PLES I GEOTHERMAL DEVELOPMENT PROJECT

FINAL
ENVIRONMENTAL IMPACT STATEMENT
AND
SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

Prepared for:

U.S. Bureau of Land Management
Bishop Resource Area Office

U.S. Forest Service
Inyo National Forest

Great Basin Unified Air
Pollution Control District

June 1989

Prepared by: Environmental Science Associates, Inc.

BUREAU OF LAND MANAGEMENT
INYO NATIONAL FOREST
GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT

FINAL
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

for the proposed
PLES I Geothermal Development Project

Ed Hastey — 6-9-89

Edward Hastey
California State Director
Bureau of Land Management
Date

Don Fatheree — 6-7-89

for Dennis Martin
Forest Supervisor
Inyo National Forest
Date

Ellen Hardebeck — 6/7/89

Ellen Hardebeck
Air Pollution Control Officer
Great Basin Unified Air Pollution Control District
Date

Dear Reader:

Enclosed is the Final Environmental Impact Statement (EIS) and Supplemental Environmental Impact Report (SEIR) prepared for the PLES I Geothermal Development Project, Mono County, California. The Bureau of Land Management's Bishop Resource Area of the Bakersfield District, the Inyo National Forest, and the Great Basin Unified Air Pollution Control District cooperated in the preparation of this document. This EIS/SEIR analyzes the proposed PLES I 10 MWe (net) geothermal power plant and its associated facilities, including production and injection wells, pipelines, and electricity transmission lines. An alternate location for the power plant, a smaller power plant alternative, and the no-action alternative are also considered.

Text which has been added since the Draft EIS/SEIR was published is double-underlined and marked by a revision bar in the right margin. Deleted text is not indicated.

This EIS was prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969. It also must comply with all provisions of the Endangered Species Act and the National Historic Preservation Act.

The Record of Decision has been included for your information. BLM intends to implement the Record of Decision by approving the PLES I Geothermal Project Plan of Development, Injection and Utilization. The action may be appealed within 30 days from the date of the filing of the Final EIS/SEIR with the Environmental Protection Agency. Any appeal must be submitted to the Interior Board of Land Appeals, Office of the Secretary, in accordance with the regulations at 43 CFR 4.400. No action will be taken by BLM until the close of the appeal period on the Record of Decision.

For further information contact:

Area Manager
Bishop Resource Area
787 N. Main Street, Suite P
Bishop, California 93514
(619) 872-4881

FINAL ENVIRONMENTAL IMPACT STATEMENT

AND SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

PLES I Geothermal Development

CA-017-P006-60

State Clearinghouse No. 86122913

Mono County, California

VOLUME I: EIS/SEIR

Federal Lead Agency: U.S. Bureau of Land Management Bishop Resource Area

State Lead Agency: Great Basin Unified Air Pollution Control District

Cooperating Agency: U.S. Forest Service Inyo National Forest

For further information contact:

Area Manager
Bishop Resource Area
787 N. Main Street, Suite P
Bishop, California 93514
(619) 872-4881

June 1989

PLES I GEOTHERMAL DEVELOPMENT PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT AND SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

June 1989

VOLUME I: EIS/SEIR

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

Page

LIST OF FIGURES

VOLUME II: APPENDICES

Appendices are bound separately in Volume II

TABLE OF CONTENTS (cont.)

Page

LIST OF TABLES

EXECUTIVE SUMMARY

INTRODUCTION

Pacific Energy of Commerce, California has proposed the development of a geothermal wellfield and the construction and operation of a 10 MWe (net) geothermal power plant on federal land administered by the Inyo National Forest in Mono County, California. The U.S. Bureau of Land Management (BLM), as the applicable mineral resource management agency, and pursuant to federal regulation (43 CFR 3200), is lead agency with respect to compliance with the National Environmental Policy Act (NEPA) of 1969. The Great Basin Unified Air Pollution Control District is lead agency for compliance with the California Environmental Quality Act (CEQA).

The purpose of this document is to analyze the impacts of the four alternatives, including the proposed project, so that decision-makers will have adequate information on which to base their decision to approve the PLES I proposed project or one of the other alternatives. The decision will be made using the findings presented in this Environmental Impact Statement/Supplemental Environmental Impact Report (EIS/SEIR).

Background

The Plans of Operation for Development, Utilization and Injection, as amended, submitted by Pacific Energy were received by the BLM and describe the purpose of the project, which is to develop and utilize geothermal resources believed to exist within federal geothermal lease CA-11667. Toward this end, Pacific Energy proposes to drill and test geothermal wells, pump the subsurface geothermal fluids to the surface, extract heat from the produced fluids, convert that heat into electrical energy in a 10 MWe (net) binary-cycle power plant, and inject the cooled fluid to a subsurface injection reservoir.

Purpose and Need for Action

The need for the project was stated by the U.S. Congress in the Geothermal Steam Act of 1970, the Mining and Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976, and the National Materials and Minerals Policy, Research, and Development Act of 1980.

These acts direct the Federal Government to foster and encourage private enterprise in the development of alternative energy resources within appropriate environmental constraints. Towards this end, each federal geothermal lessee is required to perform "... diligent exploration until there is a well(s) capable of commercial production on the leased lands." (43 CFR 3203.5). The lessee is also required to commercially produce or utilize the geothermal resource within ten years of the lease issuance or forfeit the geothermal lease. Federal policy encourages the use of alternate energy resources, such as the geothermal resource at Casa Diablo because unlike an electrical generation facility which utilizes oil, gas coal or other fossil fuels, the PLES I geothermal facility would utilize a clean, domestic energy resource, natural hot water, that would not produce stack emissions, such as carbon monoxide, nitrogen oxides, or particulates, which are produced by fossil fueled facilities. This energy resource would not, therefore, impact or produce emissions which would impact the Earth's ozone layer or add to the generation of photochemical smog. Also, the electricity produced by this facility would utilize an energy resource which is not dependent on foreign sources, unlike a significant percentage of the oil and gas utilized by this nation. The utilization of any alternate domestic energy resources would reduce this nation's energy dependence on foreign countries and strengthen our national security.

Project Location

The project is proposed for federal geothermal lease CA-11667, located in Geothermal Lease Block I within the Mono-Long Valley Known Geothermal Resource Area (KGRA). This 1,510-acre lease is located on land within the Inyo National Forest, three to four miles east of Town of Mammoth Lakes, Mono County, California. This area is in the southwestern part of the Long Valley Caldera, in the Mammoth Creek drainage basin.

Issues Analyzed in the EIS

During the earlier environmental review of the proposed project and in response to the Notice of Preparation for the EIS, attention was focused on a few major issues; thermal springs, particularly those at Hot Creek Hatchery and Hot Creek Gorge; the Hot Creek/Mammoth Creek fishery and other aquatic organisms in the area; hydrologic monitoring; visual resources; and mule deer. Cumulative impacts of the proposed PLES I project and other developments in the vicinity of the project area were also raised as a major issue.

Thermal Springs: Potential impacts to the thermal features are a major issue. Thermal water contributes to flows at several springs in the Casa Diablo/Hot Creek area including those at Hot Creek Gorge, a geological interpretive area, and those springs supplying Hot Creek Hatchery operated by Fish and Game. Hot Creek Gorge and Hot Creek Hatchery are important to the recreation-based economy of the region, in addition to their intrinsic value. Fish and Game has also raised the issue of snails and other aquatic invertebrates which may live in thermal springs and how they might be affected if the thermal contribution were changed. Issues regarding potential adverse impacts to thermal springs are discussed along with the related issues of the potential for geothermal reservoir pressure and temperature change.

Surface Water Contamination: Another major issue is the potential for spills or erosion from the project site which could cause damage to the Mammoth/Hot Creek fishery. Hot Creek is a nationally-known, catch-and-release, trophy trout stream and its protection is very important. This includes protection of the invertebrates and stream vegetation which provide food and shelter for the fish. The concern is that thermal and/or chemical degradation of the stream could result from accidental spills of geothermal fluids.

Hydrologic Monitoring: Issues were raised concerning specific monitoring methods; determination of critical reservoir parameters triggering remedial action; and the feasibility, potential effectiveness, and environmental consequences of proposed mitigation measures.

Visual Resources: Visual quality is highly valued in the region. People have expressed concern that the presence of an additional geothermal power plant would be visually intrusive and would have a detrimental effect on visitors and residents.

Mule Deer: Mule deer are abundant in Mono County and there is concern that development along the eastern side of the Sierra Nevada may jeopardize habitats and routes of migration crucial to the continued vitality of local deer herds.

Cumulative Impacts: Cumulative impacts are effects on the resources of an area or region caused by the combination of existing developments and uses along with proposed and reasonably foreseeable development. The major issues for the cumulative impacts analysis are the same as those described above for the project impacts analysis. The cumulative analysis in the EIS generally assesses impacts based on the development scenario described in Appendix F and discusses the relative contribution of the proposed project to the total cumulative impact.

Issues Considered but not Further Discussed

Extensive geothermal power generation occurs at the Geysers, a KGRA located largely in Sonoma and Lake Counties in northern California. During review of the Joint Draft EA/EIR, a number of commentors suggested that environmental impacts at the Geysers should be used to evaluate potential impacts on the project area. There are two major reasons the Geysers experience is not particularly relevant: topography and air cooling of the working fluid.

Siltation of salmonid spawning gravels and decreased food production in the form of benthic invertebrates are of particular concern at the Geysers. The steep slopes characteristic of the area are susceptible to erosion and landsliding and spills travel rapidly on the steep slopes. In addition, a great deal of earth moving, especially cut-and-fill is required by the topography of the Geysers in order to construct drill pads, access roads, and power plant sites. In contrast, the topography of Casa Diablo is gently sloping with very little cut-and-fill needed. Also significantly, the depth of the wells at the Geysers requires drill pads much larger than is needed for the shallow wells at Casa Diablo and the power plants at the Geysers are much larger than that proposed at Casa Diablo. The amount of surface disturbance at the Geysers is therefore many orders of magnitude larger than at Casa Diablo and is not realistically comparable. This impact would be much less severe at Casa Diablo because the topography is gently sloping and there are fewer perennial streams to be affected.

Spills at the Geysers have been primarily geothermal steam condensate from cooling towers and chemicals being transported to the plant sites. Condensate spills accounted for 82% of the spills from 1974 to 1984. About 2% of the spills were materials used for H_2S abatement and in the treatment of condensate (Warner et al., 1986). Therefore, over 80% of the spills are related to water cooling. At PLES I the geothermal fluid would be circulated in a closed system and the working fluid would be air cooled, so there would be no condensate nor would treatment of it be necessary.

Relationship to Federal and Local Plans, Policies, and Programs

The BLM is the agency responsible for management of geothermal resources on federal geothermal leases and enforcement of the provisions of the Geothermal Steam Act of 1970, 43 CFR 3200 regulations, and associated operational orders. The BLM is the designated federal lead agency under NEPA for preparation of this EIS.

BLM policies must be consistent with Forest Service, state, and local plans. The proposed project is consistent with federal law, regulation, planning, and policy.

Authorizing Actions

Discretionary approvals and permits from several agencies would be required for the project. These are summarized below. This EIS/SEIR has been prepared under NEPA Authorizing Actions Guidelines in response to BLM and Forest Service requirements and under CEQA regulations, with the Great Basin Unified APCD serving as Lead Agency for CEQA.

PERMITS AND APPROVALS

Agency	Permit/Approval	Facility
Great Basin Unified APCD	Authority to Construct Permits to Operate	Power plant; all wells Power plant; all wells
California RWQCB Lahontan Region	Waste Discharge Orders	Power Plant; all wells
Bureau of Land Management	Plan of Exploration	Exploration wells, roads, drill pads
	Plan of Development	Production wells, roads, drill pads
	Plan of Injection	Injection wells, roads, drill pads
	Plan of Baseline Data Collection	Facilities necessary for the collection of baseline data
	Plan of Utilization	Power plant, pipelines, power lines
	Plan for Production	Production procedures and monitoring for royalty assessment

SOURCE: Thomas, T., 1987.

PROPOSED ACTION AND ALTERNATIVES

Proposed Project (the Preferred Alternative)

Pacific Energy proposes to construct and operate a 10 MWe (net) binary power plant and geothermal wellfield development project (PLES I Project) on federal geothermal lease CA-11667. The project area is located approximately three miles east of the Town of Mammoth Lakes, Mono County, California and is within the Long Valley East Geothermal Unit on land administered by the Inyo National Forest. The project area is within the Long Valley KGRA, immediately adjacent to the existing seven MWe (net) Mammoth-Pacific I geothermal resource electric generating facility (MP I)

The proposed project would include: the drilling, construction, and operation of geothermal production and injection wellfields; the construction and operation of the related production pipeline gathering and injection pipeline distribution systems; the construction and operation of a 10 MWe (net) binary power plant facility; and construction of control facilities. As part of the proposed project, all of the mitigating stipulations previously applied by the BLM have been adopted.

Geothermal fluid, produced from up to four geothermal production wells located in the vicinity of Casa Diablo Hot Springs, would be directed by surface pipelines to the proposed binary power plant facility. Approximately 5,000 gpm of geothermal fluid would be produced. After heat extraction, the cooled geothermal fluid would be directed from the power plant by surface pipeline up to four geothermal injection wells and injected into the subsurface injection reservoir. Approximately 13 acres would be disturbed in the development and operation of the proposed project.

Alternate Power Plant Location

Under the alternative location action, the project would use the same well fields, plant design, and power output. The well fields would remain in the same locations because the resource cannot be moved. The principal difference would be the relocation of the power plant to a location 0.6 miles north of the proposed site. The alternative location is about 150 feet higher in elevation than the proposed power plant site and approximately 3,000 feet from the production and injection fields. It may be necessary to pump up to 20% more geothermal fluid (up to a total production capacity of the wells, it is possible that five production wells would be required. Two to four additional air coolers would be required, resulting in a power plant site 40 to 70 feet longer (about 0.5 acres larger) than the proposed power plant site. The power plant would have the same east-west orientation as the proposed power plant, but the sump would be located at the lowest elevation of the northwest corner. The gathering pipelines would be about 4,200 feet long and the distribution pipelines, about 4,500 feet long.

Smaller Power Plant Alternative

The smaller power plant alternative of about seven MWe (net) would be located at the site of the proposed project. It would use the same technology as the proposed project and would have two turbo expanders and generators, six heat exchangers, and 30 air condensers. The smaller power plant would be about 80 feet shorter in the westerly direction than the proposed project. Three production wells producing 3,800 gpm and three injection wells would be required.

Preferred Alternative and Comparison of Alternatives

The BLM in cooperation with the Forest Service has identified the proposed project as the preferred alternative. A summary comparison of the general characteristics of the proposed project and the alternatives is shown in the following table:

SUMMARY OF COMPARISON OF ALTERNATIVES/a/

	Proposed Project	Alternate Location	Smaller Alternative
Power Output (net) MWe	10	10	7
Power Plan Footprint (acres)	5.1	5.6	4.5
Generators (#)	3	3	2
Heat Exchangers (#)	9	9	6
Air Coolers (#)	40	42 to 44	30
Production Wells (#)	4	4 or 5	3
Production (gpm)	5,000	6,000	3,800
Length of Gathering Pipeline (feet)	2,600	4,200	2,400/c/
Length of Injection Pipeline (feet)	1,700	4,500	1,500/d/
Disturbed Area (acres)	13/b/	15	12

/a/ The no-action alternative would have none of the components listed above.
/b/ Taken from information provided to the BLM by Pacific Energy.
/c/ Assumes production well SF 35A-32 is not drilled.
/d/ Assumes injection well SFI 54A-32 is not drilled.

SOURCE: Pacific Energy and Environmental Science Associates, Inc.

AFFECTED ENVIRONMENT

PHYSICAL ENVIRONMENT

Air Quality

Air quality within the Mammoth Lakes/Long Valley area can be generally characterized as good during the summer months; however, during winter months federal and/or state air quality standards for nitrogen oxides, carbon monoxide, and particulate matter have occasionally been exceeded. The Great Basin Unified Air Pollution Control District is the local agency responsible for enforcing federal and state ambient air quality standards. The Great Basin Unified Air Pollution Control District monitored particulate matter smaller than 10 microns in diameter (PM_{10}) and hydrogen sulfide (H_2S) levels from January 1987 through December 1987 at a monitoring station approximately one mile east of the proposed project site. The purpose of the monitoring was to determine baseline concentrations upon which to evaluate the air quality effects of full-cycle geothermal resource development on the populated areas within Long Valley. The baseline concentrations of these pollutants were found to be well below the applicable ambient standards.

Geology

The project area is located along the southwestern edge of the resurgent dome of the Long Valley Caldera. The surface geology is dominated by post-caldera rhyolite lavas which form the resurgent dome and the moat basalt/andesite. A thin alluvium of 10- to 40-foot thickness covers these flows in most locations. Immediately below these basalt flows is a 1,200- to 1,500-foot thick rhyolitic lava interval. This post-caldera series of rhyolite flows with minor interbedded tuffs is the rock which forms the resurgent dome and constitutes the geothermal reservoir currently being exploited in the Casa Diablo area. Below the rhyolites is an 80- to 140-foot thick "landslide" horizon that is composed of granitic and metasedimentary lithic clasts which may represent a paleosol. The Bishop Tuff occurs beneath the "landslide" horizon. One deep well drilled in the Casa Diablo area, Union Mammoth #1, penetrated the full thickness (3,250 feet) of the Bishop Tuff and drilled into basement rock.

Geothermal Production

The Casa Diablo Geothermal production reservoir interval is approximately 300 to 600 feet below the surface within highly fractured rhyolite lavas. At Casa Diablo the proposed injection zone is below 1,000 feet, within the uppermost portion of the Bishop Tuff.

Geologic Hazards

The proposed project area exists within a region of earthquake activity and active volcanism. A broad pattern of surface deformation in the caldera has been noted since the increase in earthquake activity along the length of the eastern escarpment of the Sierra Nevada range began in mid-1978.

Soils within the project site overlie basalt bedrock but were themselves formed from washed in material of granitic or rhyolitic source rocks. The texture is sand or loamy sand throughout, and soil thickness ranges from 40 inches to more than 60 inches. Geophysical studies of soil resistivity indicate that there may be very shallow hot water or steam at the proposed power plant site.

Noise

The major noise source at the project site is the existing MP I geothermal power plant located about 800 feet to the west of the proposed PLES I site. Operation of the MP I plant produces a continuous high level hum which has been measured at 63 to 66 dBA L_{eq} at 150 feet. Vehicular noise in the project area is minor. Intermittent aircraft noise is due to low-flying aircraft approaching and departing from Mammoth/June Lakes airport about four miles to the east of the project site.

Hydrology

The proposed project and alternative location sites are contained entirely within the Mammoth Basin, an area of approximately 60 square miles, which is defined by the surface watershed of Mammoth and Hot Creeks (including Sherwin and Laurel Creeks). These creeks flow across the Long Valley Caldera to the Owens River and then into Lake Crowley. Other small creeks in the vicinity include Dry Creek, Little Hot Creek, and Convict Creek. In addition to the creeks which drain the area, a number of springs contribute to surface flows.

Drilling and geophysical studies in the Long Valley Caldera have indicated the presence of thermal fluids at various depths and locations in the south and southwest areas, including the Casa Diablo area in general and the project site in particular. Subsurface hydrologic resources in the Casa Diablo area are characterized by shallow localized cold groundwater at zero to 40-foot depth, underlain by a thermal protection zone at a depth of 300 to 600 feet where temperatures range from approximately 330° to 350°F. A second thermal zone is located at depths of 1,500 to 2,600 feet (with temperatures about 305°F).

Scientists working in the Long Valley area have proposed two different conceptual models to explain hydrological features in the area, both of which can be supported by observed data. One model, called the Lateral Flow Model, assumes a single hot water resource supplies all the thermal features in the area. In this model, the hot water migrates up faults until it encounters the reservoir rock through which the eastward flow can be maintained. This model implies that production of hot fluids from one zone and injection into another could result in pressure and/or temperature changes in nearby areas which are hydraulically connected to the same lateral zones.

The second model is called the Upwelling/Fracture Flow Model. Under the scenario proposed by this model, the nearly vertical faults which cut across the area serve as conduits to carry heated water up from deep reservoirs. It has been suggested that fluids move from south to north, roughly along the strike of the major faults. This would suggest poor hydraulic connection between reservoirs for each thermically active area and little potential for interface between the Casa Diablo area and Hot Creek Hatchery or Hot Creek Gorge.

BIOLOGICAL ENVIRONMENT

Vegetation

The climate, altitude, and vegetation of the proposed geothermal project area include two distinctive life zones common to the eastern Sierra Nevada region: Upper Sonoran Zone (at lower altitudes) and Transition zone (at upper altitudes). Each of the life zones contains distinctive plant communities which provide characteristic habitat for wildlife species.

Both mountain and desert plants characterize the flora located in the Casa Diablo Hot Springs area. More than 160 species of vascular plants were observed within the survey area during the surveys.

Two principal habitat types were found in the survey area: (1) forest/woodland vegetation with Jeffrey pine (Pinus jeffreyi) and pinyon pine (Pinus monophylla) dominating; and (2) shrub vegetation with sagebrush (Artemisia tridentata ssp. vaseyana) dominating. In addition, ten different habitat types were observed and mapped within the survey area.

Twelve plants, considered rare or endangered by the California Native Plant Society (CNPS), could potentially occur in the vicinity of the proposed project. However, no rare or endangered vascular plant species were observed during the plant surveys conducted in November 1987 and June 1988 in the proposed project area. Earlier thorough botanical investigations and botanical collecting trips at the Casa Diablo Hot Springs found no rare or endangered species there.

Two habitat types occurring in the survey area, thermal marsh and rhyolite buckwheat scrub, are considered botanically sensitive by Fish and Game.

Terrestrial Wildlife

The plant communities of the region provide habitats for a diversity of resident and migratory wildlife. Over 400 species of terrestrial vertebrates have been recorded in the Inyo National Forest. Some species are restricted to single habitats, while other species range over almost all the habitats in the region. Similarly, major streams and spring drainage areas in the region provide unique aquatic habitats for native and introduced species.

Pine forest and sagebrush shrub are the principal wildlife habitats found within the survey area. Some meadow vegetation and rock outcrops are also located in the survey area. Jeffrey and pinyon pine provide both food and nesting sites for mammals and birds.

There are eight migrant or resident species of concern that could potentially inhabit or use the Casa Diablo Hot Springs area. Of these, the mule deer is most susceptible to impact. Mule deer have been observed within the survey area and evidence of mule deer in the Casa Diablo Hot Springs area was observed. This deer movement does not appear to be concentrated in any localized portion of the survey area, but is dispersed throughout it.

