 2016 Traffic Volumes at the US 395-SR 190 East Junction

LOCATION	ANNUAL AVERAGE DAILY TRAFFIC (AADT)	PEAK MONTH	PEAK HOUR
Along US 395 at SR 190	6,700	8,800	1,150
Along SR 190 East at US 395	240	300	50

Source: Caltrans 2016.

Table U-2 Historic Annual Average Daily Traffic Volumes at the US 395-SR 190 East Junction

LOCATION	2007	2008	2009	2010	2011	2012	2013	2014	2015
Along US 395 at SR 190	5,900	5,600	5,900	5,900	5,600	5,300	5,500	5,500	5,800
Along SR 190 East at US 395	330	300	300	300	230	240	240	240	240

Source: Caltrans 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015.

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APPENDIX V

SUPPLEMENTAL LANDS WITH WILDERNESS CHARACTERISTICS DATA

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Lands with wilderness characteristics (LWC) were not analyzed in the DEIS (BLM 2012). The affected environment and potential impacts to LWC as a result of the alternatives are discussed in Section 3.20 and Section 4.20 of the FSEIS.

As discussed in Section 3.20.2, Wilderness Inventory Unit #CDCA131 contained three subunits that were evaluated for wilderness characteristics. Table V-1 below summarizes the finding of the evaluation in each subunit.

Table V-1 WIU #CDCA 131 (Coso) Subunits.

Unit #/Name	Sufficient Size (acres)	Natural Condition? Yes/No (Y/N)	Outstanding Solitude? Y/N	Outstanding Primitive & Unconfined Recreation? Y/N	Supplemental Values? Y/N
WIU #CDCA **131-1**	**Y** 21,322.5	**Y**	**Y**	**Y**	**Y**
WIU #CDCA **131-2**	**Y** 2,560 acres but contiguous to existing wilderness	**N**	N/A	N/A	N/A
WIU #CDCA **131-3**	**N** 4,481	**N**	N/A	N/A	N/A

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APPENDIX X

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APPENDIX Y

ABBREVIATIONS AND ACRONYMS

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Abbreviations and Acronyms

AAGR	annual average growth rate
AB	Administrative Bill
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ac-ft/yr	acre feet per year
AGD	allowable ground disturbance
AICUZ	Air Installation Compatible Use Zone
AIRFA	American Indian Religious Freedom Act
AML	Abandoned Mine Lands
AMP	Allotment Management Plans
amsl	above mean sea level
APCD	Air Pollution Control District
APE	Area of Potential Effects
APLIC	Avian Power Line Interaction Committee
AQCMM	Air Quality Control Mitigation Measures
ARB	Air Resources Board
ARPA	Archaeological Resources Protection Act
ASTM	American Society for Testing and Materials
AUM	Animal Unit Months
BGEPA	Bald and Golden Eagle Protection Act
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practices
°C	degrees Celsius
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CCD	Census County Division
CDCA	California Desert Conservation Area
CDD	California Desert District
CDFG	California Department of Fish and Game (now CDFW)
CDFW	California Department of Fish and Wildlife (formerly CDFG)
CDNCL	California Desert National Conservation Lands
CDOF	California Department of Finance
CDP	Census Designated Place
CDPA	California Desert Protection Act
CDWR	California Department of Water Resources
CEC	California Energy Commission
CEDD	California Employment Development Department
CEQ	Council on Environmental Quality

CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CHL	California Historical Landmarks
CHRIS	California Historical Resource Information System
CHSR	California High-Speed Rail
CJPL	Coso Junction Planning Area
CMA	Conservation Management Actions
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
COC	Coso Operating Company
COM Plan	Construction, Operation, and Maintenance Plan
Coso	Coso Hay Ranch LLC
CPUC	California Public Utilities Commission
CRHR	California Register of Historical Resources
CRMP	Cultural Resource Management Plan
CRUP	Cultural Resource Use Permit
CSLC	California State Lands Commission
CSU	Controlled Surface Water
CUP	Conditional Use Permit
CWA	Clean Water Act
dB	decibels
dB(A)	A-weighted decibels
DC	Direct Current
DEIS	Draft Environmental Impact Statement
DFA	Development Focus Area
DOGGR	California Department of Conservation, Division of Oil, Gas & Geothermal Resources
DOI	United States Department of the Interior
DRECP	Desert Renewable Energy Conservation Plan
DSEIS	Draft Supplemental Environmental Impact Statement
DSCF	dry standard cubic feet
DWMA	Desert Wildlife Management Area
EA	Environmental Assessment
EIC	Eastern Information Center
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act