Aquatic Resources

No perennial streams are found within the project area itself, but the western portion is crossed by a small intermittent stream which originates in ephemeral lakes west of the area. No riparian vegetation is connected with the stream, and no salmonid aquatic species are believed to exist within the stream. The intermittent stream drains into Mammoth Creek about 0.6 miles from the proposed power plant site. Mammoth Creek joins Hot Creek just below Hot Creek Hatchery, a hatchery operated by Fish and Game, which uses water from springs containing 2% to 3% thermal flow.

Aquatic invertebrates in Mammoth Creek are dominated by caddisflies, stoneflies, and mayflies. Hot Creek invertebrate fauna consists primarily of amphipods and caddisflies.

Both Mammoth and Hot Creeks support naturally spawning populations of rainbow and brown trout. Fish and Game Department stocks trout in Mammoth Creek upstream of Highway 395. Hot Creek is one of only two state-classified wild trout fisheries in the Inyo National Forest. The Hot Creek headwater springs also provide a unique habitat for the state and federally listed endangered Owens tui chub (Gila bicolor synderi).

SOCIAL ENVIRONMENT

Cultural Resources

Results from numerous archaeological investigations suggest the Owens-Long Valley region was once inhabited and used, for subsistence purposes, by numerous groups of hunter-gatherers over a period of 8,000 to 9,000 years. The latest peoples to inhabit the region were Numic-speaking groups.

Any site which Native Americans considered sacred is very sensitive to impacts. Springs and other sources of water, especially hot springs or springs where healing rites are performed, are especially sensitive, having sacred connotations. Thus, Casa Diablo Geyser and other hot springs and fumaroles in the project area could be considered important, although no sites near the proposed project have been identified as sacred by Native Americans.

Site-specific cultural resources surveys were conducted, in conformance with requirements of the United States Forest Service, on Federal lease CA-11667 which contains the proposed project area. Six sites were identified to contain cultural resources.

Range Resources

The proposed project area is located within the Long Canyon Unit of the Hot Creek Grazing Allotment. It provides about 6 AUMs per acre.

Recreational Resources

The project area is three miles east of the Town of Mammoth Lakes (population approximately 5,000) and nearby Mammoth Mountain Ski Area. Summertime recreation uses in Mammoth Lakes includes backpacking, camping, fishing, mountaineering, swimming, boating and sightseeing. Hot Creek Hatchery, known for developing a unique strain of rainbow trout, is three miles east of the site at the headwaters of Hot Creek. Hot Creek Hatchery raises over 700,000 catchable size trout and 1.25 million fingerling trout for stocking in the Inyo-Mono area annually. Immediately east of the hatchery, Hot Creek Ranch offers trophy trout fishing from May 1st to October 30th. During the fishing season the ranch averages 15,000 to 20,000 visitor-days. The Hot Creek recreational area also contains the Hot Creek Gorge, where hot springs emerge in Hot Creek. It is a favorite recreational spot for visitors to the Mammoth area and is open to the public throughout the year. Dispersed recreational activities in the project vicinity include canoeing, shooting, wood collecting, jogging, bicycling, snowmobiling, and deer hunting.

Timber Resources

The project site (about 24,000 board-feet per acre, where forested) and the alternate power plant site (about 30,000 board-feet per acre) are not managed for commercial timber production but are located near the southern edge of an area within the Inyo National Forest which is managed for commercial timber production. The project site is not an important timber resource.

Transportation and Access

The proposed project area is located near the intersection of Hot Springs Road (Mono County Road No. 346A) and California State Route 203. It is immediately accessible from the Mammoth Lakes offramp (Route 203) from existing U.S. Highway 395 (Highway 395). Highway 395 is the major north-south highway along the eastern Sierras. The portion of Highway 395 near the project area is a four-lane divided highway with seasonally heavy traffic, particularly during the winter ski seasons. California State Route 203 is a two-lane paved road east of Highway 395 and a four-lane divided highway west of 395 which serves as the principal access to the Town of Mammoth Lakes from Highway 395. Traffic on Route 203 is typically light except during the winter ski season. Hot Springs Road is a very lightly traveled, two-laned, paved road maintained by Mono County which crosses the proposed project site. Access to the alternative power plant site would be along the unnamed dirt road past the SCE substation and to the site.

Visual Resources

The visual character of the project vicinity is dramatic and is one of the primary attractions for visitors to the Mammoth Lakes area. There are several local nature areas with high-quality visual resources preserved for the enjoyment of the general public in the general area of the proposed project. In addition, the vegetation and wildlife of the region contribute to its high visual quality. Major viewpoints in the project vicinity are to the west, away from the proposed project site and toward Mammoth Mountain, the Minarets, San Joaquin Ridge, and Sherwin Bowl.

Both the proposed and alternate project sites are on gently sloping areas of primarily sagebrush scrub and scattered pine trees. The proposed project site is open to view by motorists traveling northeast on Route 203 east of Highway 395. The general project area is visible from portions of State 203 west of Highway 395, but the power plant site itself cannot be distinguished from adjacent areas at these distances. The portions of the project site are also open to view from Highway 395 from about 5,000 feet southeast of its junction with State Route 203 to within 1,000 feet of the junction. The alternative power plant site is not visible from Highway 395 or Route 203.

The clearest views of the proposed power plant site along Highway 395 are from the northbound travel lanes from about 4,400 feet southeast of its junction with State Route 203 to the junction. A long, low forested ridge to the north of the project site provides a backdrop, as viewed from Highway 395, that serves to minimize the visibility of individual features of the site and of the existing MP1 geothermal development northwest of the site.

SOCIOECONOMICS

The population of the Mammoth Lakes region has been steadily increasing over the last two decades. Most of the population of Mono County resides in the recently incorporated Town of Mammoth Lakes, which has a year-round population of approximately 5,000. Peak population on winter weekends reaches 35,000. Employment is concentrated in the government, retail sales, and service sectors, with service employment mostly generated by tourism.

Land Use

There are numerous land uses within the vicinity of the proposed project, including the existing

Mammoth Pacific I Geothermal Plant, Casa Diablo Substation, Mono County buildings, a liquid propane facility, Chance Ranch, Sherwin Creek Campground, Mammoth-June Lakes Airport, Forest Service Gravel Pits, Sierra Quarry, Hot Creek Hatchery, Old Mammoth School, Hot Creek Ranch, Shady Rest Campground, 115 KV electric transmission lines, and numerous roads throughout the project vicinity.

Economics

Mono County's economy is based primarily on recreation. Retail revenues are highly seasonal, peaking during the winter skiing season, with a secondary peak during July and August. Events and activities that negatively affect the skiing season (e.g., late or little snowfall or earthquake activity) dramatically affect the region's economy. There is an imbalance in the nature of the local economy due to its heavy reliance on recreational activities.

Fish and Game's Hot Creek Hatchery is important to the state's trout program. One of only three rainbow trout brood stock hatcheries in California, Hot Creek Hatchery provides approximately 20 million fish eggs for use in the state's year-round trout program and for use by hatchery systems of several other western states. Hot Creek Hatchery is also responsible for the production and planting of 700,000 catchable trout annually in the Inyo-Mono area and handles the major part of backcountry aerial planting in the northern Sierra Nevada.

Mono County receives revenues from a variety of sources. Total revenues for fiscal year 1985 to 86 were $13,517,524. The county expenditures for fiscal year 1985-86 equaled $13,517,824.

Community Services

The Mammoth School District provides local elementary and secondary education for the area. Law enforcement is provided by the Mono County Sheriff's Department headquartered in Bridgeport. The closest medical facility is the Centinela Mammoth Hospital located in the Town of Mammoth Lakes on Sierra Park Road. Local fire protection is provided by the Long ValleyFire Protection District. Street and road maintenance is provided by the county for all non-state and non-federal county roadways. The Mono County Water District operates a community sewage system and sewage treatment facility for residents of the Mammoth Lakes and the Lakes Basin areas. Mammoth Disposal Service, a private carrier, provides bin service on a contractual basis.

The site is located outside of the water service areas of the Town of Mammoth Lakes. A well which supplies non-potable water is located at the adjacent MP I site. The MP I plant receives electricity from the Southern California Edison Company. During 1986, the electrical substation serving the immediate area had a combined designed capacity of approximately 79 megawatts. The site area is currently served by the Continental Telephone Company (Contel) which has general offices and maintenance and switching facilities in Mammoth Lakes.

Hazardous Materials

Three 10,000-gallon gasoline storage tanks are located approximately one-quarter mile southeast of the project site, and an estimated 100,000 to 150,000 gallons of propane are stored in six tanks located about one mile east of the site. The existing Mammoth Pacific I geothermal power plant is located immediately adjacent to the proposed project site and stored about 20,000 gallons of isobutane as a working fluid for the binary geothermal heat extraction process.

Geothermal Resource Lease

The project area is located entirely on federally administered land within federal geothermal lease CA-11667. Pacific Energy assumed responsibility as agent for exploration activities within the lease from Santa Fe Geothermal on May 8, 1986. Assignment of title to the geothermal lease to Pacific Energy was approved by the BLM on June 1, 1986.

ENVIRONMENTAL CONSEQUENCES

The summary table of impacts and migration measures follows.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
AIR QUALITY								
Dust Generation	An estimated 16 tons per month of dust would be generated during construction. Project includes soil wetting, placing gravel on unpaved roads, and prompt revegetation and paving or covering of disturbed areas.	Limit speeds on dirt roads to 15 mph.	Estimated 18 tons per month of dust generated during construction. This alternative includes the same measures to reduce impacts as the proposed project.	Same as proposed project	Estimated 14 tons per month of dust generated during construction. This alternative includes the same measures to reduce impacts as the proposed project.	Same as proposed project	No construction would occur.	No mitigation is recommended.
Heavy Equipment Emissions	Diesel exhaust emissions would occur during grading and construction on 13 acres.	No mitigation is recommended.	Diesel exhaust emissions would occur during grading and construction on 15 acres.	No mitigation is recommended.	Diesel exhaust emissions would occur during grading and construction on 12 acres.	No mitigation is recommended.	No construction would occur.	No mitigation is recommended.
Hydrogen Sulfide Emissions	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 8 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 9 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 6 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	No well drilling would occur.	No mitigation is recommended.
	A spill of the entire production of geothermal fluid would release approximately 0.76 kilograms of H2S.	No mitigation is recommended.	A spill of the entire production of geothermal fluid would release approximately 0.91 kilograms of H2S.	No mitigation is recommended.	A spill of the entire production of geothermal fluid would release approximately 0.58 kilograms of H2S.	No mitigation is recommended.	No geothermal fluid would be used.	No mitigation is recommended.
Hydrocarbon Emissions	Fugitive emissions of isobutane (less than 750 lbs/day) would occur from leaks in the heat exchange system. Project includes leak detection program. The Great Basin Unified Air Pollution Control District would require the use of Best Available Control Technology if it were necessary to meet their permit conditions.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Fugitive emissions of isobutane (less than 500 lbs/day) would occur from leaks in the heat exchange system; otherwise, this alternative is the same as the proposed project.	No mitigation is recommended.	No additional isobutane would be used or stored in the area.	No mitigation is recommended.
	A catastrophic rupture in the heat exchange system could release 20,000 gallons of vaporized isobutane which could form a flammable vapor cloud. Project includes a leak emergency plan.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No additional isobutane would be used or stored in the area.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
GEOLOGY AND SOILS								
Seismicity	Severe groundshaking would occur during a major seismic event.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No new facilities would be built.	No mitigation is recommended.
			Ground rupture within the plant could cause ruptured geothermal or isobutane lines or collapse of structures.	Perform geophysical studies. Trench along any suspected fault. If found, date fault. Incorporate isolation valves at both ends of surface pipelines whcih cross active faults. Relocate power plant facilities sited on the fault.	Same as proposed project.	Same as proposed project.	No new facilities would be built.	No mitigation is recommended.
Shallow Geothermal Fluids	The likely presence of shallow hot water or steam could damage power plant facilities.	Perform borings to verify current water levels. If necessary, change grading plans or relocate power plant.	If shallow or surficial warm water exists, there could be hazards.	Perform borings to verify current water levels. If necessary, change grading plans.	Same as proposed project, except that smaller power plant could be moved west up to 80 feet and remain on the designated power plant site.	Same as the proposed project.	No new facilities would be built.	No mitigation is recommended.
Volcanism	If a major volcanic eruption occured, a catastrophic spill of geothermal fluids and/or isobutane could occur.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No new facilities would be built.	No mitigation is recommended.
Subsidence	Surface subsidence could result from long-term geothermal production. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	Surface subsidence could result from long-term geothermal production. These impacts would be greater than for the proposed project since 20% more fluid would be produced. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	Surface subsidence could result from long-term geothermal production. These impacts would be less than proposed project because less fluid would be pumped. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Erosion	Construction would disturb 13 acres. Erosion control measures are included in the project and required by the BLM and Lahontan Regional Water Quality Control Board. Runoff could be captured in the emergency spill containment basins to allow settling of sediments before flow reaches Mammoth Creek.	No mitigation is recommended.	Construction would disturb 15 acres. Erosion control measures are included in the project and required by the BLM and Lahontan Regional Water Quality Control Board. Erosion would affect a larger area and could impact the ephemeral lakes northwest of the alternative power plant site.	Construct berms to direct runoff leaving the power plant site so it would flow away from the ephemeral lakes.	Construction would disturb 12 acres; otherwise, this alternative is the same as the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

	PROPOSED PROJECT		ALTERNATE LOCATION		SMALLER POWER PLANT ALTERNATIVE		NO-ACTION ALTERNATIVE	
	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation
Erosion (continued)	Closing the sluice gates on the emergency spill containment basins during construction could allow unnecessary accumulations of water resulting in damage to vegetation and "bathtub" lines if intermittent stream were flowing.	If the intermittent stream is flowing during construction, leave the sluice gates open unless there were an emergency which would call for its use.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No emergency spill containment basins would be constructed.	No mitigation is recommended.
NOISE								
Construction Noise	Heavy equipment and traffic to and from the site would generate noise, but it would not be audible at the nearest sensitive receptors. Peoples and wildlife nearby would be temporarily affected.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No construction would occur.	No mitigation is recommended.
Operational Noise	The power plant would operate 7 days a week, 24 hours a day. The combined effect of the noise from MP I and PLES I would be about 3 decibels louder than MP I alone. Noise muffling devices are included the design. According to GRO Order No. 4, noise levels would not exceed 65dBA at the lease boundary or 0.5 mile, whichever is further.	No mitigation is recommended.	Noise generated at the alternate power plant site would not blend with noise from MP I because of the distance between the two power plants. A larger area would be impacted.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Noise levels would remain the same.	No mitigation is recommended.
WATER QUALITY AND HYDROLOGY								
Surface Water	Spills of geothermal fluid would be almost certainly contained in bermed areas or in the emergency spill containment basins. In the unlikely event that the roadbed at Route 203 failed and fluid reached Mammoth Creek, under extreme conditions of low stream flow and high ambient temperature, the temperature of the mixed water at the point of entry to Mammoth Creek could reach 118%F. This would cause mortality of fish and other aquatic organisms. Degradation of water quality would occur and could also harm aquatic organisms. The operator would stock the affected reach of Mammoth Creek.	A bioassay would be required in the Plan for Baseline Data Collection.	Same as the proposed project. The greater quantity of fluid required to operate at the alternative location be compensated for by the cooling and infiltration which would occur as the water flowed toward Mammoth Creek.	Same as the proposed project.	Impacts would be like those of the proposed project, except that due to the smaller volume of fluid pumped, the the mixed temperture in the extreme-case spill would be 100 F.	Same as the proposed project.	Spills from MP I which overflowed the bermed areas would flow to Mammoth Creek.	No mitigation is recommended.
Shallow Fresh Groundwater	Vegetation could be impacted if water is used for irrigation and sanitary uses.	Reduce groundwater pumping.	Slightly more groundwater would be used for irrigation of more landscaping and revegetation.	Same as proposed project.	Slightly less groundwater would be used than for the proposed project because of the smaller area	Same as proposed project.	Groundwater consumption would not increase at Casa Diablo.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
WATER QUALITY AND HYDROLOGY (continued)								
Hydrothermal Resources	Simulated reservoir performance calculations using three different methods predict minor changes to reservoir pressure and temperature due to project operation. The project includes a comprehensive monitoring/mitigation program. One monitoring well has been drilled. The well would be monitored for baseline data. Potential migrations include a variety of reservoir management techniques which would first be triggered by observations in production and injection wells. Subsequent actions would occur, including the drilling of another monitoring well, based on analysis of monitoring results from a variety of natural features and wells. Ultimately, reduction or cessation of power production could be required to protect sensitive hydrothermal resources. If temperatures in Hot Creek headsprings change enough to deviate from their normal ranges, the operator would supply water from another source to allow continued operation of Hot Creek Hatchery and maintenance of the Owens tui chub habitat.	Change some trigger mechanisms (see Section 4.1.4.3.1 in the body of the EIS/ Supplemental EIR. Install a monitoring well near existing monitoring well SF 65-32 which would penetrate the injection reservoir. Before commercial power plant operation begins, require that a detailed program for timely implementation of remedial action measures to supply water to Hot Creek headsprings be approved by the authorized officer.	Same as proposed project, except that up to 20% more geothermal fluid would be pumped for the alternative location.	Same as proposed project.	Same as proposed project, except that 24% less geothermal fluid would be pumped for the smaller power plant alternative.	Same as proposed project.	PLES I could not impact hydrothermal resources.	No mitigation is recommended.
	If, contrary to all reasonable expectations, flow at Hot Creek Gorge fumaroles and springs were diminished by project operations, it would have less value as a geologic interpretive site.	Inject geothermal water upgradient of Hot Creek Gorge to restore flows.	Same as proposed project, except that up to 20% more geothermal fluid would be pumped for the alternative location.	Same as proposed project.	Same as proposed project, except that 24% less geothermal fluid would be pumped for the smaller power plant alternative.	Same as proposed project.	PLES I could not impact hydrothermal resources.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
BIOLOGICAL ENVIRONMENT								
Vegetation	Approximately 13 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. The project includes vegetation protection meassures and extensive revegetation.	No mitigation is recommended.	Approximately 15 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. Rhyolite buckwheat scrub would be disturbed by pipelines. Otherwise, this alternative would be the same as the proposed project.	Relocate injection pipelines to avoid rhyolite buckwheat scrub.	Approximately 12 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. The project includes vegetation protection measures and extensive revegetation.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Terrestrial Wildlife	The habitat which would be lost is common in the region. No impacts to sage grouse, pygmy nuthatch, bald eagle, peregrine falcon, northern goshawk, Williamson's sapsucker, yellow warbler, hairy woodpecker, or special status animal species would occur.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
	Noise may affect wildlife around the power plant, but no clear impacts can be defined.	No mitigation is recommended.	If noise impacts wildlife populations, the affect would occur over a larger area if the alternative power plant site were used.	Locate the power plant at the proposed site.	Same as for the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Mule Deer	Approximately 70 deer were found to use the project area during the spring 1987 migration. They could be affected by pipelines, fencing, and the power plant. Does carrying fawns may be more vulnerable. The proposed project includes below-grade pipeline installation were appropriate. All fencing would be approved by the BLM.	New projects could contribute to off-site mitigation measures in proportion to their impacts.	Impacts to deer would be more severe for this alternative because a larger area would be disrupted and the pipelines would be longer.	Locate the power plant at the proposed site and contribute to off-site mitigation.	Same as for the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Aquatic Resources	Impacts to aquatic resources are highly unlikely, as described in the hydrology summary. See that section for a discussion of impacts to water quality. The Lahontan Regional Water Quality Control Board has a variety of requirements to protect water quality. Fish would be restocked if mortality resulted from project activities.	A bioassay would be required in the Plan for Baseline Data Collection.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as proposed project.	There would be no project impacts.	No mitigation is recommended.
Owens Tui Chub	The Owens tui chub, found in some of the Hot Creek headsprings, would be protected under the progressive monitoring/mitigation program described under hydrology.	See mitigations listed under hydrology.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as proposed project.	There would be no project impacts.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT								
Cultural Resources	Construction and operations personnel could collect or disturb cultural artifacts.	Educate project personnel to the need to leave cultural remains undisturbed.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	The injection pipeline would pass immediately adjacent to Cultural Resource Sites-7, -8, and -9. Careless use of equipment could damage the sites during laying of the line.	Flag the designated route before work begins and avoid during construction.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	Subsurface resources may be encountered during construction. If such artifacts are found, construction would stop until suitable actions, approved by the Inyo Forest Supervisor, were taken.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Native American Values	Traditional Native American interests often include areas around hot springs and fumaroles for their special soils and plants and for the springs themselves. Although no specific sites in the project area have been identified as sacred, Pacific Energy has indicated that continued access would be provided.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Range	Approximately two AUMs would be lost to the permittee.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Recreational Resources	In the highly unlikely event that the geothermal features at Hot Creek Gorge were reduced or depleted, a feature which accounts for 95,000 visitor days per year would be lost.	Inject geothermal water upgradient of Hot Creek Gorge to restore flows.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	The trout-stocking program would be adversely affected if the hatchery could not function year-round.	See the discussion in the hydrology section.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT (continued)								
Timber	Up to 40,000 board-feet of timber would be harvested. The site is not managed for timber production and is not included in the Inyo National Forest timber base.	No mitigation is recommended.	Up to 220,000 board-feet of timber would be harvested. Otherwise, impacts would be the same as for the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No timber would be harvested.	No mitigation is recommended.
Transportation and Access	Traffic impacts would be minor. If peak project traffic occurred during winter weekend traffic periods, project traffic would be routed to Hot Springs Road at Sherwin Creek Road, if necessary, thereby avoiding the busier Route 203 offramp from Highway 395.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	Unpaved existing roads on the project site would be used for access.	No mitigation is recommended.	The power plant site would be reached by the unpaved dirt road leading to the SCE substation.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
Visual Resources	Drilling rigs would be visually strong but temporary elements. After wells were completed, they would be screened by vegetation.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	The power plant would be the most visible element of the project, visible from Route 203 and northbound Highway 395. Existing and transplanted trees would mostly screen the power plant from view, but there would be narrow corridors through which the full 30-foot height of the condensers could be seen. The extensive landscaping, revegetation, and camouflage proposed as part of the project would reduce impacts. There would be no overhead electrical transmission lines. Exterior surfaces would be non-reflective to the extent feasible, exterior night lighting would be minimized, and natural terrain and vegetation would be used to provide visual screening.	No mitigation is recommended.	The power plant would not be visible from Route 203 or Highway 395. It could be seen from Antelope Springs Road, an unpaved road serving dispersed recreation in Little Antelope Valley.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Lanscaping of the area east of MP I where pipelines cross Hot Springs Road would not be done.	No mitigation is recommended.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT (continued)								
Community Services	The number of students would increase slightly	The school district may assess fees on commercial development.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
	No significant demands on law enforcement are expected.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	Health care facilities would be adequate to treat all injuries excetp for severe burns or scalds. Local facilities are not equipped to handle such cases and they would be evacuated.	Revise local emergy response plans to include geothermal accidents. Train on-site personnel in CPR. Develop evacuation procedures for burn victims.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Similar burn accidents could occur at the MP I plant.	Same as the proposed project.
	The proposed project has a fire prevention and protection plan approved by the Long Valley Fire Protection District.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Street and Road Maintenance	Construction traffic may result in the need for additional maintenance or repair on county and Forest Service roads.	Transfer the cost of repairing damage caused by project activities to the operator. A performance bond could be posted or user fees assessed.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Wastewater, Soilid Waste, and Utilities	About 300 gallons per day of wastewater would be generated. Solid waste would be taken to the Benton Crossing landfill. Electricity would be bought from SCE if needed.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Hazardous Materials	Some hazardous materials such as diesel fuel, paints, or solvents would be used and stored on the project site. Regional Water Quality Control Board requirement would be followed where applicable.	Follow proper procedures for use, storage, and disposal of all potentially hazardous materials.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Geothermal Resource Lease	The proposed project would result in the beneficial use of the geothermal resources within the federal geothermal lease.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	The reduction in output to 7 MWe would constitute a breach of the existing power agreement between the applicant and SCE and could result in termination of the project.	Approve the proposed project.	This alternative would prohibit development of the geothermal lease as currently proposed and could result in forfeiture of the lease.	Approve the proposed project.

SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT (continued)								
Land Use and Planning	The proposed project would change the partially undeveloped character of the site to one of light industrial activity. The project is compatible with Forest Service plans and would not conflict with existing or planned uses in the area.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	No land use changes would occur.	No mitigation is recommended.
Employment, Population, and Housing	An average of 48 workers would be employed over the 9-month construction period, peaking with 82 workers in the fifth month. 16 full-time employees would operate the facility when commercial production begins. Outside workers could cause an increased demand for housing at the lower end of the price scale, potentially increasing housing prices.	Time construction to avoid having the peak construction housing needs coincide with the peak winter housing demand.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	No project impacts would occur.	No mitigation is recommended.
Economics	The local economy would benefit from the payroll paid to workers, which would be similar to the MP I payroll ($451,000 in 1986), and from plant purchases. The year-round operation of the plant would help stabilize the highly seasonal nature of employment and retail sales.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	The community would forego the economic benefits of the project.	No mitigation is recommended.
	In the highly unlikely event that water temperature changes at Hot Creek Hatchery prevented year-round operation, the hatchery would lose eggs worth up to $16,000 annually at current market rates. In addition, a major portion of the facilities for backcountry aerial planting would have to be moved to other hatcheries. The power plant operator is obligated to supply water to the hatchery so that normal operations can be maintained.	See mitigations described in the hydrology section.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	Same as for the proposed project.	No project impacts would occur.	No mitigation is recommended.
	County revenues would increase by about $250,000 per year from property taxes, sales taxes, and a portion of the geothermal lease.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Lower revenues would be generated by the proposed project.	No mitigation is recommended.	The community would forego the economic benefits of the project.	No mitigation is recommended.

1.0 INTRODUCTION

Pacific Energy of Commerce, California has proposed the development of a geothermal wellfield and the construction and operation of a 10 MWe (net) geothermal power plant on federal land administered by the Inyo National Forest in Mono County, California. The U.S. Bureau of Land Management (BLM), as the applicable mineral resource management agency, and pursuant to federal regulation (43 CFR 3261.3), is lead agency with respect to compliance with the National Environmental Policy Act (NEPA) of 1969. The Great Basin Unified Air Pollution Control District is lead agency for compliance with the California Environmental Quality Act (CEQA).

The purpose of this document is to analyze the impacts of the four alternatives, including the proposed project, so that decision-makers will have adequate information on which to base their decision to approve the PLES I proposed project or one of the other alternatives. The decision will be made using the findings presented in this Environmental Impact Statement / Environmental Impact Report Supplement (EIS/SEIR).

The EIS/SEIR is divided into three major sections in addition to the introductory and supporting material. Proposed Action and Alternatives (Chapter 2), contains a description of each alternative. Chapter 3 describes the environment, resource by resource, which would be affected by the actions. Environmental Consequences, included as Chapter 4, is also organized by resource. For each resource, an impact and mitigation analysis is included for each alternative. A discussion of the nature of the potential impact is given. Features of the proposed project, the alternative location, and smaller power plant which serve to reduce impacts are identified and mitigation measures are enumerated along with an assessment of their likely effectiveness and a brief discussion of impacts which might result from their implementation. Cumulative impacts are discussed in this chapter as well.

1.1 BACKGROUND

The PLES I project was first formally proposed when Pacific Energy (then named Pacific Lighting Energy Systems) submitted a Plan of Operation for the project to the BLM in September 1986. On the basis of the likely significance of expected impacts from the project, a joint decision between BLM, U.S. Forest Service (Forest Service), and the Great Basin Unified Air Pollution Control District was made to prepare an Environmental Assessment/ Environmental Impact Report (EA/EIR) to satisfy the provisions of NEPA and the California Environmental Quality Act (CEQA). The Great Basin Unified Air Pollution Control District, a local agency with discretionary permit authority for the proposed project, is lead agency under CEQA. The chronology of events in the environmental review process culminating in the decision to prepare an EIS/SEIR for the project is as follows:

September 3, 1986	Plan of Operation for PLES I project was submitted to Bishop Resource Area (RA).
October 21, 1986	Bishop RA conducted a public site inspection.
November 15, 1986	Comment period on PLES I plan closed.
November 25, 1986	Proposal was issued to contract for preparation of joint EA/EIR.
August 19, 1987	Joint Draft EA/EIR was distributed for public review and comment.
September 15, 1987	Public hearing on Draft EIR was held in Mammoth Lakes.
October 9, 1987	Comment period on PLES I Draft EA/EIR closed.
October 14, 1987	Sierra Club submitted a protest to BLM California State Office (CSO).
February 10, 1988	U.S. Fish and Wildlife Service, after a Section 7 Consultation regarding the Owens tui chub, issued a "No Jeopardy Opinion."
February 11, 1988	Bishop RA and Inyo N.F. approved the PLES I project.
February 26, 1988	CSO dismissed Sierra Club protest.
March 9, 1988	California Department of Fish and Game (Fish and Game) appealed the decision of the Bishop RA.
March 9, 1988	Bishop RA approved the PLES I Plan for Baseline Data Collection.
March 11, 1988	Sierra Club et al. also appealed BLM decision.
March 31, 1988	BLM CSO requested an expedited Interior Board of Land Appeals review.
April 8, 1988	Fish and Game appealed the BLM approval of the PLES I Plan for Baseline Data Collection.
May 2, 1988	BLM and Fish and Game met in Sacramento to discuss Fish and Game concerns.

May 12, 1988	Sierra Club et al. and Fish and Game filed their Statement of Reasons with BLM.
May 23, 1988	BLM and Fish and Game met in Bishop to discussed the specific concerns identified by Fish and Game.
May 24, 1988	Final EIR was certified.
May 31, 1988	BLM staff from CSO and solicitor met to evaluate Fish and Game and Sierra Club Statement of Reasons. The decision to require an EIS was made.
June 23, 1988	BLM sends out public notice of the July 8, 1988 public scoping meeting and site visit to identify specific issues and concerns for analysis in the PLES I EIS.
July 8, 1988	BLM conducts public scoping meeting and site visit of the PLES I project area.
August 30, 1988	Memorandum of Understanding between BLM and Great Basin Unified Air Pollution Control District to prepare a joint EIS/SEIR
Sept. 9, 1988	Public notice in Federal Register of the availability of the PLES I Draft EIS No. 880294.
Oct. 21, 1988	The Great Basin Unified Air Pollution Control District conducts a Public Hearing on the Supplemental EIR for the PLES I Project.

The decision to require an EIS is not based on the belief that the Joint EA/EIR incorrectly assessed the significance of impacts but on the fact that public controversy persists regarding potential impacts of the project on surface hydrothermal features in the area. The introduction of a report on the project's potential hydrothermal impacts in Fish and Game's Statement of Reasons has increased concern over the potential impacts to Hot Creek Hatchery and Hot Creek Gorge. Accordingly, the BLM has determined that the threshold of "significance" for controversy as defined in 40 CFR §1508.27(b)(4) which would require preparation of an EIS for the project has been crossed.

The EIS deals with two alternatives, including an alternative power plant location, which were not analyzed in the Joint EA/EIR. There are also a number of measures to reduce impacts which are included in the currently proposed project but were not part of the project analyzed in the Joint EA/EIR. Many of these measures, developed since the Joint EA/EIR was published, would serve to lessen visual impacts and to improve the monitoring/mitigation plan for hydrothermal resources. Because of these factors and in accordance with CEQA Guidelines, Section 15163, Great Basin Unified Air Pollution Control District has determined that the EIS should serve as an EIR Supplement to the Final EIR certified May 24, 1988. A Memorandum of Understanding to that effect between the BLM and Great Basin Unified Air Pollution Control District was signed August 30, 1988.

1.2 PURPOSE AND NEED FOR ACTION

The Plans of Operation for Development, Utilization and Injection, submitted by Pacific Energy, were received by the BLM on September 8, 1986, and describe the purpose of the project, which is to develop and utilize geothermal resources believed to exist within federal geothermal lease CA-11667. Toward this end, Pacific Energy proposes to drill and test geothermal wells, pump the subsurface geothermal fluids to the surface, extract heat from the produced fluids, convert that heat into electrical energy in a 10 MWe (net) binary-cycle power plant, and inject the cooled fluid to a subsurface injection reservoir.

The need for the project was stated by the U.S. Congress in the Geothermal Steam Act of 1970, the Mining and Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976, and the National Materials and Minerals Policy, Research, and Development Act of 1980. These acts direct the Federal Government to foster and encourage private enterprise in the development of alternative energy resources within appropriate environmental constraints. Towards this end, each federal geothermal lessee is required to perform "... diligent exploration until there is a well(s) capable of commercial production on the leased lands."
(43 CFR 3203.5). The lessee is also required to commercially produce or utilize the geothermal resource within ten years of the lease issuance or forfeit the geothermal lease. Federal policy encourages the use of alternate energy resources, such as the geothermal resource at Casa Diablo because unlike an electrical generation facility which utilizes oil, gas, coal or other fossil fuels, the PLES I geothermal facility would utilize a clean, domestic energy resource, natural

hot water, that would not produce stack emissions, such as carbon monoxide, nitrogen oxides, or particulates, which are produced by fossil fueled facilities. This energy resource would not, therefore, impact or produce emissions which would impact the Earth's ozone layer or add to the generation of photochemical smog. Also, the electricity produced by this facility would utilize an energy resource which is not dependent on foreign sources, unlike a significant percentage of the oil and gas utilized by this nation. The utilization of any alternate domestic energy resources would reduce this nation's energy dependence on foreign countries and strengthen our national security.

1.3 PROJECT LOCATION AND STUDY AREA

The project is proposed for federal geothermal lease CA-11667, located in Geothermal Lease Block I within the Mono-Long Valley Known Geothermal Resource Area (KGRA). This 1,510-acre lease, shown on Figure 1-1, is located on land within the Inyo National Forest, three to four miles east of Town of Mammoth Lakes, Mono County, California. This area is in the southwestern part of the Long Valley Caldera, in the Mammoth Creek drainage basin.

In the EIS/SEIR, several terms are used to describe the area around the project, with varying degrees of specificity.

Proposed project site refers to the smallest area. It includes the production and injection fields and the power plant site, shown on Figure 1-1.

The project area includes the project site, all of federal lease CA-11667, and the private and federal property enclosed within it. The project area is generally the same as the Casa Diablo area.

The project vicinity includes the Mammoth Creek drainage basin.

1.4 MAJOR ISSUES

1.4.1 ISSUES ANALYZED IN THE EIS

During the earlier environmental review of the proposed project and in response to the Notice of Preparation for the EIS, attention was focused on a few major issues: thermal springs, particularly those at Hot Creek Hatchery and Hot Creek Gorge; the Hot Creek/Mammoth Creek fishery and other aquatic organisms in the area; hydrologic monitoring; visual resources; and mule deer. Cumulative impacts of the proposed PLES I Project and other developments in the vicinity of the project area were also raised as a major issue.

1.4.1.1 Thermal Springs

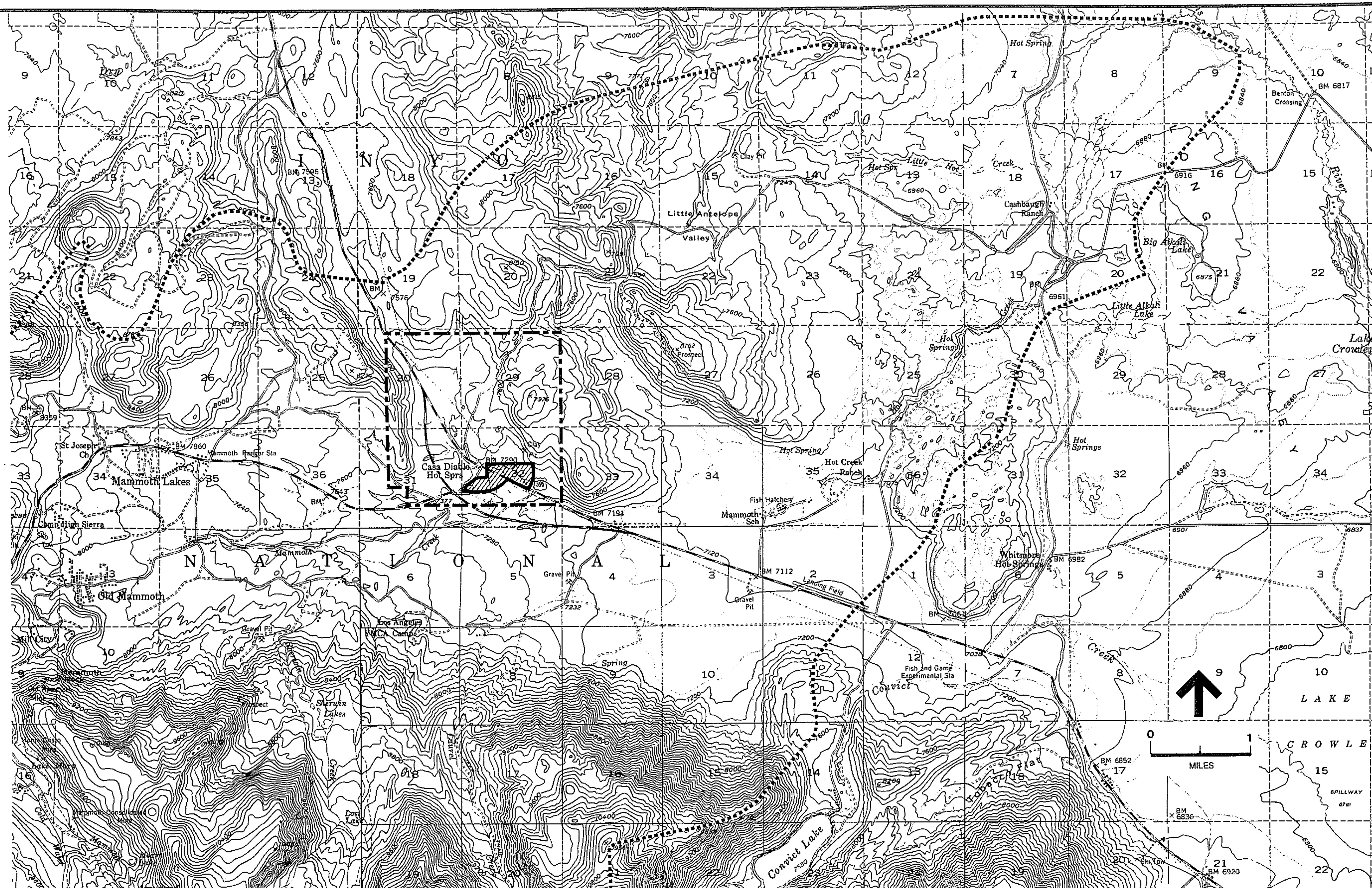
Potential impacts to the thermal features are a major issue. Thermal water contributes to flows at several springs in the Casa Diablo/Hot Creek area including those at Hot Creek Gorge, a geological interpretive area, and those springs supplying Hot Creek Hatchery operated by Fish and Game. Hot Creek Gorge and Hot Creek Hatchery are important to the recreation-based economy of the region, in addition to their intrinsic value. Fish and Game has also raised the issue of snails and other aquatic invertebrates which may live in thermal springs and how they might be affected if the thermal contribution were changed. Issues regarding potential adverse impacts to thermal springs are discussed along with the related issue of the potential for geothermal reservoir pressure and temperature change.

1.4.1.2 Surface Water Contamination

Another major issue is the potential for spills or erosion from the project site which could cause damage to the Mammoth/Hot Creek fishery. Hot Creek is a nationally-known, catch-and-release, trophy trout stream and its protection is very important. This includes protection of the invertebrates and stream vegetation which provide food and shelter for the fish. The concern is that thermal and/or chemical degradation of the stream could result from accidental spills of geothermal fluids.

1.4.1.3 Hydrologic Monitoring

Issues were raised concerning specific monitoring methods; determination of critical reservoir



Proposed Project Site

Project Area

Project Vicinity

Note: The Project Vicinity extends to the Sierra Crest in the southwest.

FIGURE 1-1
PLES I, Project Vicinity,
Lease CA-11667, and Project Site

parameters triggering remedial action; and the feasibility, potential effectiveness, and environmental consequences of proposed mitigation measures.

1.4.1.4 Visual Resources

Visual quality is highly valued in the region. People have expressed concern that the presence of an additional geothermal power plant would be visually intrusive and would have a detrimental effect on visitors and residents.

1.4.1.5 Mule Deer

Mule deer are abundant in Mono County and there is concern that development along the eastern side of the Sierra Nevada may jeopardize habitats and routes of migration crucial to the continued vitality of local deer herds.

1.4.1.6 Cumulative Impacts

Cumulative impacts are effects on the resources of an area or region caused by the combination of existing developments and uses along with proposed and reasonably foreseeable development. The major issues for the cumulative impacts analysis are the same as those described above for the project impacts analysis. The cumulative analysis in the EIS generally assesses impacts based on the development scenario described in Appendix F and discusses the relative contribution of the proposed project to the total cumulative impact.

1.4.2 ISSUES CONSIDERED BUT NOT FURTHER DISCUSSED

Extensive geothermal power generation occurs at the Geysers, a KGRA located largely in Sonoma and Lake Counties in northern California. During review of the Joint Draft EA/EIR, a number of commentors suggested that environmental impacts at the Geysers should be used to evaluate potential impacts on the project area. There are two major reasons the Geysers experience is not particularly relevant: topography and air cooling of the working fluid. Siltation of salmonid spawning gravels and decreased food production in the form of benthic invertebrates are of particular concern at the Geysers. The steep slopes characteristic of the area are susceptible to erosion and landsliding and spills travel rapidly on the steep slopes. In addition, a great deal of earth moving, especially cut-and-fill is required by the topography of the

Geysers in order to construct drill pads, access roads, and power plant sites. In contrast, the topography of Casa Diablo is gently sloping with very little cut-and-fill needed. Also significantly, the depth of the wells at the Geysers requires drill pads much larger than is needed for the shallow wells at Casa Diablo and the power plants at the Geysers are much larger than that proposed at Casa Diablo. The amount of surface disturbance at the Geysers is therefore many orders of magnitude larger than at Casa Diablo and is not realistically comparable. This impact would be much less severe at Casa Diablo because the topography is gently sloping and there are fewer perennial streams to be affected.

Spills at the Geysers have been primarily geothermal steam condensate from cooling towers and chemicals being transported to the plant sites. Condensate spills accounted for 82% of the spills from 1974 to 1984. About 2% of the spills were materials used for H_2S abatement and in the treatment of condensate (Warner et al., 1986). Therefore, over 80% of the spills are related to water cooling. At PLES I the geothermal fluid would be circulated in a closed system and the working fluid would be air cooled, so there would be no condensate nor would treatment of it be necessary.

1.5 RELATIONSHIP TO FEDERAL AND LOCAL PLANS, POLICIES, AND PROGRAMS

1.5.1 BLM

The BLM is the agency responsible for management of geothermal resources on federal geothermal leases and enforcement of the provisions of the Geothermal Steam Act of 1970, 43 CFR 3200 regulations, and associated operational orders. The BLM is the designated federal lead agency under NEPA for preparation of this EIS. In addition, the BLM has a Mineral Resources Policy which reflects the provisions of the Mining and Mineral Policies Act of 1970, the Federal Land Policy and Management Act of 1976, and the National Materials and Minerals Policy, Research and Development Act of 1980. The BLM, under these laws, is responsible for making public lands available for and encouraging orderly and efficient development of energy resources under principles of environmental protection and multiple-use management. BLM policies must be consistent with Forest Service, state, and local plans. The proposed project is consistent with federal law, regulation, planning, and policy.

1.5.2 INYO NATIONAL FOREST

The Land and Resource Management Plan establishes policies and management direction in determining the appropriateness of geothermal energy development on lands under Forest Service jurisdiction. In evaluating applications for geothermal development, the Forest Service participates jointly with the BLM in an environmental analysis to estimate the impacts of geothermal activity and recommends mitigation measures to minimize those impacts.

Lease CA-11667 is located in two Management Areas: #7, the Upper Owens River and #9, Mammoth. Direction for managing these areas is incorporated in Forest-wide Standards and Guidelines, Management Prescriptions and Management Area direction. The Forest-wide Standards and Guidelines for management of the geothermal resource state:

- Provide for the leasing of National Forest lands for exploration and development of oil, gas and geothermal resources commensurate with other resource values. Follow existing Memoranda of Understanding between the Bureau of Land Management and the Forest Service that relate to oil, gas, and geothermal mineral activities. Follow applicable regulations, operating orders, and notices for oil, gas, and geothermal leases issued pursuant to appropriate authority.

- Prepare environmental documents that analyze full-scale development prior to consenting to Bureau of Land Management's issuance of geothermal leases.

- Prepare postlease environmental documents in cooperation with the Bureau of Land Management for site-specific exploration, development, and production proposals. Assure that impacts to resources are appropriately analyzed. Assure that impacts to resources are mitigated to the extent possible.

- Consider the location of fluid conveyance lines and facilities for geothermal development to ensure the viability of deer migration corridors. Encourage geothermal development that utilizes air cooling rather than evaporative cooling systems.

1.5.3 MONO COUNTY

The Mono County General Plan includes a Geothermal Element which was adopted in 1982 and a supporting EIR. The Geothermal Element was prepared by the Inyo-Mono Association of Governmental Entities (IMAGE), the regional planning agency for the Inyo and Mono Counties and the City of Bishop. Currently, adopted County policy in the Geothermal Element encourages geothermal development.

The county does not have jurisdiction over development on federal lands. However, they may recommend reasonable environmental constraints. The county approved construction of a seven MWe binary power plant in 1982. Due to the visual, noise, air quality, and potential hydrological and biological impacts of this initial geothermal power plant, and changes in the political climate, Mono County is reconsidering its policies on geothermal development. The county is preparing a new Energy Element of the General Plan which would include new policies on geothermal resources. The intent of the new Energy Element is to adopt energy policies consistent with other county policies. The Administrative Draft Energy Element is currently under review by the county.