Epsilon	Epsilon Systems Solutions, Inc.
ERMA	Extensive Recreation Management Area
ESA	Endangered Species Act
ºF	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act
FOIA	Freedom of Information Act
FR	Federal Register
FEIS	Final Environmental Impact Statement
ft^2/day	square feet per day
GBUAPCD	Great Basin Unified Air Pollution Control District
GBVAB	Great Basin Valleys Air Basin
GDP	Geothermal Drilling Permit
G-E-M	Geology-Energy-Minerals
GHG	Green House Gas
GIS	geographic information system
gpd/ft^2	gallons per day/square foot
GRDA	geothermal resources development account
GSA	Groundwater Sustainability Agency
GWP	global warming potential
HCP	habitat conservation plan
HGLA	Haiwee Geothermal Leasing Area
HMA	Herd Management Areas
HMMP	Hydrologic Monitoring and Mitigation Plan
hp	horsepower
HPTP	Historic Properties Treatment Plan
HUC	hydrologic unit code
H_2S	hydrogen sulfide
ICC	Inyo County Code
IM	Instruction Memorandum
IS	Induced Seismicity
Kf	water erosion factor
KGRA	known geothermal resource area
km	kilometer
KOP	key observation point
kph	kilometers per hour
kV	kilovolt
LADPW	Los Angeles County Department of Public Works
LADWP	Los Angeles Department of Water and Power (City of Los Angeles)

L-C-M	Lacy-Cactus-McCloud
L_{dn}	day-night average noise level
L_{eq}	equivalent, average sound level
LORS	Laws, Ordinances, Regulations and Standards
LOS	Level of Service
LRWQCB	Lahontan Office of the Regional Water Quality Control Board
LUPA	Land Use Plan Amendment
LWC	Lands with Wilderness Characteristics
M	Magnitude
MBTA	Migratory Bird Treaty Act
MDM	Mt. Diablo Meridian
MEQ	micro-earthquake
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MGSCA	Mojave Ground Squirrel Conservation Area
MOA	Memorandum of Agreement
mph	miles per hour
MUC	multiple use class
MW	megawatts
N_2O	nitrous oxide
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection Act
NAHC	Native American Heritage Commission
NAWS	Naval Air Weapons Station
NCEC	Northern California Earthquake Center
NCL	National Conservation Lands
NCG	non-condensable gases
ND	No Date
NEMO	Northern and Eastern Mojave
NEPA	National Environmental Policy Act
NFS	National Forest Service
NHL	National Historic Landmark
NHPA	National Historic Preservation Act of 1966
NLCS	National Landscape Conservation System
NO_2	nitrogen dioxide
NOI	Notice of Intent
NOTS	Naval Ordnance Test Station
NOx	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places

NSO	No Surface Occupancy
O_3	ozone
OEHHA	California Office of Environmental Health Hazard Assessment
OHP	Office of Historic Preservation *(in the California Department of Parks and Recreation)*
OHV	off-highway vehicles
Omnibus Act	Omnibus Public Land Management Act of 2009
PA	Plan Amendment
Pb	lead
PEIS	Programmatic Environmental Impact Statement
PFYC	Potential Fossil Yield Classification
PL	Public Law
PM_{10}	suspended particulate matter less than or equal to 10 microns in diameter
$PM_{2.5}$	fine particulate matter less than or equal to 2.5 microns in diameter
POD	Plan of Development
POO	Plan of Operations
ppb	parts per billion
ppm	parts per million
PRPA	Paleontological Resource Preservation Act
REAT	Renewable Energy Action Team
REIS	Regional Economic Information System
RFD	reasonably foreseeable development
RFO	Ridgecrest Field Office
RMP	Resource Management Plan
ROD	Record of Decision
ROG	reactive organic gases
ROW	right-of-way
RPS	Renewable Portfolio Standard
RV	recreational vehicle
RWQCB	Regional Water Quality Control Board
SAA	Streambed Alteration Agreement
SB	Senate Bill
SCAB	South Coast Air Basin
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SCEC	Southern California Earthquake Center
SDG&E	San Diego Gas and Electric
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	sulfur dioxide
SPER	Statewide Portable Equipment Registrations
SQRU	Scenic Quality Rating Units

SR	State Route
SRMA	Special Recreation Management Area
SSA	socioeconomic study area
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAC	toxic air contaminants
TCP	traditional cultural properties
TDS	Total Dissolved Solids
TGA	Taylor Grazing Act
TL	timing limitations
TWRA	Tehachapi Wind Resources Area
μm	microns
$\mu g/m^3$	micrograms per cubic meter
U.S.	United States
US 395	United States Highway 395
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFS	United States Department of Agriculture, Forest Service
USFWS	United States Department of the Interior, Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
VPL	Variance Process Lands
VRI	Visual Resource Inventory
VRM	Visual Resource Management
WECC	Western Electricity Coordinating Council
WEMO	West Mojave
WIU	Wilderness Inventory Unit
WRCC	Western Regional Climate Center