1.5.4 TOWN OF MAMMOTH LAKES

The Town of Mammoth Lakes General Plan established a planning area boundary beyond the town limits, pursuant to Government Code Section 65300. The planning area includes areas where existing or proposed facilities have a direct relationship to the current town boundaries. The eastern boundary of the planning area lies between Highway 395 and Crowley Lake. The PLES I Project site itself is adjacent to and directly east of the town's planning area boundary. The town's General Plan (Mammoth Lakes, Town of, 1987) states that cooperative planning in this extraterritorial planning area will help establish consistency in development standards, promote orderly and efficient extension and expansion of community facilities and services, and will clearly identify the town's continued interests and involvement in the area. According to this policy, the town desires to be consulted and pursue cooperative planning in developing lands within the extraterritorial planning area, which includes the PLES I site. The Town of Mammoth Lakes has participated in Forest Service planning and environmental review. The town does not have jurisdiction over actions within its extraterritorial planning area. However, the goals, policies and actions of the General Plan state the policies the town would use in reviewing development outside the town boundary but within the planning area. The town will use General Plan goals and policies on land use, open space, scenic, flood hazard and noise, as well as plans on adjacent land within the town limits, to evaluate the PLES I Project. Directly adjacent to the west of the PLES I site is the area called Urban Planning District 10 - Gateway, which means it is the gateway or entry to the Town of Mammoth Lakes and is the town's eastern boundary. Land uses within Gateway are designated for general open space and Open Space / Institutional / Public Facilities. Maintaining scenic views is a priority in this area.

Two other Urban Planning Districts area located outside town limits but within the planning area. The town has made plans for these districts as a statement of town policy. About three miles southwest of the proposed site is the proposed Sherwin Bowl Ski Area, which is located within Urban Planning District 14. Sherwin Bowl, which is subject to approval by the Forest Service, is proposed to accommodate 8,000 skiers-at-one-time. In addition to downhill ski facilities, nordic and snow play areas are also proposed. The town has designated the area for open space, which allows active and passive recreation development and supports commercial uses. A Draft EIS is currently being circulated for public review. San Joaquin Ridge Planning District 17, about five miles northwest of the proposed site, is designated for open space and allows recreation activities.

1.6 AUTHORIZING ACTIONS

Discretionary approvals and permits from several agencies would be required for the project. These are summarized in Table 1-1. This EIS/SEIR has been prepared under NEPA Guidelines in response to BLM and Forest Service requirements and under CEQA Guidelines in response to California requirements. The original EA for the project also served as the EIR (SCH #86122913), with the Great Basin Unified APCD serving as Lead Agency for CEQA. The EIR was certified on May 24, 1988.

1.7 ENVIRONMENTAL COMPLIANCE MONITORING

Recently enacted California legislation requires that a monitoring or reporting program be developed to ensure that mitigation measures to reduce the significant or potentially significant impacts are carried out. No significant impacts have been identified for the PLES I Project, in large measure due to the inclusion as part of the project of a number of features which serve to reduce project impacts to insignificance. Although one could argue, therefore, that California would not require monitoring in this case, the authorized officer in carrying out his duties would function as the environmental compliance monitor in verifying that the features of the project included to reduce impacts are carried out.

TABLE 1-1: PERMITS AND APPROVALS

Agency	Permit/Approval	Facility
Great Basin Unified APCD	Authority to Construct	Power plant; all wells
	Permits to Operate	Power plant; all wells
California RWQCB, Lahontan Region	Waste Discharge Orders	Power plant; all wells
Bureau of Land Management	Plan of Exploration	Exploration wells, roads, drill pads
	Plan of Development	Production wells, roads, drill pads
	Plan of Injection	Injection wells, roads, drill pads
	Plan of Baseline Data Collection	Facilities necessary for the collection of baseline data
	Plan of Utilization	Power plant, pipelines, power lines
	Plan for Production	Production procedures and monitoring for royalty assessment

SOURCE: Thomas, T., 1987.

2.0 PROPOSED ACTION AND ALTERNATIVES

This chapter describes alternatives which are analyzed and those which were considered but dismissed. The proposed project site was the alternative site analyzed in the PLES I Joint EIR/EA and is presented as the proposed project in this EIS/SEIR a result of the earlier analysis. The alternative location for the power plant was chosen in order to fully mitigate the visual impacts from Highway 395 associated with the proposed power plant. The smaller power plant alternative was selected by removing one of the three proposed generators. The no-action alternative is required by NEPA regulations.

Two alternatives which are not being analyzed in this EIS/SEIR are the power plant located adjacent to MP I, which was originally proposed in September 1986, and a solar-powered electricity facility located outside Long Valley Caldera.

The PLES I Joint EA/EIR analyzed a project which would have been located immediately adjacent to the existing MP I power plant and within the PLES I production field. The BLM and Forest Service selected an alternative which is the same as the proposed project in this EIS/SEIR. The analysis in the Joint EA/EIR clearly identified the originally proposed site as having greater impacts to visual resources with few concomitant benefits. It has been dropped in favor of the currently proposed project.

In the public scoping meeting for the EIS/SEIR, it was suggested that the alternative of using solar generated electricity "from somewhere else in SCE's service area" be analyzed. This alternative is not being considered in this analysis because the basic action under consideration by the BLM is not the generic generation of electrical energy, but the appropriate development of the federal geothermal lease. The federal geothermal lessee has been granted the exclusive rights to explore, develop, and produce geothermal resources from this lease and has an obligation under the terms of the lease to diligently pursue production of these geothermal resources under approval which must be obtained from the BLM. The BLM must evaluate and consider the environmental consequences of any proposal and may determine not to approve a proposed action because of its environmental consequences, but any alternative which does not consider the development of the geothermal lease becomes functionally equivalent to the no-action alternative.

In summary, the four alternatives selected for analysis are:

- the proposed project, a 10 MWe (net) binary power plant and supporting well field;
- the alternate power plant location, a 10 MWe (net) binary power plant sited in a different part of the lease using the same well field;
- the smaller power plant, a seven MWe (net) binary power plant on the site of the proposed project; and
- the no-action alternative.

A summary comparison of their general characteristics is shown in Table 2-1. The BLM in cooperation with the Forest Service has identified the proposed project as the preferred alternative.

TABLE 2-1: SUMMARY COMPARISON OF ALTERNATIVES/a/

	Proposed Project	Alternate Location	Smaller Alternative
Power Output (net) MWe	10	10	7
Power Plan Footprint (acres)	5.1	5.6	4.5
Generators (#)	3	3	2
Heat Exchangers (#)	9	9	6
Air Coolers (#)	40	42 to 44	30
Production Wells (#)	4	4 or 5	3
Production (gpm)	5,000	6,000	3,800
Length of Gathering Pipeline (feet)	2,600	4,200	2,400/c/
Length of Injection Pipeline (feet)	1,700	4,500	1,500/d/
Disturbed Area (acres)	13/b/	15	12

/a/ The no-action alternative would have none of the components listed above.
/b/ Taken from information provided to the BLM by Pacific Energy.
/c/ Assumes production well SF 35A-32 is not drilled.
/d/ Assumes injection well SFI 54A-32 is not drilled.

SOURCE: Pacific Energy and Environmental Science Associates, Inc.

2.1 PROPOSED ACTION

The project area is within the Long Valley KGRA, immediately adjacent to the existing seven MWe (net) Mammoth-Pacific I geothermal resource electric generating facility (MP I). There are no other existing geothermal projects in the project vicinity.

Pacific Energy proposes to construct and operate a 10 MWe (net) binary power plant and geothermal wellfield development project (PLES I Project) on federal geothermal lease CA-11667./1/ The project area is located approximately three miles east of the Town of Mammoth Lakes, Mono County, California (Section 32, T.3S., R.28E., MDB&M) and is within the Long Valley East Geothermal Unit on land administered by the Inyo National Forest (Figure 2-1).

The proposed project would include: the drilling, construction, and operation of geothermal production and injection wellfields; the construction and operation of the related production pipeline gathering system; injection pipeline distribution system and the construction and operation of a 10 MWe (net) binary power plant facility; and construction of control facilities.

Geothermal fluid, produced from up to four geothermal production wells located in the vicinity of Casa Diablo Hot Springs, would be directed by surface pipelines to the proposed binary power plant facility (Figure 2-1). After heat extraction, the cooled geothermal fluid would be directed from the power plant by surface pipeline to up to four geothermal injection wells and injected into the subsurface injection reservoir. Approximately 13 acres would be disturbed in the development and operation of the proposed project.

Electrical energy produced by the utilization facility would be directed to on-site transformers. There it would be converted to the appropriate line voltage and delivered to the existing SCE Casa Diablo Substation, located approximately one-quarter mile northwest of the proposed power plant site. Power transmission lines would be mounted on <u>sleepers</u> supporting the production pipeline.

/1/ The net power output is the gross power output of the plant minus the so-called "parasitic" uses within the facility, such as power used for pumping geothermal fluid to and from the wells. The gross power output is highly dependent on ambient temperature because the working fluid is air cooled. On cold days power output is much higher than on hot days, Therefore, the contractual obligation to supply 10 MWe of power year-round would require construction of a plant with gross capacity of about 15 MWe to compensate for parasitic uses and the lower summertime efficiency.

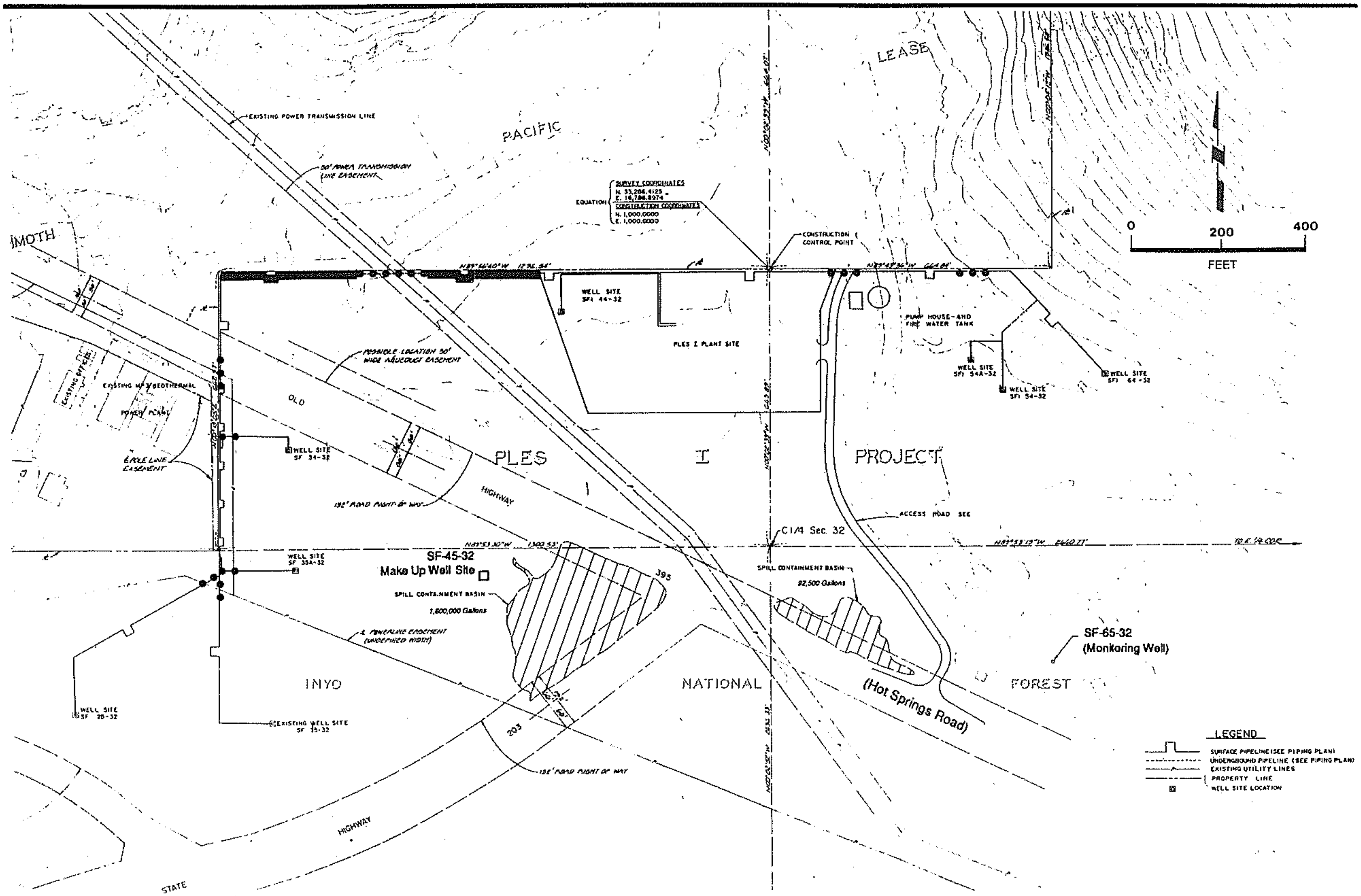


FIGURE 2-1
Proposed Project Site Plan

SOURCE: Pacific Energy

2.1.1 MEASURES INCORPORATED AS A RESULT OF PREVIOUS PROJECT APPROVAL

The project applicant has incorporated as part of the project description, all of the stipulations of the previous BLM Decision Record on the PLES I Project, dated February 11, 1988. To the degree possible, these stipulations are consistent with conditions drafted by Mono County for the proposed Mammoth Pacific II and III Projects. These stipulations are reproduced below:

1. Permanent structures shall be less than 32 feet in height as measured from final grade.
2. All facilities shall be designed to avoid areas of potential slope instability, ground rupture and withstand reasonable seismic accelerations and offsets. An engineering/geotechnical analysis may be required to identify potential hazards.
3. The power plant site, well pads, pipelines, and access roads, will avoid mature trees whenever possible.
4. Pipelines:
   a) Pipelines shall be sited as far north and west as practical to maximize screening by natural vegetation and terrain.
   b) Pipelines shall be built as close to the ground as possible.
   c) The authorized officer may require burial (covering) or screening of segments of the pipeline as appropriate.
5. Roads:
   a) Construct and maintain all roads to USFS Standards. Standards such as width, cut/fill slope design, and surfacing requirements will be addressed on a case by case basis.
   b) No road construction will be permitted for pipeline construction.
6. Fire and Safety
   a) Construct all hydrocarbon storage and utilization facilities in conformance with applicable industry standards and in compliance with applicable fire and safety codes.
   b) Keep potential ignition sources away from the hydrocarbon accumulator and storage tanks areas, the power plant site drainage courses, and the catchment basin.
   c) Post "no smoking" and "flammable liquid" signs in all areas except areas specifically designated as smoking areas.

d) Prepare and review emergency fire and spill contingency plans with local fire fighting authorities.

7. No offroad vehicle or equipment travel will be permitted outside of approved construction areas and access routes.

8. To the extent possible, construction traffic should be routed to avoid the route 203/395 interchange on weekends during the winter ski season.

9. Electrical transmission lines will be screened from view from the south and west.

10. Should a vapor cloud be generated during flow testing which could cause hazardous driving conditions, the authorized officer will limit flow testing until weather conditions improve.

11. Maximize cut and minimize fill in leveling the plant site to reduce the overall height of the power plant facilities.

12. Approval for noise intensive activities may be limited from April 15 through June 15 and October 15 through November 1 of each year (during deer migration).

13. Fencing of areas or facilities will require approval by the authorized officer.

14. Water and erosion control measures will be required for all surface disturbance in conformance with USFS Best Management Practices.

15. Should operation under this plan cause significant fish kills, as determined by the authorized officer, the operator will restock the affected fishery(s).

16. To the extent compatible with engineering considerations, all exterior surfaces shall be of rough texture, with no reflective metal or glass surfaces oriented toward the south or west.

17. All permanent facilities shall be neutral earth-tone colors approved by the authorized officer.

18. Exterior structural lighting shall be minimized and shielded from view from the south and west. Work lights should be equipped with switches or timers to minimize continuous use.

19. Emergency shutdown systems will be designed to prevent large spills of geothermal or secondary working fluids. A testing/maintenance/inspection schedule will be established prior to production. The shutdown system and the testing/maintenance schedule will be developed in accordance with GRO #6.

20. Construct and maintain a one (1) foot minimum berm within the power plant site capable of containing a geothermal spill. The bermed area shall drain to a catchment basin which must be capable of containing a spill of at least 25,000 gallons. The catchment basin size must take into consideration lost capacity resulting from the collection of rain water or snow melt. The basin overflow structure will be designed to minimize erosion.

21. The authorized officer shall be notified immediately in the event of a blowout, or spill or discharge of any significance. Containment and/or cleanup will be determined on a case by case basis.

22. Develop a hydrogen sulfide (H_2S) emergency contingency plan for well drilling and testing operations. The plan will include detection monitoring, training, and emergency response actions for reacting to unsafe concentrations of H_2S.

23. The following mitigation process will be used to mitigate potential hydrothermal impacts on the Owens tui chub and may be modified as appropriate to mitigate impacts to Hot Creek Fish Hatchery and Hot Creek Gorge springs:

    a) The operator shall be responsible for reporting to the authorized officer the monitoring measurements required to be collected by the Plan for Baseline Data Collection (PBDC) approved for the project, or any other monitoring data which may be required by the authorized officer. The approved PBDC will incorporate the monitoring program recommended for the project by the Long Valley Hydrologic Advisory Committee (LVHAC) dated October 1987, as corrected, and shall require monitoring information be collected and reported for the C-D Hot Creek headsprings comparable to that recommended by the LVHAC for the A-B Hot Creek headsprings which is Critical Habitat for the endangered Owens tui chub.

    b) The authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, will evaluate the monitoring data and consult with the U.S. Geological Survey, the California Division of Oil and Gas, the County of Mono, and the U.S. Fish and Wildlife Service, if appropriate (the "consulting agencies"), regarding the analysis of the data and the development of mitigating measures as indicated appropriate by the conclusions of the analysis of the data.

    c) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, determines a need to supplement monitoring information developed from existing Monitoring Well 65-32, a second monitoring well may be required to be drilled, maintained, and monitored in conformance with the requirements of Stipulation 23(a) (above). The well shall generally be located in the area of Colton Springs, with the specific location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction. The authorized officer may also require mitigation actions in addition to the second monitoring well including, but not limited to, one or more of the following actions:

        (1) Temporarily modify the production or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one or more of the following:

            (i) Change fluid volumes or pressures in one (1) or more wells;

            (ii) Discontinue use of one (1) or more production or injection wells; or

            (iii) Relocate one (1) or more production or injection wells.

        (2) Permanently modify the production/injection program.

    d) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, determines that monitoring information from the second monitoring well (located near Colton springs) and all other monitoring information indicated a need for further information with respect to a threat posed by plant operations to beneficial uses of thermal water, or to the continued existence of the Owens tui chub, the Authorized Officer may require that a third monitoring well be drilled, maintained, and monitored in conformance with the requirements of Stipulation (a) (above). The well shall generally be located in the area between Colton springs and the Hot Creek headsprings, with the specific location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction.

e) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, determines that monitoring information from the second monitoring well (located near Colton Springs) and all other monitoring information indicate that plant operations may threaten an unacceptable impact to other current beneficial uses of thermal water, or threaten a reduction in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including but not limited to, those listed in paragraphs c(1) and c(2), above, shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

f) After monitoring the third monitoring well (located in the area between Colton Springs and Hot Creek headsprings) should the authorized officer determine that plant operations threaten an unacceptable impact or are resulting in an unacceptable impact to beneficial uses of thermal water, or threaten a reduction or are resulting in a reduction in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including, but not limited to, those listed in subparagraphs (a) through (d) below shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

(1) Temporarily modify the production or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one of more of the following:

(i) Change fluid volumes or pressures in one (1) or more wells;

(ii) Discontinue use of one (1) or more production or injection wells; or

(iii) Relocate one (1) or more production or injection wells.

(2) Permanently modify the production/injection program.

(3) Provide an alternative source of thermal water to the affected Hot Creek headspring(s). Such thermal water shall be conveyed to the Hot Creek headspring(s) in a manner that does not facilitate the introduction of other fishes into the headsprings.

(4) Reduce or discontinue power production.

g) If monitoring activities of the three monitoring wells described above indicate a progressive temperature decline is occurring that threatens a change of temperature at the Hot Creek headsprings, A-B or C-D, or threatens the continued existence of the Owens tui chub, the operator shall, at a minimum, implement the mitigation action described in Stipulation f(3) above.

h) The Operator shall be responsible for maintaining the thermal water conveyance facilities described in Stipulation f(3) above for as long as an alternate source of thermal water is needed to maintain water temperatures in the affected Hot Creek headsprings at levels existing prior to the onset of impacts from plant operations.

i) The Operator shall establish a funding mechanism to ensure that the mitigation actions described in Stipulations (a) through (i) above, will be implemented in a timely manner. Such funding mechanism shall be provided either directly through the provision of materials and services needed to satisfy the monitoring and alternate thermal water supply requirements described above, or indirectly, through insurance, performance bond, dedicating project revenues to a special escrow account or other mechanism acceptable to the Authorized Officer. The funding mechanism shall be developed by the Operator in consultation with the Authorized Officer and the U.S. Fish and Wildlife Service, and agreed to by the Authorized Officer in cooperation with the U.S. Fish and Wildlife Service, prior to the commencement of geothermal production by the Operator.

24. Reclamation:

a) Topsoil from all areas of surface disturbance shall be stockpiled for use in revegetation. The authorized officer may require stabilization of stockpiles using the revegetation plan described below.

b) Reclaim all disturbed areas not required for ongoing activities or operations as soon as practical. Revegetation should be completed by the fifteenth of October of the year the area was disturbed.

c) All disturbed areas shall be recontoured to blend with the surrounding topography. Compacted soils shall be scarified.

d) Spread topsoil evenly over the recontoured area.

e) All areas targeted for revegetation shall be broadcast seeded and mulched with the following seed types and amounts:

Seed type	Amount/acre
Big sagebrush	5 lbs
Antelope bitterbrush	5 lbs
Indian rice grass	10 lbs
Pubescent wheat grass	10 lbs

The revegetated areas shall be fertilized with 16-20-0 ammonium sulfate at the rate of 350 pounds per acre. Seed and fertilizer shall be hand raked into the soil.

Cover the seeded area with brush and rocks or a 2 ton/acre straw mulch.

f) The planting and protection of Jeffrey pine seedlings will be required in locations to be determined by the authorized officer.

g) Revegetation success will be evaluated two years after planting. Replacement plantings or seedings may be required.

h) Irrigation of revegetated areas may be required.

25. An accidential spill containment structure will be constructed at the two culverts near the Highway 203/Hot Springs Road junction. The shutoff gates used to control flow through the culverts will be automatically operated and have a manual override. Design specifications will be submitted for approval via sundry notice or with the utilization permit application (see Appendix A).

26. A quality control officer will be designated by Pacific Energy. This person will have a detailed knowledge of all operational constraints addressed in the plan and all stipulations. This person will be on site during all construction and drilling activities to assure that subcontractors comply with operational constraints. This person will be the primary contact between Pacific Energy and the BLM.

27. A final project reclamation plan shall be submitted to the authorized officer for approval within two (2) years of overall project approval. The reclamation plan will provide details concerning methods and timing of facilities shutdown, removal, and reclamation activities not covered by the reclamation plan included in Stipulation 24 above.

Because these measures have now become part of the project, they are not considered "mitigation measures" in the EIS/SEIR, even though they substantially mitigate the potential environmental impacts of the project. Only those additional measures identified through this analysis are listed in Chapter 4 under "Mitigation." The measures would also apply to the alternative site.

2.1.2 PRODUCTION WELLFIELD AND GATHERING SYSTEM

A total of four production well locations have been identified for the proposed action and are shown on Figure 2-1 as Well Nos. SF 25-32, SF 34-32, SF 35-32, and SF 35A-32. A fifth production well site, SF 45-32, is not currently proposed but would be available as a make-up well or additional production well for the alternative site action (see Section 2.2). Three well sites (SF 25-32 not drilled, SF 35-32 already completed, and SF 45-32 not drilled) were previously proposed in Pacific Energy's Plan of Exploration. The impacts of this plan were analyzed in Environmental Assessment CA-017-86-53, and the plan was approved by the BLM on July 2, 1986. The fluid requirement for the proposed project would be approximately 5,000 gallons per minute (gpm) of 330°F geothermal fluid. The total surface disturbance required to drill the four production well sites is approximately 3.5 acres. Fewer wells may be required depending upon drilling and flow test results.

2.1.2.1 Production Well Drilling and Testing Description

At each approved drilling site, a drill pad approximately 150 feet x 200 feet would be built along with an access road, a 50,000± gallon reserve pit, and on-site sediment collection basins. The reserve pit would be lined with a 40-mil plastic liner and used for the containment and temporary storage of waste drilling mud and fluids. A typical drilling pad and equipment layout is shown in Figure 2-2. Final equipment placement will depend upon site-specific topographic and environmental considerations and the actual drilling equipment utilized.

A drill rig would then move on-site and commence drilling operations. Production wells are each scheduled to be drilled in about 12 days of drilling time. The drilling rig would also be required to remain on the hole for at least one day for well clean-up and an initial short-term flow testing (approximately two to four hours) into on-site tanks. The drilling rig would be moved from the well site following the short-term flow test.

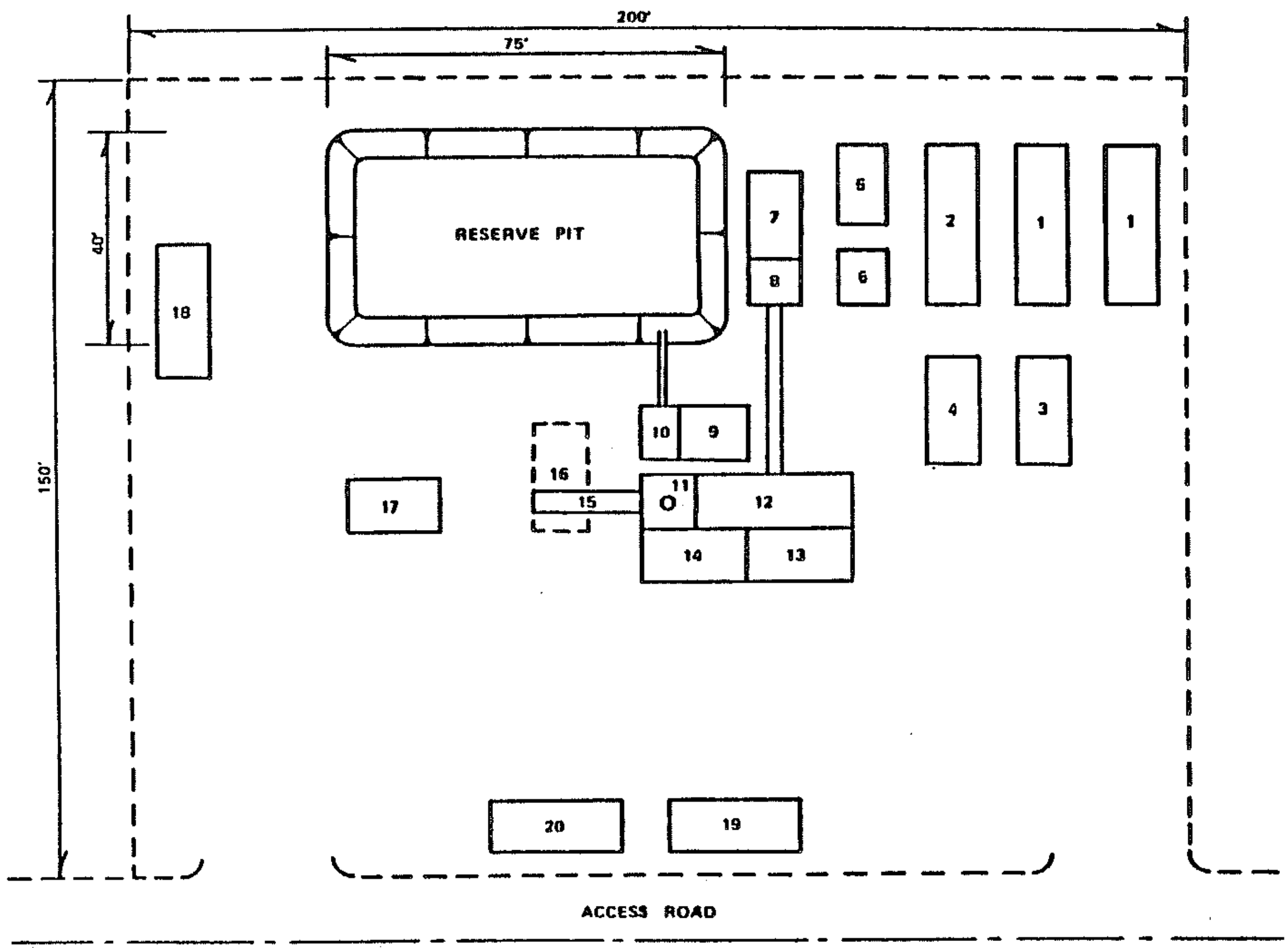
The production wells are each designed to reach a total depth of 700 feet and would be completed in the fractured rhyolite geothermal reservoir. The proposed well casing program consists of 30-inch conductor cemented to 10 feet, 22-inch conductor casing cemented to 80 feet, 16-inch surface casing cemented to 350 feet, and completed with a 13-3/8-inch partially slotted production liner from 350 to 700 feet. All mud used during the drilling of each well would consist of a 8.6 to 9.0 pound-per-gallon weight gel. No hazardous or toxic mud additives are proposed to be used. A typical production well completion drawing is shown in Figure 2-3.

A long-term flow test (two to four days) of each new production well may then be conducted to more accurately determine well productivity. The long-term test would consist of pumping the geothermal fluids from the well through on-site test equipment closed to the atmosphere, and then through a surface booster pump and a temporary pipeline to the MP I power plant. The on-site test equipment would include standard flow metering, recording, and sampling apparatus. Produced fluid would be directed through the existing plant's heat exchangers and injected with the rest of the plant's cooled geothermal fluid into the injection reservoir. All surface test equipment and temporary pipeline would then be removed.

Fewer than five production wells may be required, depending upon drilling and flow test results. If any well drilled as a production well lacks commercial potential, (1) a workover and/or deepening of the well may be conducted in an attempt to make the well commercially productive, (2) the well may be converted to an observation or injection well, or (3) the well may be plugged and abandoned in conformance with applicable federal requirements.

2.1.2.2 Production Wellhead and Downhole Facilities

Each well would be pumped using a deep well, 13-stage, non-toxic, oil-lubricated, centrifugal lineshaft turbine pump driven by a vertical electric motor located on top of the well. An electric



1. Air Compressors
2. Mud Tank
3. Fuel Tank
4. Water Tank
5. Mud Storage
6. Generator
7. Change House
8. Accumulator
9. Mud Pit
10. Shale Shaker
11. Rig Floor
12. Draw Works
13. Storage
14. Dog House
15. Catwalk
16. Pipe Rack
17. Electric Logger
18. Mud Logger
19. Trailer House
20. Trailer Office

SOURCE: Pacific Energy

FIGURE 2-2
Typical Drilling Pad
and Equipment Layout

motor would be mounted on top of the pump discharge head. Wellhead dimensions are not expected to exceed a height of fifteen feet above the ground or four feet in diameter. A small control building (approximately 8 feet x 15 feet) would be located within approximately 50 feet of each well, and would house auxiliary systems, motor switch gear, controls and sensors, and transmitters for key temperature, pressure, and flow rate data. These data would be measured for purposes of process control, continuing resource data acquisition, safety, and environmental protection.

The production of hot geothermal fluid from each lineshaft turbine pump would be flow-rate controlled. Pressure limit sensors would also automatically shut down the pump in the event of an excessively high discharge pressure, which could damage the pump, or an excessively low discharge pressure, which might occur if a pipe ruptured. These and other automatic shutdowns would be equipped, as appropriate, with delays to avoid false shutdowns caused by momentary conditions, and would require overrides during startup.

2.1.2.3 Gathering System

The permanent gathering system for transporting hot geothermal fluid from the wells to the power plant would use insulated pipelines. The pipeline routes are depicted on Figure 2-1. The precise routing could vary slightly depending on final engineering and the design option selected. Pipelines, including insulation, would vary in diameter from 18 to 24 inches depending upon individual well productivities. Horizontal expansion loops (typically a square bend in the pipeline approximately 30 feet x 30 feet) would be constructed every 250 to 350 feet along the pipeline route. An estimated 2,600 feet of production pipeline would be required. The pipe would be buried or located near or below ground level on sleepers and would be colored to blend with the terrain. Selected sections of pipe would be placed below ground level in excavated trenches or buried (see Section 2.1.6.9). Downhole pumps in the production wells would deliver the geothermal fluid to the plant at about 200 pounds per square inch gauge (psig).

2.1.3 POWER PLANT

The proposed power plant would use hot geothermal fluids produced from the geothermal production wells described in Section 2.1.2 to generate electrical power. The power plant facility would be designed to produce a minimum of 10 MWe (net) of electricity. Generated electrical power would be transported from the power plant interconnection facility to SCE's Casa Diablo Substation, located approximately one-quarter mile northwest of the project site. Electrical transmission lines would be mounted along pipelines. The generated power would be

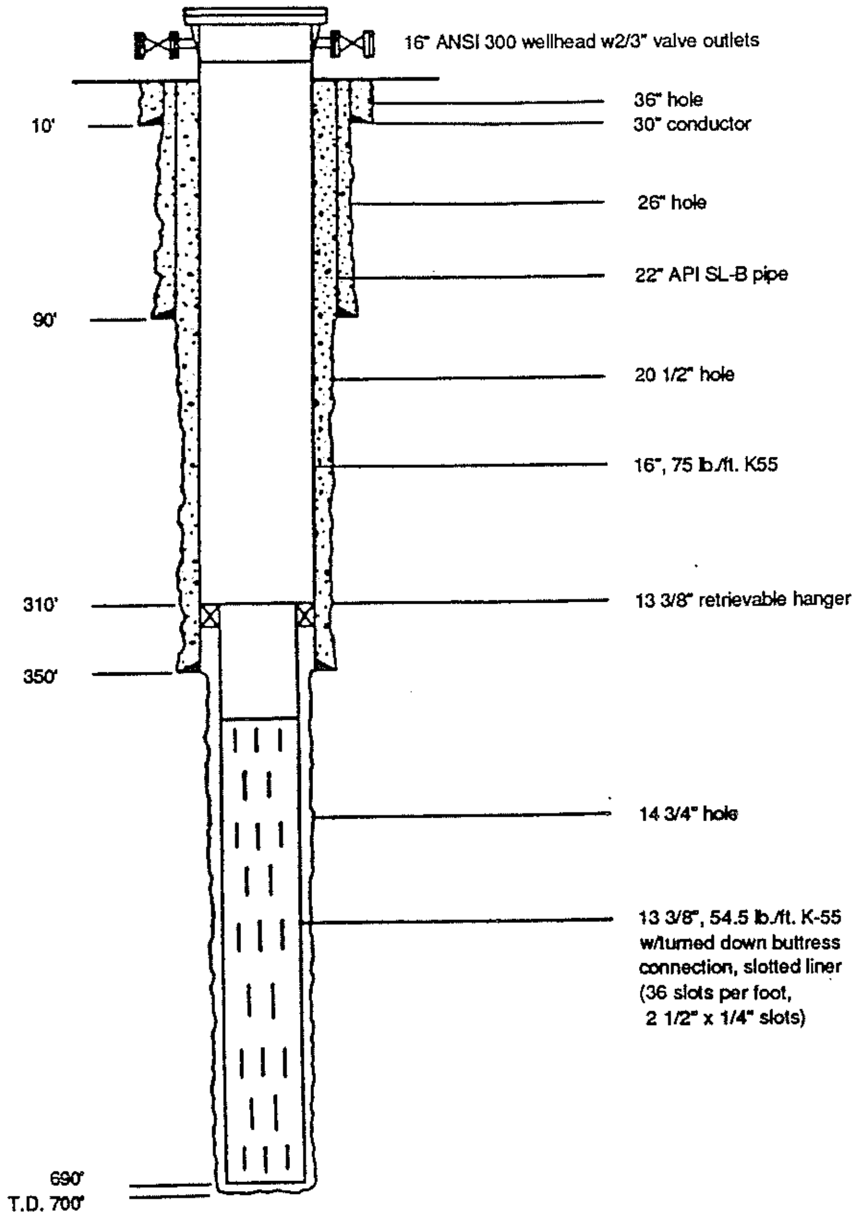


FIGURE 2-3
Typical Production Well
Completion Drawing

SOURCE: Pacific Energy

adjacent to the northwest corner of the project site and following Hot Springs Road to the SCE substation.

The power plant would utilize a closed-system binary process cycle to extract heat from the hot geothermal fluid pumped from the production wells. The geothermal fluid would not be flashed nor exposed to the atmosphere at any time during its utilization. After heat is extracted from the produced geothermal fluid in the facility heat exchangers, the cooled geothermal fluid would be transported from the power plant by a surface pipeline to the injection wellfield facilities (see Section 2.1.4).

The proposed locations of all significant surface development, utilization and injection facilities (collectively termed the project site) are identified in Figure 2-1, including: the production and injection well sites; power plant site; access roads; interconnecting pipelines; electric transmission line; and on-site electrical interconnection facility.

2.1.3.1 Radial Turbo-Expander Generator

Under the proposed engineering design, heat would be extracted from the geothermal fluid in shell-and-tube heat exchangers and transferred to isobutane, the hydrocarbon working fluid. The heated isobutane would be expanded through a turbo-expander generator system, converting the mechanical energy produced to electrical energy. Isobutane vapor from the turbine exhaust would be condensed in air-cooled condensers. The condensed isobutane would then be directed to a storage vessel (accumulator), from which the cooled and condensed isobutane would be pumped to start the closed-system binary cycle again. The principal power generation facilities would be constructed within an area approximately 320 feet wide by 690 feet long, as depicted on the Figure 2-4. The power plant site and adjacent facilities would be protected within a chain-link fence.

The major equipment requirements include shell-and-tube heat exchangers, three turbo-expander generators, air-cooled condensers, isobutane accumulator, isobutane storage vessel, isobutane circulating pump, geothermal fluid injection pump, air compressors, gas freeing compressor, lubricant coolers, firewater tank, utility building, transformers, and electrical switchgear house. Two banks of air-cooled condensers would be used, each approximately 308 feet long by 60 feet wide, with an overall height of approximately 30 feet. The use of air-cooled condensers would eliminate the need for consumptive water use during power plant operation.

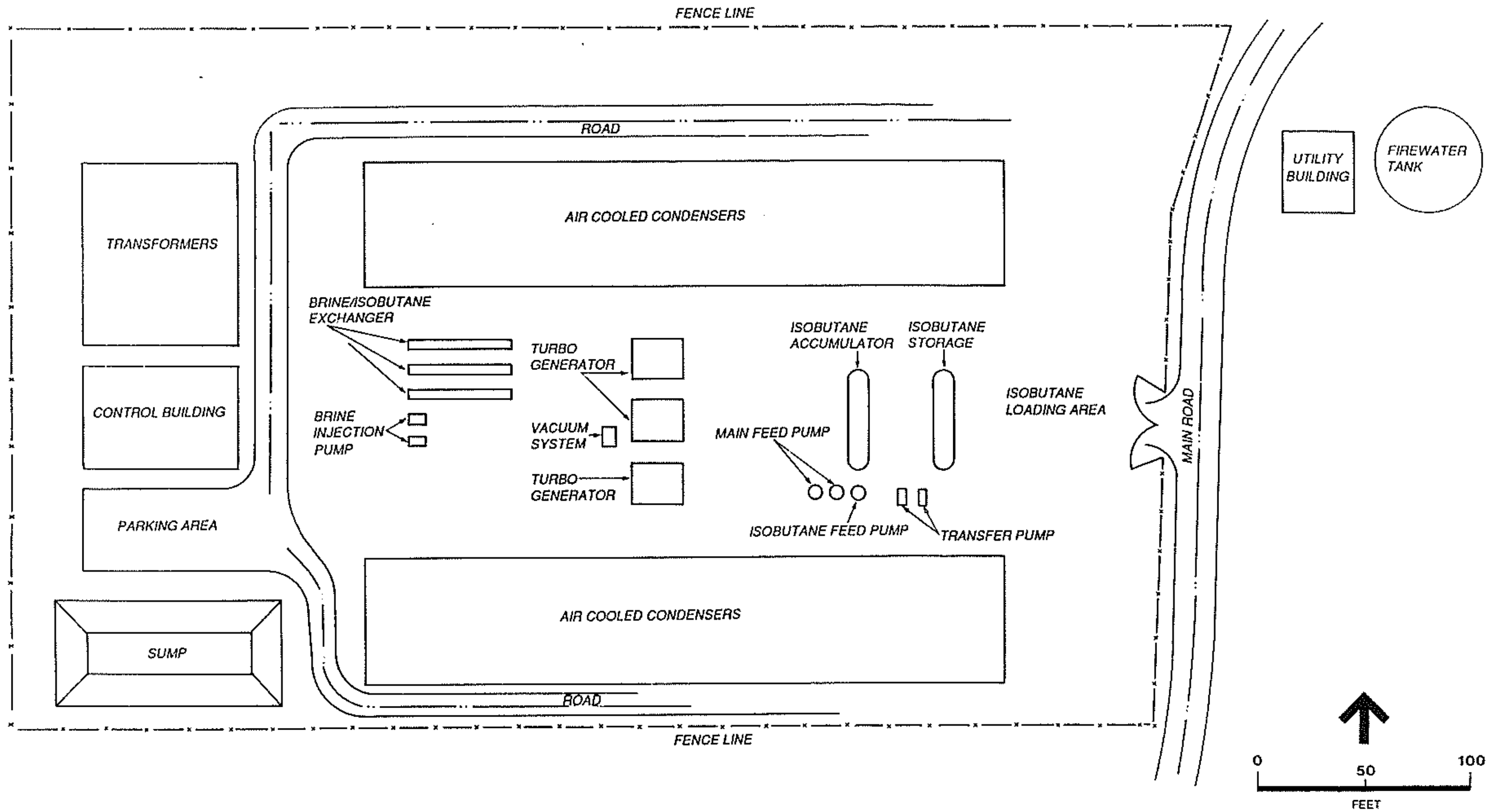


FIGURE 2-4
Power Plant Plot Plan

SOURCE: Pacific Energy

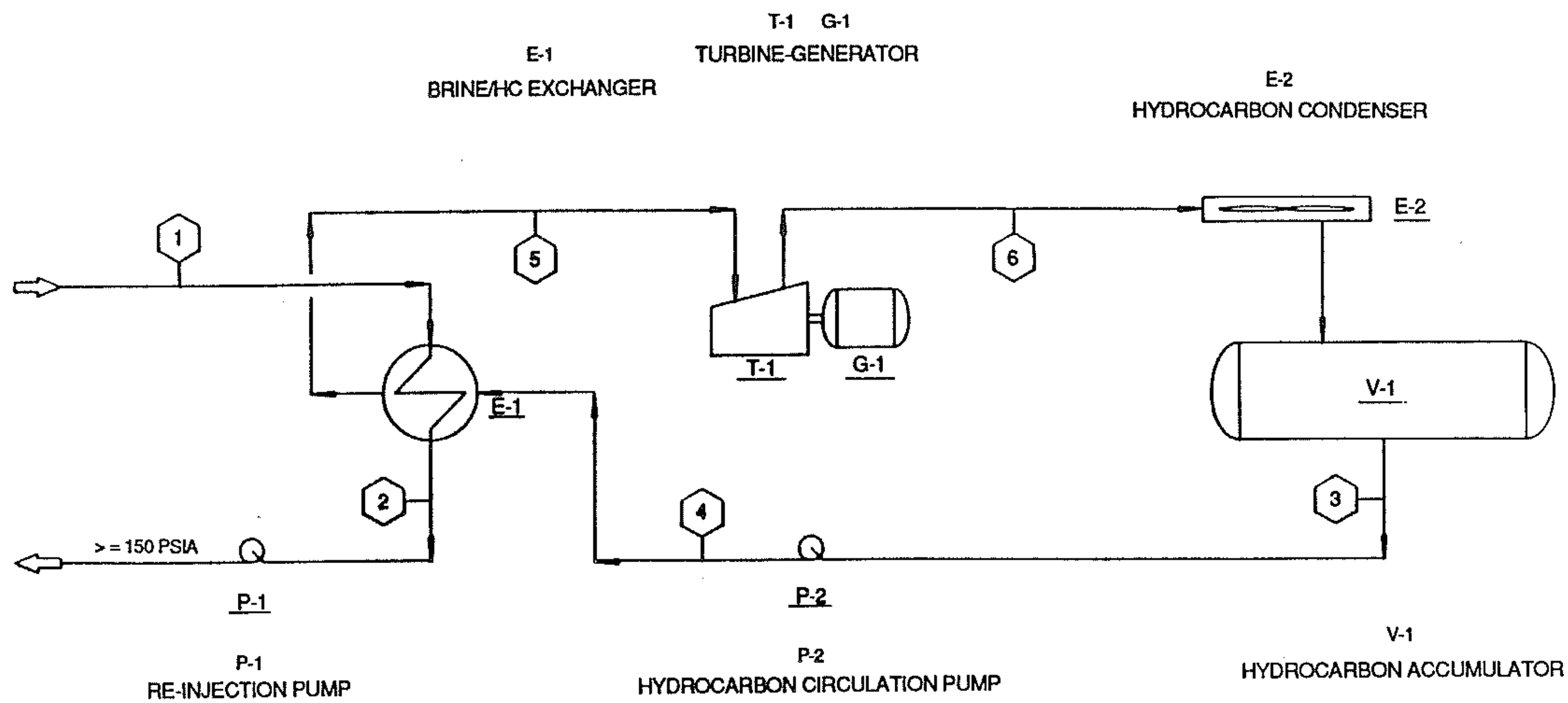
The proposed shell-and-tube heat exchangers would occupy a space approximately 50 feet long by twenty feet wide and twenty feet high. The isobutane accumulator and isobutane storage vessel are cylindrical vessels approximately 70 feet long and ten feet in diameter. The vessels would be placed on supports along their length and would rest about five feet off the ground, reaching a total height of approximately fifteen feet. The remaining major power plant components would not exceed a height of ten feet.

A process flow diagram depicting the mass flows of both the geothermal fluid and the isobutane working fluid through the binary power plant is provided as Figure 2-5. Approximately 5,000 gallons per minute of hot geothermal fluid would be pumped from the production wells through pipelines to the tube side of a shell-and-tube heat exchanger to heat the isobutane fluid. The cooled geothermal fluid would not be exposed to the atmosphere during the cycle but would be pumped directly to the injection wells for subsurface disposal. The apparent loss of geothermal fluid volume indicated on the mass flow diagram results from the cooling of the fluid through the facility and does not result from consumptive use. There would be no difference between the fluid mass produced and fluid mass injected.

2.1.3.2 Additional Power Plant Facilities

One building would be constructed which would serve as an office and control room (O/CR). The O/CR building would house the controls for the facility and offices for plant operating personnel. The O/CR building would be a one-story structure approximately twenty feet in height with an area of from 2,000 to 3,000 square feet. The O/CR building is the only enclosed structure (all other structures at the power plant are open to air circulation).

A potable water and sanitary disposal (septic) system would be provided for the building. The location of the septic system would be determined subsequent to soil suitability testing during final site engineering. As there are no known potable water wells at the proposed power plant site and as the project site is outside of the water service area of the Town of Mammoth Lakes, a water storage tank would be constructed to store water delivered to the site from either the existing MP I groundwater well located on the adjacent private land and/or by re-activating an old Magma water well on the adjoining private land. The expected potable water requirement for the facility, based on an estimated manpower requirement of sixteen people, would be 300 gallons per day. Bottled water would be furnished for drinking during construction and production operations.



STREAM NO.	1	2	3	4	5	6
FLUID	Brine	Brine	HC	HC	HC	HC
FLOW 1000/HR	2,250	2,250	2,040	2,040	2,040	2,040
GPM	5,000	4,600	7,730	7,010	-	-
RCFM	-	-	-	-	4,090	48,000
TEMP (DEG. F)	330	169	114	116	200	166
PRESS. (PSIA)	220	170	87	560	500	92
DENSITY	56.3	60.9	32.7	32.6	6.95	0.05
MMBTU/HR.	665.2	302.0	0	6.0	368.4	325.0

10 MWe Net PLANT

GENERATOR OUTPUT	13,875 KW
PARASITIC LOAD (ONSITES)	2,625
BRINE PUMPING (OFF SITES)	1,250
NET	10,000 KW

FIGURE 2-5
Process Flow Diagram

SOURCE: Pacific Energy

The power plant facility area would be diked with a one- to two-foot berm, or block wall, and drained to a catch basin, located downslope of the facility, of approximately 88,000 gallon capacity. The catch basin is designed for a 20-year storm event and would collect plant runoff and would be available for emergency spill containment. See Section 2.1.5.1 for a description of project-wide emergency spill containment.

All facilities would be constructed to meet or exceed applicable building codes and industry standards.

2.1.4 INJECTION WELLFIELD AND DISTRIBUTION FACILITIES

Based on the three injection wells supporting the existing MPI Project, the proposed project would require four injection wells. The proposed locations for injection wells Nos. SFI 44-32, SFI 54-32, SFI 54A-32 and SFI 64-32, are shown on Figure 2-1. The total surface disturbance required to drill the four injection well sites would be approximately three acres.

2.1.4.1 Injection Well Drilling and Testing Description

At each approved drilling site, a drill pad approximately 150 feet x 200 feet would be built along with access and a 50,000± gallon, plastic-lined reserve pit for the containment and temporary storage of waste drilling mud and fluids and on-site sediment containment basins as discussed for production well sites (see Section 2.1.2.1). A typical drilling pad and equipment layout would also be similar to that discussed earlier for production well drilling (Figure 2-2). Final equipment placement would depend upon site-specific topographic and environmental considerations and the actual drilling equipment utilized.

The injection wells have been designed to reach a maximum depth of 2,000 feet and would be completed in the Bishop Tuff. The proposed well casing program consists of 30-inch conductor cemented to ten feet, 22-inch conductor casing cemented to 120 feet, 13-3/8-inch surface casing cemented to 1,000 feet and completed with 10-3/4-inch slotted liner to 1,000 to 2,000 feet. All mud used during the drilling of each well would consist of a 8.6 to 9.0 pound-per-gallon weight gel. No hazardous or toxic mud additives are proposed to be used.

Following well drilling, the well would be cleaned up in much the same way as described for production well testing. An initial injectivity test may also be conducted by injecting the geothermal fluid produced during the initial flow test back into the well. A long-term flow test may be conducted to more accurately determine the well's injectivity and/or productivity. This test would be similar to the long-term production well flow test described in Section 2.1.2.1.

Fewer injection wells may be required, depending upon actual drilling and injectivity test results. Expectations are that three injectors may suffice, with the fourth well providing standby capacity. If any well drilled as an injection well lacks commercial injection potential, a workover and/or redrilling of the well may be conducted, the well may be converted to an observation well or the well may be plugged and abandoned in conformance with federal requirements. If any well drilled as an injection well indicates commercial production potential, it could be converted to a production well.

2.1.4.2 Injection Pumps and Gathering System

Residual, cooled geothermal fluid from the plant would be pumped to the injection wells through pipelines having diameters ranging from 18 to 24 inches, including insulated wrapping to meet applicable safety regulations. The injection pump would be an above ground, horizontal, centrifugal pump driven by a variable speed electrical motor. It would be located within the power plant area and would be about five feet high by ten feet long. An estimated total of 1,700 feet of injection pipeline would be required. The pipelines would be either buried or at or near ground level on sleepers or in trenches below grade and would be colored to blend with the terrain. Each well would be monitored as to injection rate, temperature, and pressure in order to aid in process control and resource management.

2.1.5 EMERGENCY RESPONSE AND PREVENTION

Design features as well as plans of action have been developed to deal with spills, well blowouts, fire and the release of hazardous gases. The Emergency Spill Containment Plan and its attachments which describe the plans are summarized in subsequent sections. The entire plan is in Appendix A of this EIS/SEIR Addendum.

2.1.5.1 Spill Prevention and Containment

2.1.5.1.1 Well Drilling, Testing and Construction

During well site construction prior to drilling, each well site would be graded to drain to a lined mud pit. The entire well site would be bermed to contain small spills on-site during drilling and testing operations. Sedimentation basins would also be constructed on each well site to contain site runoff from storm events which may occur during drilling operations. Down gradient sides of cut or fill slopes would be lined with filter fences or hay bales to retard soil erosion and sedimentation should on-site containment fail.

During well drilling operations 10,000 gallons of cold water would be stored on-site to be available to kill the well in the event that well control problems should arise. During power plant operations 50,000 gallons of cold water would be stored within the project area and would be available for well control problems after commercial operations begin.

In addition, the project-wide site spill containment facility described in Section 2.1.5.1.3 would be utilized as a backup containment mechanism to prevent spills from leaving the project site.

2.1.5.1.2 Operations

Wellhead areas would be bermed to prevent minor spills from leaving the site such as could occur during well servicing operations.

Seamless welded pipes would be used along the entire length of production and injection pipeline to minimize the possibility of leaking connections. Isolation valves would be located within the pipelines the prevent backflow of geothermal fluid, should a leak occur. Major pipeline leaks or ruptures would be detected by in-line sensing equipment. A fail-safe mechanism is included that, in the event of an electrical failure, the flow from all wells would automatically be blocked by safety shut-off valves. If pressure suddenly dropped, alarms would sound in the plant, isolation valves in the pipeline would close, and the wells would be shutdown automatically within less than one minute. If all automatic shutdown controls failed, the pumps and isolation valves could be shutdown from the plant control rooms within two to three minutes. Should all electricity fail, pumps would stop and valves would shut automatically. In addition, all pumps and valves could be closed manually by plant personnel within five minutes. The power plant facility would be diked and drained to an on-site catchment basin of approximately 88,000-gallon design capacity. The catchment basin would collect site runoff and would be available for emergency spill containment. This basin is designed to catch any surface runoff or rainwater up to the volume from a 20-year one-hour design storm event. Rainwater in the catchment basin would be allowed to infiltrate and evaporate.

Under almost all expected atmospheric conditions, isobutane, if spilled, would evaporate before the spill could spread. Any identified potential spill sources in the power plant, such as the isobutane accumulator and switchyard transformers, would be individually curbed to contain spills during operations. In the event that spills were not fully contained by the on-site source specific containment facilities, leakage would flow to the on-site catchment basin and then to the project-wide containment facilities.

2.1.5.1.3 Project-Wide Emergency Spill Containment

Prior to well drilling or power plant construction, emergency spill containment facilities would be constructed down gradient of all proposed PLES Project facilities as shown in Figure 2-1. The emergency spill containment facilities would take advantage of the natural drainage in the project site and would be available to contain spilled substances from anywhere in the project site. The large spill containment basin to the west would serve as the principal emergency spill containment facility for most of the project site and is designed to contain about 1.6 million gallons. The smaller spill containment area to the east provides backup storage capacity of about 92,500 gallons and serves as the principal emergency containment for part of the injection well field.

The spill containment facilities would be constructed by installing vertical sluice gates down gradient of the project site on extensions of two existing culverts which drain the project site. One culvert crosses beneath State Route 203 and the second culvert crosses beneath Hot Springs Road.

The existing culvert pipes under State Route 203 and Hot Springs Road would be extended to approximately 43 feet from the centerline of the existing road where a concrete headwall would be constructed. A vertical lift gate would have an electric valve actuator which would activate a compressed gas (nitrogen) gate closure mechanism for automatic operation. The gate could also be closed by an independent handwheel for manual operation. The valve would be open under normal operating conditions, but closed in the event of a spill from a pipeline or wellsite. The spill would be held in the containment facility, analyzed, and disposed of in a manner approved by the Lahontan Regional Water Quality Control Board.

These containment facilities would be constructed before any new construction or well drilling took place. Each portion of the project site drains to one of the two spill containment areas. Therefore, should any discharges or spills occur during drilling, testing, or servicing activities, the spill containment facilities would be in place to handle them.

During the short term well drilling, testing, and site construction activities prior to commercial production, the sluice gates would be maintained in a closed position except to permit natural drainage from rain, snow melt, or spring flow from the area. The closed sluice gates would thereby provide secondary emergency spill containment prior to installation of an automatic control system for commercial production operations. Operation of sluice gates would be manual during this preliminary phase of development.

During normal commercial production operations the sluice gates would remain open allowing a natural drainage. However, if a major spill should occur the gates would be closed providing secondary containment of any spilled substance in the project area. The gates would automatically close as a result of loss of electrical power or if there were an imbalance between the measured rates of production and injection. The gates could also be actuated to close manually from the control room. The production and injection flow would be continually compared electronically. Under normal circumstances the flows should be equal with minor fluctuations. The Emergency Spill Containment Plan states that should the difference between the production flow and the injection flow be as large as 10% of the total flow (such as would occur if there were a major geothermal fluid leak or pipeline rupture) the sluice gate valve actuators would automatically close, the production pumps and injection pump(s) would stop, and an alarm would sound and be displayed in the control room.

2.1.5.2 Well Blowout Control

Blowout prevention equipment would be kept in operating condition and tested in compliance with BLM regulations and industry standards. During drilling operations, a minimum of 10,000 gallons of cool water and 12,000 pounds of barite would be stored at the well site for use in killing the well in the event of a blowout.

2.1.5.3 Fire Prevention and Control

The power plant equipment containing the isobutane working fluid would be protected from overheating and fire damage by a fire resistant insulation or cement. Such equipment includes the isobutane accumulator vessel and the heat exchangers. A water system with hydrants and fire hoses would also be installed to assist in fire suppression and in cooling equipment, if necessary. The working air-cooled isobutane condensers would be located on top of a steel supporting structure about twenty feet above grade. The structural steel columns and beams would be fireproofed to resist fire damage for up to two hours. Fire-related equipment would include: (1) a water-storage tank (minimum 220,000-gallons capacity); (2) fire pump and accessories, including: electric fire pump with batteries and charger, diesel fire pump with diesel fuel system, jockey pump controllers, and associated valves, pipes and fittings; (3) fire protection apparatus, including: fire hydrants, monitors, and valves; automatic sprinkler for the control building; fire line pipes and fittings; and (4) fire alarm system, including: control panel and six combustible gas monitors. The monitors sound a "warning" in the control room if the combustible gas concentration at the sensor reaches 30 percent of the lower explosive limit (LEL) and sound an "alarm" if the concentration reaches 60 percent of the LEL.

2.1.6 LANDSCAPE, REVEGETATION, AND CAMOUFLAGE

The Landscape and Revegetation Plan for the proposed action is attached as Appendix B. It includes the elements described in the following sections.

2.1.6.1 Stockpiling of Topsoil

Topsoil would be stockpiled from all graded areas. After disturbed areas have been recontoured, the topsoil and duff would be spread and planting or seeding done. This procedure had been very successful in providing a planting bed for seedlings with a bank of seed from the native vegetation which allows for the rapid re-establishment of native flora.

2.1.6.2 Mulching

Mulching of seeded areas increases germination rates while also decreasing runoff and erosion. All seeded areas would be mulched.

2.1.6.3 Seeding

After the topsoil and duff has been spread over disturbed areas, these areas would be seeded with a mix of grass and shrub seeds as shown in Table 2-2.

TABLE 2-2: SEED MIX/a/

Species	Common Name	Percentage of Mix
Artemisia tridentata	Sagebrush	15%
Purshia tridentata	Bitterbrush	15%
Orysopsis hymenoides 'Nespar'	Indian rice grass	10%
Elymus cinereus	Great basin wild rye	20%
Agropyron desetorum 'Nordan'	Crested wheat grass	20%
Agropyron trichophorum 'Mandan'	Pubescent wheat grass	20%

/a/ No rate of seed application was given in the plan. After seeding, a 20-20-20 fertilizer would be applied at a rate of 350 pounds per acre.

SOURCE: Josephine McProud. 1988. Landscape and Revegetation Master Plan for PLES I Geothermal Plant. Submitted by Pacific Energy as part of the project description.

2.1.6.4 Seedling Planting

In some areas additional planting of shrub seedlings (see Table 2-3) are specified in the Landscape plan. These seedlings would be contract grown from locally collected seed. Percentages and spacings would be designed to match natural plant distribution as closely as possible. Reforestation with pine seedlings would occur in some of the more heavily forested areas.

2.1.6.5 Container-Grown Plants

In some areas, plants larger than seedlings are recommended for visual mitigation. Careful consideration has been given to selecting plants which are native to the Eastern Sierra area. However, since the availability of nursery-grown natives is somewhat limited, a strict adherence to the "natives only" rule seems impossible. Rate of growth, screening properties, and availability were also factors in plant selections. See Table 2-3 for a list of container grown plantings.

2.1.6.6 Tree Spade Transplanting

Trees in excess of 30 feet in height would be transplanted from areas scheduled for occupancy using a large tree spade, to areas around the plant site. Transplanted pines would range in height from eight to 30+ feet and would be guaranteed for a period of one year. Locations have been selected to conceal plant facilities from the immediate view, as well as the distant view.

TABLE 2-3: SEEDLINGS AND CONTAINER-GROWN PLANTINGS

Species	Common Name	Percentage of Mix
Artemisia tridentata	Sagebrush	45%
Purshia tridentata	Bitterbrush	30%
Chrysothamenus nauseosus	Rubber rabbitbrush	15%
Prunus andersonii	Desert peach	10%
Pinus jeffreyii	Jeffrey pine	seedling or container grown as needed for screening and reforestation.
Ribes cereum	squaw current	container-grown
Salix exigua	native willow	container-grown
Rosa woodsi	wood rose	container-grown
Amelanchier almifolia	serviceberry	container-grown
Quercus vaccinifolia	huckleberry oak	container-grown

SOURCE: Josephine McProud. 1988. Landscape and Revegetation Master Plan for PLES I Geothermal Plant. Submitted by Pacific Energy as part of the project description.

2.1.6.7 Irrigation

Irrigation to seeded and planted areas is provided to ensure seed germination and successful establishment of seedlings and container-grown stock. A temporary overhead system would be installed as indicated on the plans. This system would remain in place for at least a two-year period for appropriate establishment of vegetation. A permanent drip irrigation system would be installed to container-grown stock and transplanted specimens. Water usage would be kept to a minimum.

2.1.6.8 Painting

Colors would be selected for painting of pipelines and other structures. These colors would blend with natural occurring tones in each specific area. Camouflage techniques would be used in some areas, and would involve the use of several colors to create a texture or pattern more in keeping with the natural surroundings.

2.1.6.9 Trenching and Retaining Walls

Production and injection pipelines would be buried or placed in trenches is some areas which are especially visually sensitive and for which other techniques for concealing the pipeline are impractical (see Figure 2-1). Erosion control and revegetation is specified on all areas disturbed by trenching. Where the new grade encroaches significantly into the drip line of existing trees, retaining walls would be constructed. These walls would help ensure the survival of many existing trees which would otherwise need to be removed. Ramps would be built across pipelines at the discretion of the authorized officer to facilitate the passage of deer.

2.1.7 HYDROLOGIC MONITORING PLAN

The monitoring plan, shown in Table 2-4, was developed in consultation with the Long Valley Hydrologic Advisory Committee./2/ It is designed to help determine baseline conditions in the hydrologic systems, changes which may occur, and factors which may affect them. It would also provide information which can be used to trigger reservoir management or other mitigation techniques. Pacific Energy has agreed to participate fully in LVHAC and will supply appropriate information. The hydrologic monitoring plan for which Pacific Energy is responsible is shown in Table 2-4.

/2/ The use of water resources, including geothermal resources, in Long Valley Caldera is a major resource management issue in Mono County. There is a consensus that more information about the hydrologic regime would help decision-makers, land managers, and users of the resource to plan for the area. Accordingly, the Long Valley Hydrologic Advisory Committee (LVHAC) has been established under the auspices of Mono County to bring together, in an advisory capacity, representatives of agencies that have hydrology-related permitting authority or operations and parties who have proposed or current activities which would affect hydrologic systems within Long Valley Caldera. The primary activity of LVHAC is to oversee a hydrologic monitoring program. The monitoring program is designed to help determine baseline conditions in the hydrologic systems, changes to the systems, and factors which may affect the systems.

TABLE 2-4: BLM's REQUIRED HYDROLOGIC MONITORING PLAN (developed in coordination with LVHAC)

Sites	Purpose	Type	Frequency
	Fish Hatchery Springs		
AB & CD group springs at Hot Creek Hatchery	Detect changes in flow, temperature, and water chemistry	F,T C/a/, I	C Q
	Hot Creek Gorge Springs		
Hot Creek above swimming area	Upstream site for salinity-gain measurements to calculate flow of thermal springs in gorge	F,C_L,T	M
Hot Creek Flume	Downstream site for salinity-gain measurements	F,C_L,T	M
	Casa Diablo Power Plants		
Colton Spring	Detect changes in spring flow, temperature, and chemistry caused by wells supplying geothermal power plants	F T C/a/, I	C M S
Casa Diablo Spring	Detect changes in spring flow, temperature, and chemistry caused by wells supplying geothermal power plants	F T C/a/, I	C M S
Production and injection wells	Determine reservoir characteristics and changes changes due to production and injection	C, I (for selected wells) Following the drilling of wells, the company will provide pressure and temperature profiles and data from short term flow or injection tests. During production, the company will continuously monitor well discharge and injection rates and downhole production pressure. Well head temperatures and injection pressures are to be taken daily.	S

(cont.)

TABLE 2-4: BLM's REQUIRED HYDROLOGIC MONITORING PLAN (developed in coordination with LVHAC) (Continued)

Sites	Purpose	Type	Frequency
	Casa Diablo Power Plants (cont.)		
Observation Well 65-32	Detect changes in reservoir characteristics due to production and injection	W	C (1st yr), M (after 1st yr)
		Tp,C,I	S
Unnamed stream upstream of culvert under Hot Springs Road east of MPI and upstream of culvert under gas tank road.	Determine stream flow and water quality	S	Q
		C	S

Legend of Abbreviations

Type of Data:
- A atmospheric pressure
- C chemistry-components given in /a/
- C_L limited chemistry (B, Cl, F, Specific conductance, and temperature)
- F flow of springs or streams
- I isotopic analyses (0 18/16, D/H, ^3H)
- P precipitation
- Q quantity of water
- S turbidity and suspended sediment
- T temperature
- T_P temperature profile
- W Water level and/or pressure

Frequency:
- C continuous or at 15 minute intervals
- D daily
- M monthly
- Q quarterly
- S semiannually
- A annually

/a/ pH, alkalinity, chloride, fluoride, nitrite-nitrate, phosphorus, sulfate, ammonia, calcium, magnesium, strontium, sodium, potassium, silica, boron, arsenic, lithium, mercury, iron, manganese, dissolved solids, oxygen isotopes, hydrogen isotopes, tritium.

2.2 ALTERNATIVE LOCATION ACTION

Under the alternative location action, the project would use the same well fields, plant design, and power output. The well fields would remain in the same locations because the resource cannot be moved. The principal difference would be the relocation of the power plant to a location 0.6 miles north of the proposed site, as shown on Figure 2-6. The alternative location is about 150 feet higher in elevation than the proposed power plant site and approximate 3,000 feet from the production and injection fields, it may be necessary to pump approximately 10 to 20% more geothermal fluid (up to a total 6,000 gpm) in order to compensate for temperature losses in the longer gathering lines and to generate more electricity to pump the fluid to and from the well fields. Depending on the production capacity of the wells, it is possible that five production wells would be required. Two to four additional air coolers would be required, resulting in a power plant site 40 to 70 feet longer (about 0.25 acres larger) than the proposed power plant site.

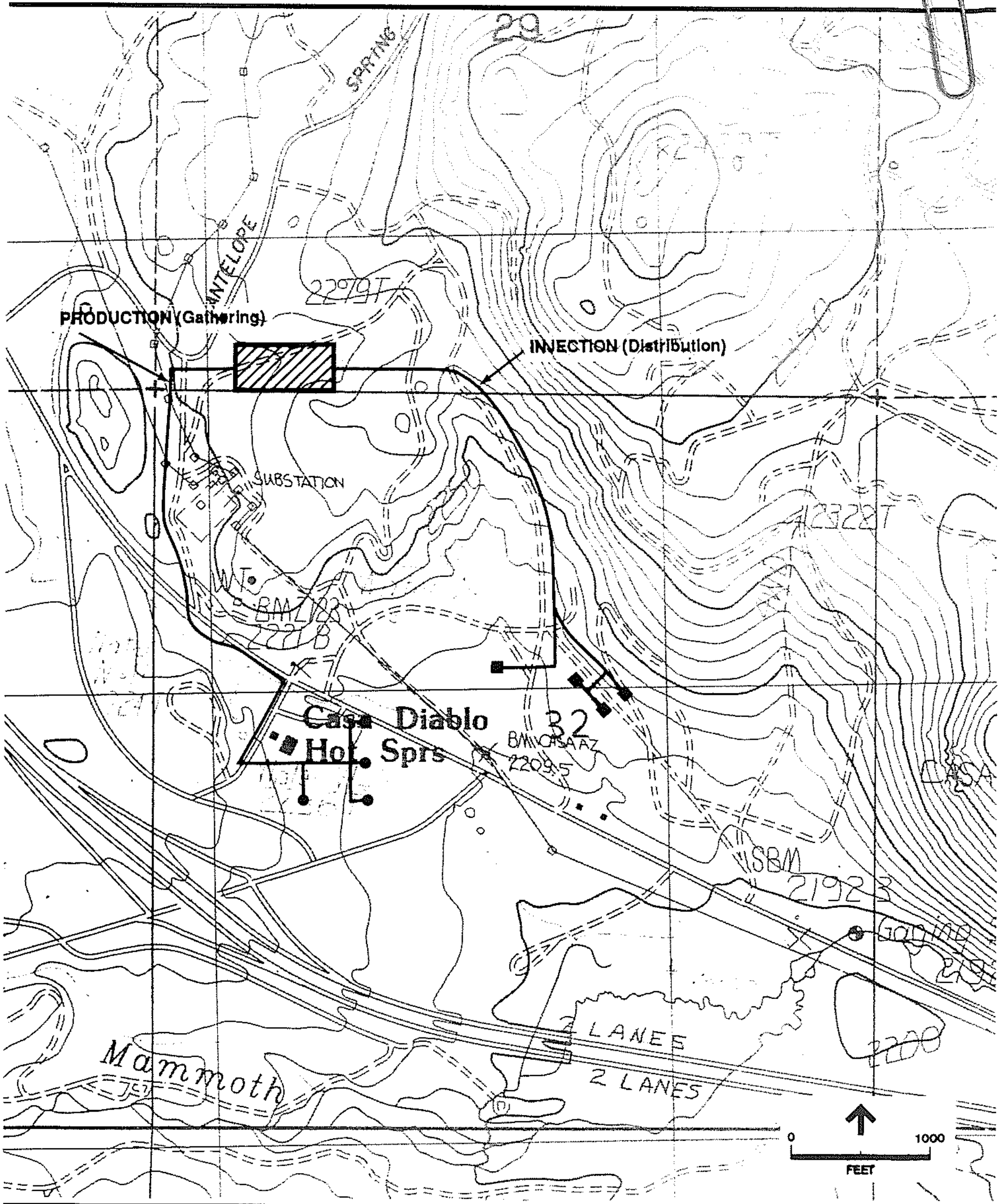
The power plant would have the same east-west orientation as the proposed power plant, but the sump would be located at the lowest elevation on the northwest corner. The gathering pipelines would be about 4,200 feet long and the distribution pipelines, about 4,500 feet long. Their approximate locations are shown in Figure 2-6.

2.2.1 MEASURES INCORPORATED AS A RESULT OF PREVIOUS PROJECT APPROVAL

All mitigations incorporated into the proposed project would be included in this alternative if applicable. Site specific mitigations may be required. See Section 2.1.1.

2.2.2 PRODUCTION WELLFIELD AND GATHERING SYSTEM

A total of four production well locations have been identified for the alternate location action and are shown in Figure 2-1 as Well Nos. SF 25-32, SF 34-32, SF 35-32, and SF 35A-32. A fifth production well site, SF 45-32 would be available as an additional production well if necessary. Three well sites (SF 25-32 not drilled, SF 35-32 already completed, and SF 45-32 not drilled) were previously proposed in Pacific Energy's Plan of Exploration. The impacts of this plan were analyzed in Environmental Assessment CA-017-86-53, and the plan was approved by the BLM on July 2, 1986. The fluid requirement for this alternative would be approximately 6,000 gallons per minute (gpm) of 330°F geothermal fluid. The total surface disturbance required to drill the four production well sites is approximately 3.5 acres. The fifth well would disturb an additional acre.



Alternate Power Plant Site ● Production Wells ■ Injection Wells

SOURCE: Pacific Energy

FIGURE 2-6
Alternate Power Plant Location

2.2.2.1 Production Well Drilling and Testing Description

All production well drilling and testing would be done the same as for the proposed project. See Section 2.1.2.1.

2.2.2.2 Production Wellhead and Downhole Facilities

Production wellhead and downhole facilities would be the same as for the proposed action. See Section 2.1.2.2.

2.2.2.3 Gathering System

The permanent gathering system for transporting hot geothermal fluid from the wells to the power plant would use insulated pipelines. The pipeline routes are depicted on Figure 2-6. The precise routing could vary slightly depending on final engineering and the design option selected. Pipelines, including insulation, would vary in diameter from 18 to 24 inches depending upon individual well productivities. Horizontal expansion loops (typically a square bend in the pipeline approximately 30 feet x 30 feet) would be constructed every 250 to 350 feet along the pipeline route. An estimated 4,200 feet of production pipeline would be required. The pipe would be located near or below ground level on sleepers and would be colored to blend with the terrain. Selected sections of pipe would be placed below ground level in excavated trenches (see Section 2.1.6.9). Downhole pumps in the production wells would deliver the geothermal fluid to the plant at about 200 pounds per square-inch gauge (psig).

2.2.3 POWER PLANT

The proposed power plant would use hot geothermal fluids produced from the geothermal production wells described in Section 2.1.2 to generate electrical power. The power plant facility would be designed to produce a minimum of 10 MWe (net) of electricity. Generated electrical power would be transported from the power plant interconnection facility to SCE's Casa Diablo Substation, located immediately southwest of the alternative power plant site.

The power plant would utilize a closed-system binary process cycle to extract heat from the hot geothermal fluid pumped from the production wells. The geothermal fluid would not be flashed nor exposed to the atmosphere at any time during its utilization. After heat is extracted from the produced geothermal fluid in the facility heat exchangers, the cooled geothermal fluid would be transported from the power plant by a surface pipeline to the injection wellfield facilities (see Section 2.1.4).

The locations of the production and injection well sites, power plant site, and interconnecting pipelines are shown in Figure 2-6.

2.2.3.1 Radial Turbo-Expander Generator

Under the proposed engineering design, heat would be extracted from the geothermal fluid in shell-and-tube heat exchangers and transferred to a hydrocarbon fluid (isobutane). The heated isobutane would be expanded through a turbo-expander generator system, converting the mechanical energy produced to electrical energy. Isobutane vapor from the turbine exhaust would be condensed in air-cooled condensers. The condensed isobutane would then be directed to a storage vessel (accumulator), from which the cooled and condensed isobutane would be pumped to start the closed-system binary cycle again. The principal power generation facilities would be constructed within an area approximately 320 feet wide by 760 feet long, as depicted on Figure 2-6. The power plant site and adjacent facilities would be protected within chain-link fence.

The major equipment requirements include shell-and-tube heat exchangers, three (3) turbo-expander generators, air-cooled condensers, isobutane accumulator, isobutane storage vessel, isobutane circulating pump, geothermal fluid injection pump, air compressors, gas freeing compressor, lubricant coolers, firewater tank, utility building, transformers, and electrical switchgear house. Two banks of air-cooled condensers would be used, approximately 380 feet long by 60 feet wide, with an overall height of approximately 30 feet. The use of air-cooled condensers would eliminate the need for consumptive water use during power plant operation. The proposed shell-and-tube heat exchangers would occupy a space approximately 50 feet long by 20 feet wide and 20 feet high. The isobutane accumulator and isobutane storage vessel are cylindrical vessels approximately 70 feet long and 10 feet in diameter. The vessels would be placed on supports along their length and would rest about five feet off the ground, reaching a total height of approximately 15 feet. The remaining power plant components would not exceed a height of 10 feet.

A process flow diagram depicting the mass flows of both the geothermal fluid and the isobutane working fluid through the binary power plant is provided as Figure 2-5. Approximately 6,000 gpm of hot geothermal fluid would be pumped from the production wells for subsurface disposal. The apparent loss of geothermal fluid volume indicated on the mass flow diagram results from the cooling of the fluid through the facility and does not result from consumptive use. There would be no difference between the fluid mass produced and fluid mass injected.

2.2.3.2 Additional Power Plant Facilities

Additional power plant facilities would be the same as for the proposed project.

2.2.4 INJECTION WELLFIELD AND DISTRIBUTION FACILITIES

The alternative location probably would require four injection wells. The proposed locations for injection wells Nos. SFI-44-32, SFI 54-32, SFI 54A-32 and SFI 64-32 are shown on Figure 2-1. The total surface disturbance required to drill the four injection well sites would be approximately three acres.

2.2.4.1 Injection Well Drilling and Testing Description

Injection well drilling and testing would be the same as for the proposed project. See Section 2.1.4.1.

2.2.4.2 Injection Pumps and Gathering System

Residual, cooled geothermal fluid from the plant would be pumped to the injection wells through pipelines having diameters ranging from 18 to 24 inches, including the insulated wrapping to meet applicable safety regulations. The injection pump would be an above ground, horizontal, centrifugal pump driven by a variable speed electrical motor. It would be located within the power plant area and would be about five feet high by ten feet long. An estimated total of 4,500 feet of injection pipeline would be required. The pipelines would be at or near ground level on sleepers and would be colored to blend with the terrain. Each well would be monitored as to injection rate, temperature and pressure in order to aid in process control and resource management.

2.2.5 EMERGENCY RESPONSE AND PREVENTION

Design features as well as plans of action have been developed to deal with spills, well blowouts, fire and the release of hazardous gases. The Emergency Spill Containment Plan and its attachments which describe the plans are summarized in Section 2.1.5. The entire plan is in Appendix A of this EIS/SEIR.

2.2.6 LANDSCAPE, REVEGETATION, AND CAMOUFLAGE

The Landscape and Revegetation Plan for the alternate location action, attached as Appendix B, would contain the same basic elements as for the proposed project (see Section 2.1.6).

2.2.7 HYDROLOGIC MONITORING PLAN

At a minimum, the hydrologic monitoring plan for the alternative site would be the same as for the proposed project. See Section 2.1.7.

2.3 SMALLER POWER PLANT ALTERNATIVE

The smaller power plant alternative of about seven MWe (net) would be located at the site of the proposed project. It would use the same technology as the proposed project and would have two turbo exchangers and generators, six heat exchangers, and 30 air condensers. The smaller power plant would be about 80 feet shorter in the westerly direction than the proposed project. Three production wells producing 3,800 gpm and three injection wells would be required. The smaller power plant alternative plot plan is shown in Figure 2-7.

2.3.1 MEASURES INCORPORATED AS A RESULT OF PREVIOUS PROJECT APPROVAL

The stipulations would be the same as for the proposed project. See Section 2.1.1.

2.3.2 PRODUCTION WELLFIELD AND GATHERING SYSTEM

A total of three production well locations have been identified for the smaller power plant. They are shown on Figure 2-1 as Well Nos. SF 25-32, SF 34-32, and SF 35-32. Production well sites SF 45-32 and SF 35A-32 are not currently proposed but would be available as make-up wells or additional production wells. Three well sites (SF 25-32 not drilled, SF 35-32 already completed, and SF 45-32 not drilled) were previously proposed in Pacific Energy's Plan of Exploration. The impacts of this plan were analyzed in Environmental Assessment CA-017-86-53, and the plan was approved by the BLM on July 2, 1986. The fluid requirement for this alternative would be approximately 3,800 gpm of 330° geothermal fluid. The total surface disturbance required to drill the three production well sites would be approximately 2.7 acres.

2.3.2.1 Production Well Drilling and Testing Description

Production well drilling and testing would be the same as for the proposed project.

2.3.2.2 Production Wellhead and Downhole Facilities

Production wellhead and downhole facilities would be the same as for the proposed project.

2.3.2.3 Gathering System

The permanent gathering system for transporting hot geothermal fluid from the wells to the power plant would use insulated pipelines. The pipeline routes are depicted on Figure 2-1. The precise routing could vary slightly depending on final engineering and the design option selected. Pipelines, including insulation, would vary in diameter from 18 to 24 inches depending upon individual well productivities. Horizontal expansion loops (typically a square bend in the pipeline approximately 30 feet x 30 feet) would be constructed every 250 to 350 feet along the pipeline route. An estimated 2,400 feet of production pipeline would be required. The pipe would be located near or below ground level on sleepers and would be colored to blend with the terrain. Selected sections of pipe would be placed below ground level in excavated trenches (see Section 2.1.6.9). Downhole pumps in the production wells would deliver the geothermal fluid to the plant at about 200 psig.

2.3.3 POWER PLANT

The proposed power plant would use hot geothermal fluids produced from the geothermal production wells described in Section 2.1.2 to generate electrical power. The power plant facility would be designed to produce a minimum of seven MWe (net) of electricity. Generated electrical power would be transported from the power plant interconnection facility to SCE's Casa Diablo Substation, located approximately one-quarter mile northwest of the power plant site. Electrical transmission lines would be mounted along pipelines. The generate power would be transmitted from the project site to the substation via the existing power line poles located adjacent to the northwest corner of the project site and following Hot Springs Road to the SCE substation.

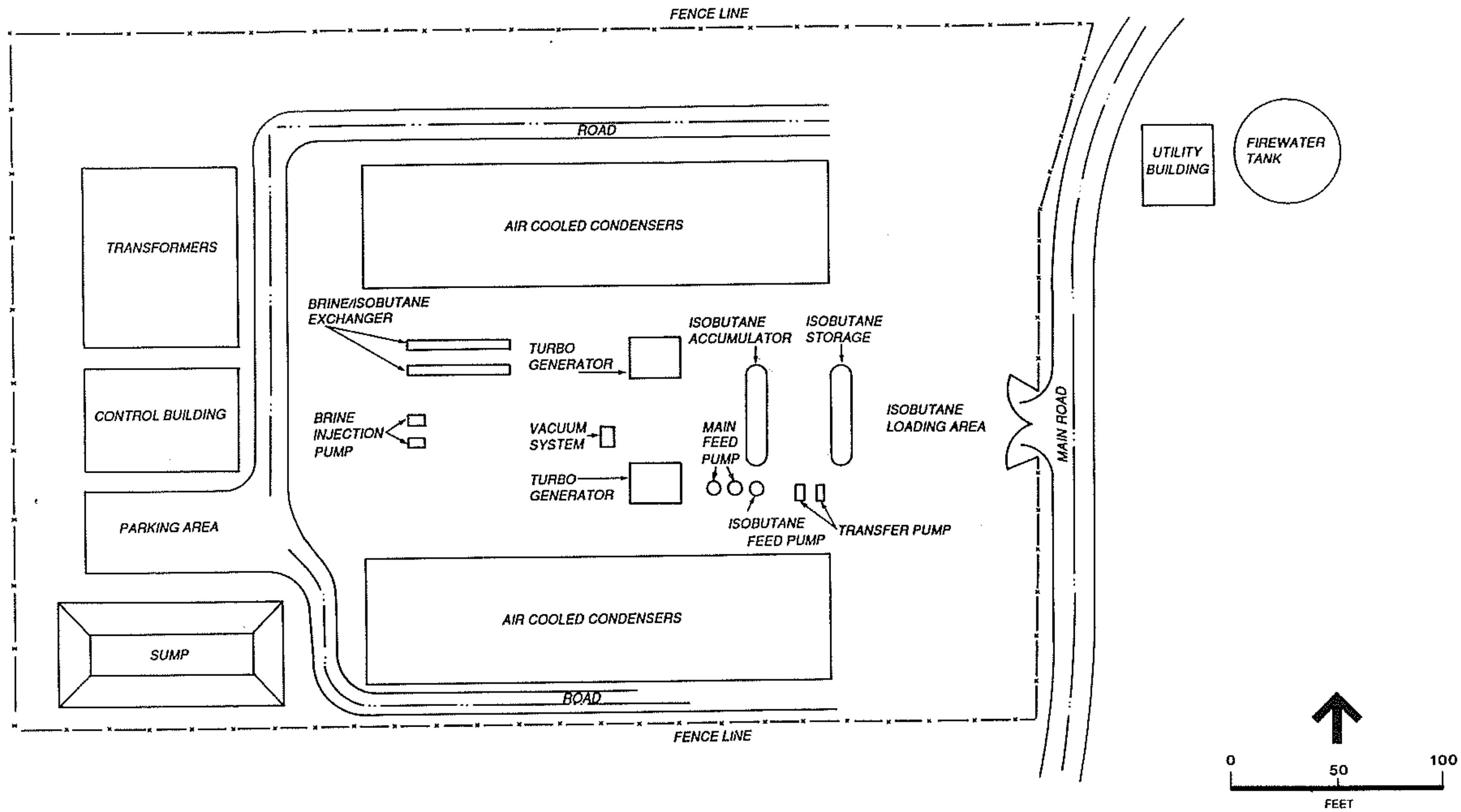
The power plant would utilize a closed-system binary process cycle to extract heat from the hot geothermal fluid pumped from the production wells. The geothermal fluid would not be flashed or exposed to the atmosphere at any time during its utilization. After heat is extracted from the produced geothermal fluid in the facility heat exchangers, the cooled geothermal fluid would be transported from the power plant by a surface pipeline to the injection wellfield facilities (see Section 2.1.4).

The proposed locations of all significant surface development, utilization and injection facilities (collectively termed "the project site") are identified in Figure 2-1, including: the production and injection well sites; power plant site; access roads; interconnecting pipelines; electric transmission line; and on-site electrical interconnection facility.

2.3.3.1 Radial Turbo-Expander Generator

Under the proposed engineering design, heat would be extracted from the geothermal fluid in shell-and-tube heat exchangers and transferred to a hydrocarbon fluid (isobutane). The heated isobutane would be expanded through a turbo-expander generator system, converting the mechanical energy produced to electrical energy. Isobutane vapor from the turbine exhaust would be condensed in air-cooled condensers. The condensed isobutane would then be directed to a storage vessel (accumulator), from which the cooled and condensed isobutane would be pumped to start the closed-system binary cycle again. The principal power generation facilities would be constructed within an area approximately 320 feet wide by 610 feet long, as depicted on the Figure 2-7. The power plant site and adjacent facilities would be protected within chain-link fence.

The major equipment requirements include shell-and-tube heat exchangers, two turbo-expander generators, air-cooled condensers, isobutane accumulator, isobutane storage vessel, isobutane circulating pump, geothermal fluid injection pump, air compressors, gas freeing compressor, lubricant coolers, firewater tank, utility building, transformers, and electrical switchgear house. Two banks of air-cooled condensers would be used, approximately 230 feet long by 60 feet wide, with an overall height of approximately 30 feet. The use of air-cooled condensers would eliminate the need for consumptive water use during power plant operation. The proposed shell-and-tube heat exchangers would occupy a space approximately 50 feet long by 20 feet wide and 20 feet high. The isobutane accumulator and isobutane storage vessel are cylindrical vessels approximately 70 feet long and 10 feet in diameter. The vessels would be



SOURCE: Pacific Energy and ESA

FIGURE 2-7

Smaller Power Plant Alternative Plot Plan placed on supports along their length and would rest about five feet off the ground, reaching a total height of approximately 15 feet. The remaining power plant components would not exceed a height of 10 feet. A process flow diagram depicting the mass flows of both the geothermal fluid and the isobutane working fluid through the binary power plant is provided as Figure 2-5. Approximately 3,800 gpm of hot geothermal fluid would be pumped from the production wells through pipelines to the tube side of a shell-and-tube heat exchanger to heat the isobutane fluid. The cooled geothermal fluid would not be exposed to the atmosphere during the cycle but would be pumped directly to the injection wells for subsurface disposal. The apparent loss of geothermal fluid volume indicated on the mass flow diagram results from the cooling of the fluid through the facility and does not result from consumptive use. There would be no difference between the fluid mass produced and fluid mass injected.

2.3.3.2 Additional Power Plant Facilities

Additional power plant facilities would be the same as for the proposed project.

2.3.4 INJECTION WELLFIELD AND DISTRIBUTION FACILITIES

Based on the three injection wells supporting the MPI Project, the project would require three injection wells. The proposed locations for injection wells Nos. SFI-44-32, SFI 54-32, and SFI 64-32 are shown on Figure 2-1. The total surface disturbance required to drill the three injection well sites would be approximately three acres.

2.3.4.1 Injection Well Drilling and Testing Description

Injection well drilling and testing would be the same as for the proposed project.

2.3.4.2 Injection Pumps and Gathering System

Residual, cooled geothermal fluid from the plant would be pumped to the injection wells through pipelines having diameters ranging from 18 to 24 inches, including insulated wrapping to meet applicable safety regulations. The injection pump would be an above ground, horizontal, centrifugal pump driven by a variable speed electrical motor. It would be located within the power plant area and would be about five feet high by ten feet long. An estimated total of 1,500 feet of injection pipeline would be required. The pipelines would be at or near ground level on sleepers and would be colored to blend with the terrain. Each well would be monitored as to injection rate, temperature and pressure in order to aid in process control and resource management.

2.3.5 EMERGENCY RESPONSE AND PREVENTION

Design features as well as plans of action have been developed to deal with spills, well blowouts, fire and the release of hazardous gases. The Emergency Spill Containment Plan and its attachments which describe the plans would be the same as for the proposed project. They are summarized in Section 2.1.5. The entire plan is in Appendix A of this EIS/SEIR.

2.3.6 LANDSCAPE, REVEGETATION, AND CAMOUFLAGE

The Landscape and Revegetation Plan attached as Appendix B, would be the same as for the proposed project. See Section 2.1.6.

2.3.7 HYDROLOGIC MONITORING PLAN

The hydrologic monitoring plan would be the same as for the proposed project. See Section 2.1.7.

2.4 NO-ACTION ALTERNATIVE

Under the no-action alternative, neither proposed well sites nor access roads would be constructed, production and injection well drilling activities would not take place and well testing would not occur, pipelines would not be built, and construction and operation of a 10 MWe (net) binary power plant would not take place as proposed by Pacific Energy.

2.5 SUMMARY OF IMPACTS

The summary of impacts for the four alternatives is in Table 2-5. See Chapter 4 for a complete discussion of impacts.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
AIR QUALITY								
Dust Generation	An estimated 16 tons per month of dust would be generated during construction. Project includes soil wetting, placing gravel on unpaved roads, and prompt revegetation and paving or covering of disturbed areas.	Limit speeds on dirt roads to 15 mph.	Estimated 18 tons per month of dust generated during construction. This alternative includes the same measures to reduce impacts as the proposed project.	Same as proposed project	Estimated 14 tons per month of dust generated during construction. This alternative includes the same measures to reduce impacts as the proposed project.	Same as proposed project	No construction would occur.	No mitigation is recommended.
Heavy Equipment Emissions	Diesel exhaust emissions would occur during grading and construction on 13 acres.	No mitigation is recommended.	Diesel exhaust emissions would occur during grading and construction on 15 acres.	No mitigation is recommended.	Diesel exhaust emissions would occur during grading and construction on 12 acres.	No mitigation is recommended.	No construction would occur.	No mitigation is recommended.
Hydrogen Sulfide Emissions	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 8 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 9 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	About one kilogram of H2S per hour would be vented to the atmosphere during short-term (2 to 4 hours) well testing and clean out of 6 wells. The project includes an H2S emergency plan.	No mitigation is recommended.	No well drilling would occur.	No mitigation is recommended.
	A spill of the entire production of geothermal fluid would release approximately 0.76 kilograms of H2S.	No mitigation is recommended.	A spill of the entire production of geothermal fluid would release approximately 0.91 kilograms of H2S.	No mitigation is recommended.	A spill of the entire production of geothermal fluid would release approximately 0.58 kilograms of H2S.	No mitigation is recommended.	No geothermal fluid would be used.	No mitigation is recommended.
Hydrocarbon Emissions	Fugitive emissions of isobutane (less than 750 lbs/day) would occur from leaks in the heat exchange system. Project includes leak detection program. The Great Basin Unified Air Pollution Control District would require the use of Best Available Control Technology if it were necessary to meet their permit conditions.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Fugitive emissions of isobutane (less than 500 lbs/day) would occur from leaks in the heat exchange system; otherwise, this alternative is the same as the proposed project.	No mitigation is recommended.	No additional isobutane would be used or stored in the area.	No mitigation is recommended.
	A catastrophic rupture in the heat exchange system could release 20,000 gallons of vaporized isobutane which could form a flammable vapor cloud. Project includes a leak emergency plan.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No additional isobutane would be used or stored in the area.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
GEOLOGY AND SOILS								
Seismicity	Severe groundshaking would occur during a major seismic event.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No new facilities would be built.	No mitigation is recommended.
			Ground rupture within the plant could cause ruptured geothermal or isobutane lines or collapse of structures.	Perform geophysical studies. Trench along any suspected fault. If found, date fault. Incorporate isolation valves at both ends of surface pipelines whcih cross active faults. Relocate power plant facilities sited on the fault.	Same as proposed project.	Same as proposed project.	No new facilities would be built.	No mitigation is recommended.
Shallow Geothermal Fluids	The likely presence of shallow hot water or steam could damage power plant facilities.	Perform borings to verify current water levels. If necessary, change grading plans or relocate power plant.	If shallow or surficial warm water exists, there could be hazards.	Perform borings to verify current water levels. If necessary, change grading plans.	Same as proposed project, except that smaller power plant could be moved west up to 80 feet and remain on the designated power plant site.	Same as the proposed project.	No new facilities would be built.	No mitigation is recommended.
Volcanism	If a major volcanic eruption occured, a catastrophic spill of geothermal fluids and/or isobutane could occur.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	Same as proposed project.	No mitigation is recommended.	No new facilities would be built.	No mitigation is recommended.
Subsidence	Surface subsidence could result from long-term geothermal production. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	Surface subsidence could result from long-term geothermal production. These impacts would be greater than for the proposed project since 20% more fluid would be produced. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	Surface subsidence could result from long-term geothermal production. These impacts would be less than proposed project because less fluid would be pumped. Project includes construction of subsidence monuments to detect significant surface deformation.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Erosion	Construction would disturb 13 acres. Erosion control measures are included in the project and required by the BLM and Lahontan Regional Water Quality Control Board. Runoff could be captured in the emergency spill containment basins to allow settling of sediments before flow reaches Mammoth Creek.	No mitigation is recommended.	Construction would disturb 15 acres. Erosion control measures are included in the project and required by the BLM and Lahontan Regional Water Quality Control Board. Erosion would affect a larger area and could impact the ephemeral lakes northwest of the alternative power plant site.	Construct berms to direct runoff leaving the power plant site so it would flow away from the ephemeral lakes.	Construction would disturb 12 acres; otherwise, this alternative is the same as the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

	PROPOSED PROJECT		ALTERNATE LOCATION		SMALLER POWER PLANT ALTERNATIVE		NO-ACTION ALTERNATIVE	
	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation
Erosion (continued)	Closing the sluice gates on the emergency spill containment basins during construction could allow unnecessary accumulations of water resulting in damage to vegetation and "bathtub" lines if intermittent stream were flowing.	If the intermittent stream is flowing during construction, leave the sluice gates open unless there were an emergency which would call for its use.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No emergency spill containment basins would be constructed.	No mitigation is recommended.
NOISE								
Construction Noise	Heavy equipment and traffic to and from the site would generate noise, but it would not be audible at the nearest sensitive receptors. Peoples and wildlife nearby would be temporarily affected.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No construction would occur.	No mitigation is recommended.
Operational Noise	The power plant would operate 7 days a week, 24 hours a day. The combined effect of the noise from MP I and PLES I would be about 3 decibels louder than MP I alone. Noise muffling devices are included the design. According to GRO Order No. 4, noise levels would not exceed 65dBA at the lease boundary or 0.5 mile, whichever is further.	No mitigation is recommended.	Noise generted at the alternate power plant site would not blend with noise from MP I because of the distance between the two power plants. A larger area would be impacted.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Noise levels would remain the same.	No mitigation is recommended.
WATER QUALITY AND HYDROLOGY								
Surface Water	Spills of geothermal fluid would be almost certainly contained in bermed areas or in the emergency spill containment basins. In the unlikely event that the roadbed at Route 203 failed and fluid reached Mammoth Creek, under extreme conditions of low stream flow and high ambient temperature, the temperature of the mixed water at the point of entry to Mammoth Creek could reach 118%F. This would cause mortality of fish and other aquatic organisms. Degradation of water quality would occur and could also harm aquatic organisms. The operator would stock the affected reach of Mammoth Creek.	A bioassay would be required in the Plan for Baseline Data Collection.	Same as the proposed project. The greater quantity of fluid required to operate at the alternative location be compensated for by the cooling and infiltration which would occur as the water flowed toward Mammoth Creek.	Same as the proposed project.	Impacts would be like those of the proposed project, except that due to the smaller volume of fluid pumped, the the mixed temperture in the extreme-case spill would be 100 F.	Same as the proposed project.	Spills from MP I which overflowed the bermed areas would flow to Mammoth Creek.	No mitigation is recommended.
Shallow Fresh Groundwater	Vegetation could be impacted if water is used for irrigation and sanitary uses.	Reduce groundwater pumping.	Slightly more groundwater would be used for irrigation of more landscaping and revegetation.	Same as proposed project.	Slightly less groundwater would be used than for the proposed project because of the smaller area	Same as proposed project.	Groundwater consumption would not increase at Casa Diablo.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
WATER QUALITY AND HYDROLOGY (continued)								
Hydrothermal Resources	Simulated reservoir performance calculations using three different methods predict minor changes to reservoir pressure and temperature due to project operation. The project includes a comprehensive monitoring/mitigation program. One monitoring well has been drilled. The well would be monitored for baseline data. Potential migrations include a variety of reservoir management techniques which would first be triggered by observations in production and injection wells. Subsequent actions would occur, including the drilling of another monitoring well, based on analysis of monitoring results from a variety of natural features and wells. Ultimately, reduction or cessation of power production could be required to protect sensitive hydrothermal resources. If temperatures in Hot Creek headsprings change enough to deviate from their normal ranges, the operator would supply water from another source to allow continued operation of Hot Creek Hatchery and maintenance of the Owens tui chub habitat.	Change some trigger mechanisms (see Section 4.1.4.3.1 in the body of the EIS/ Supplemental EIR. Install a monitoring well near existing monitoring well SF 65-32 which would penetrate the injection reservoir. Before commercial power plant operation begins, require that a detailed program for timely implementation of remedial action measures to supply water to Hot Creek headsprings be approved by the authorized officer.	Same as proposed project, except that up to 20% more geothermal fluid would be pumped for the alternative location.	Same as proposed project.	Same as proposed project, except that 24% less geothermal fluid would be pumped for the smaller power plant alternative.	Same as proposed project.	PLES I could not impact hydrothermal resources.	No mitigation is recommended.
	If, contrary to all reasonable expectations, flow at Hot Creek Gorge fumaroles and springs were diminished by project operations, it would have less value as a geologic interpretive site.	Inject geothermal water upgradient of Hot Creek Gorge to restore flows.	Same as proposed project, except that up to 20% more geothermal fluid would be pumped for the alternative location.	Same as proposed project.	Same as proposed project, except that 24% less geothermal fluid would would be pumped for the smaller power plant alternative.	Same as proposed project.	PLES I could not impact hydrothermal resources.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
BIOLOGICAL ENVIRONMENT								
Vegetation	Approximately 13 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. The project includes vegetation protection measures and extensive revegetation.	No mitigation is recommended.	Approximately 15 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. Rhyolite buckwheat scrub would be disturbed by pipelines. Otherwise, this alternative would be the same as the proposed project.	Relocate injection pipelines to avoid rhyolite buckwheat scrub.	Approximately 12 acres of sagebrush scrub and Jeffrey pine plant communities would be lost. The project includes vegetation protection measures and extensive revegetation.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Terrestrial Wildlife	The habitat which would be lost is common in the region. No impacts to sage grouse, pygmy nuthatch, bald eagle, peregrine falcon, northern goshawk, Williamson's sapsucker, yellow warbler, hairy woodpecker, or special status animal species would occur.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
	Noise may affect wildlife around the power plant, but no clear impacts can be defined.	No mitigation is recommended.	If noise impacts wildlife populations, the affect would occur over a larger area if the alternative power plant site were used.	Locate the power plant at the proposed site.	Same as for the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Mule Deer	Approximately 70 deer were found to use the project area during the spring 1987 migration. They could be affected by pipelines, fencing, and the power plant. Does carrying fawns may be more vulnerable. The proposed project includes below-grade pipeline installation were appropriate. All fencing would be approved by the BLM.	New projects could contribute to off-site mitigation measures in proportion to their impacts.	Impacts to deer would be more severe for this alternative because a larger area would be disrupted and the pipelines would be longer.	Locate the power plant at the proposed site and contribute to off-site mitigation.	Same as for the proposed project.	No mitigation is recommended.	There would be no project impacts.	No mitigation is recommended.
Aquatic Resources	Impacts to aquatic resources are highly unlikely, as described in the hydrology summary. See that section for a discussion of impacts to water quality. The Lahontan Regional Water Quality Control Board has a variety of requirements to protect water quality. Fish would be restocked if mortality resulted from project activities.	A bioassay would be required in the Plan for Baseline Data Collection.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as proposed project.	There would be no project impacts.	No mitigation is recommended.
Owens Tui Chub	The Owens tui chub, found in some of the Hot Creek headsprings, would be protected under the progressive monitoring/mitigation program described under hydrology.	See mitigations listed under hydrology.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as proposed project.	There would be no project impacts.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT		ALTERNATE LOCATION		SMALLER POWER PLANT ALTERNATIVE		NO-ACTION ALTERNATIVE	
	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation
SOCIAL ENVIRONMENT								
Cultural Resources	Construction and operations personnel could collect or disturb cultural artifacts.	Educate project personnel to the need to leave cultural remains undisturbed.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	The injection pipeline would pass immediately adjacent to Cultural Resource Sites-7, -8, and -9. Careless use of equipment could damage the sites during laying of the line.	Flag the designated route before work begins and avoid during construction.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	Subsurface resources may be encountered during construction. If such artifacts are found, construction would stop until suitable actions, approved by the Inyo Forest Supervisor, were taken.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Native American Values	Traditional Native American interests often include areas around hot springs and fumaroles for their special soils and plants and for the springs themselves. Although no specific sites in the project area have been identified as sacred, Pacific Energy has indicated that continued access would be provided.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Range	Approximately two AUMs would be lost to the permittee.	No mitigation is rescommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
Recreational Resources	In the highly unlikely event that the geothermal features at Hot Creek Gorge were reduced or depleted, a feature which accounts for 95,000 visitor days per year would be lost.	Inject geothermal water upgradient of Hot Creek Gorge to restore flows.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.
	The trout-stocking program would be adversely affected if the hatchery could not function year-round.	See the discussion in the hydrology section.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	There would be no project impacts.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT		ALTERNATE LOCATION		SMALLER POWER PLANT ALTERNATIVE		NO-ACTION ALTERNATIVE	
	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation	Impact	Mitigation
SOCIAL ENVIRONMENT (continued)								
Timber	Up to 40,000 board-feet of timber would be harvested. The site is not managed for timber production and is not included in the Inyo National Forest timber base.	No mitigation is recommended.	Up to 220,000 board-feet of timber would be harvested. Otherwise, impacts would be the same as for the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No timber would be harvested.	No mitigation is recommended.
Transportation and Access	Traffic impacts would be minor. If peak project traffic occurred during winter weekend traffic periods, project traffic would be routed to Hot Springs Road at Sherwin Creek Road, if necessary, thereby avoiding the busier Route 203 offramp from Highway 395.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	Unpaved existing roads on the project site would be used for access.	No mitigation is recommended.	The power plant site would be reached by the unpaved dirt road leading to the SCE substation.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
Visual Resources	Drilling rigs would be visually strong but temporary elements. After wells were completed, they would be screened by vegetation.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	The power plant would be the most visible element of the project, visible from Route 203 and northbound Highway 395. Existing and transplanted trees would mostly screen the power plant from view, but there would be narrow corridors through which the full 30-foot height of the condensers could be seen. The extensive landscaping, revegetation, and camouflage proposed as part of the project would reduce impacts. There would be no overhead electrical transmission lines. Exterior surfaces would be non-reflective to the extent feasible, exterior night lighting would be minimized, and natural terrain and vegetation would be used to provide visual screening.	No mitigation is recommended.	The power plant would not be visible from Route 203 or Highway 395. It could be seen from Antelope Springs Road, an unpaved road serving dispersed recreation in Little Antelope Valley.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Lanscaping of the area east of MP I where pipelines cross Hot Springs Road would not be done.	No mitigation is recommended.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT (continued)								
Community Services	The number of students would increase slightly	The school district may assess fees on commercial development.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
	No significant demands on law enforcement are expected.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	No project impacts would occur.	No mitigation is recommended.
	Health care facilities would be adequate to treat all injuries except for severe burns or scalds. Local facilities are not equipped to handle such cases and they would be evacuated.	Revise local emergy response plans to include geothermal accidents. Train on-site personnel in CPR. Develop evacuation procedures for burn victims.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Similar burn accidents could occur at the MP I plant.	Same as the proposed project.
	The proposed project has a fire prevention and protection plan approved by the Long Valley Fire Protection District.	No mitigation is recommended.	Same as the proposed project.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Street and Road Maintenance	Construction traffic may result in the need for additional maintenance or repair on county and Forest Service roads.	Transfer the cost of repairing damage caused by project activities to the operator. A performance bond could be posted or user fees assessed.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Wastewater, Solid Waste, and Utilities	About 300 gallons per day of wastewater would be generated. Solid waste would be taken to the Benton Crossing landfill. Electricity would be bought from SCE if needed.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Hazardous Materials	Some hazardous materials such as diesel fuel, paints, or solvents would be used and stored on the project site. Regional Water Quality Control Board requirement would be followed where applicable.	Follow proper procedures for use, storage, and disposal of all potentially hazardous materials.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	Same as the proposed project.	No project impacts would occur.	No mitigation is recommended.
Geothermal Resource Lease	The proposed project would result in the beneficial use of the geothermal resources within the federal geothermal lease.	No mitigation is recommended.	Same as the proposed project.	Same as the proposed project.	The reduction in output to 7 MWe would constitute a breach of the existing power agreement between the applicant and SCE and could result in termination of the project.	Approve the proposed project.	This alternative would prohibit development of the geothermal lease as currently proposed and could result in forfeiture of the lease.	Approve the proposed project.

TABLE 2-5: SUMMARY OF IMPACTS AND MITIGATION MEASURES FOR ALL ALTERNATIVES (Continued)

RESOURCE	PROPOSED PROJECT Impact	PROPOSED PROJECT Mitigation	ALTERNATE LOCATION Impact	ALTERNATE LOCATION Mitigation	SMALLER POWER PLANT ALTERNATIVE Impact	SMALLER POWER PLANT ALTERNATIVE Mitigation	NO-ACTION ALTERNATIVE Impact	NO-ACTION ALTERNATIVE Mitigation
SOCIAL ENVIRONMENT (continued)								
Land Use and Planning	The proposed project would change the partially undeveloped character of the site to one of light industrial activity. The project is compatible with Forest Service plans and would not conflict with existing or planned uses in the area.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	No land use changes would occur.	No mitigation is recommended.
Employment, Population, and Housing	An average of 48 workers would be employed over the 9-month construction period, peaking with 82 workers in the fifth month. 16 full-time employees would operate the facility when commercial production begins. Outside workers could cause an increased demand for housing at the lower end of the price scale, potentially increasing housing prices.	Time construction to avoid having the peak construction housing needs coincide with the peak winter housing demand.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	Same as for the proposed project.	No project impacts would occur.	No mitigation is recommended.
Economics	The local economy would benefit from the payroll paid to workers, which would be similar to the MP I payroll ($451,000 in 1986), and from plant purchases. The year-round operation of the plant would help stabilize the highly seasonal nature of employment and retail sales.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	The community would forego the economic benefits of the project.	No mitigation is recommended.
	In the highly unlikely event that water temperature changes at Hot Creek Hatchery prevented year-round operation, the hatchery would lose eggs worth up to $16,000 annually at current market rates. In addition, a major portion of the facilities for backcountry aerial planting would have to be moved to other hatcheries. The power plant operator is obligated to supply water to the hatchery so that normal operations can be maintained.	See mitigations described in the hydrology section.	Same as for the proposed project.	No mitigation is recommended.	Same as for the proposed project.	Same as for the proposed project.	No project impacts would occur.	No mitigation is recommended.
	County revenues would increase by about $250,000 per year from property taxes, sales taxes, and a portion of the geothermal lease.	No mitigation is recommended.	Same as for the proposed project.	No mitigation is recommended.	Lower revenues would be generated by the proposed project.	No mitigation is recommended.	The community would forego the economic benefits of the project.	No mitigation is recommended.

3.0 AFFECTED ENVIRONMENT

This analysis of existing conditions is based on the Affected Environment chapter from the earlier EA, but there have been a number of changes. The descriptions have been broadened to include the area of the alternate power plant site. In response to public concern, more information has been included in the biology, hydrology, and cultural resources sections. Additional information from an air quality study done by Great Basin Unified Air Pollution Control District, from a rare plant survey in the Casa Diablo area, and from a geotechnical report on geologic hazards at the proposed power plant site have also been incorporated into this EIS/SEIR. Finally, improvements in equipment operations at the MP I power plant have reduced noise levels and decreased isobutane emissions and these changes are reflected in the appropriate descriptions.

3.1. PHYSICAL ENVIRONMENT

3.1.1 AIR QUALITY

3.1.1.1 Climatological and Meteorological Setting

The following discussion of existing meteorology in the area largely summarizes findings from a meteorological and air quality assessment report prepared for the Mammoth Lakes-Long Valley Caldera area (Tesche, T.W., 1985).

The climate in the eastern Sierra region is predominantly influenced by the large-scale anticyclone centered off the west coast and known as the Pacific High. This semipermanent Pacific high-pressure system moves south in the winter and north in the summer. The Pacific High typically directs storms northward into Oregon and Washington in the summer creating a warm dry climate in the region. In the winter, the high-pressure cell moves south allowing the westerly storm front to bring precipitation, rain and snowfall, to the region.

Frontal activity generally begins in October with intermittent activity for about four to five months, and about 20 to 30 frontal systems pass through the air basin each winter.

Spring is less subject to cloudiness or precipitation but is typically the windiest season of the year. Summers are typically warm and dry with clear skies; however, heavy thundershower activity can occur. Fall has low seasonal precipitation and is usually a transition period between the summer thundershower activity and the winter frontal activity. Annual precipitation within the region varies widely, in part, because of the rain shadow effects of the Sierra Nevada Mountains and ranges from an annual average of 9.87 inches at Lake Crowley (elevation about 6,800 feet) to 29.46 inches at Lake Mary (elevation about 8,900 feet).

Regional summer daytime temperatures range from 65°F to 90°F, and nighttime temperatures range from 37°F to 55°F (WESTEC Services, Inc., 1986). The mean minimum and maximum temperatures for the winter months, December through February, are approximately 27°F and 31°F, respectively, at the Mammoth Ranger Station (Tesche, T.W., 1985).

Typical wind flow is from the west or northwest, but wind direction is strongly influenced by local topography. Wind patterns in the summer are typically orographic influenced systems with daytime upslope (valley winds) and nighttime downslope winds. In the winter, cyclonic storms typically generate wind speeds ranging from 10 to 20 mph; however, winds venting through the Mammoth Summit pass can gust from 50 to 70 mph with occasionally more severe gusts. Santa Ana winds can occur at any time of the year bringing warm dry easterly winds to the area (WESTEC Services, Inc., 1986).

Temperature inversions are meteorologically important with respect to air quality because they inhibit the vertical dispersal of pollutants. A temperature inversion occurs when cool air underlies warmer air. Two basic types of inversion systems occur within Long Valley: radiation and subsidence inversions. Radiation inversions occur on clear cold nights, typical of winter conditions, and are of short duration; while, subsidence inversions are associated with large scale compressional heating of the air column and may last for extended periods.

Climatological information on the structure of temperature inversions in the Mammoth Lakes region is sparse. Generic study results suggest that the average morning mixing heights range from 350 meters in fall to 650 meters in spring. Afternoon mixing heights range from 2,800 meters in summer to about 1,100 meters in winter.

The Great Basin Unified Air Pollution Control District has constructed a meteorological station within the project area on existing well site SF 35-32. Continuous meteorological data collection, including: ambient air temperature, wind speed, and wind direction, began in January of 1987. A similar meteorologic data collection activity was initiated by the Great Basin Unified Air Pollution Control District at the old Mammoth school, approximately 2.5 miles east of the project site.

3.1.1.2 Air Quality Setting

Although limited air quality monitoring information for the region is available, the Great Basin Unified Air Pollution Control District has monitored the Mammoth Lakes area since 1979 for four criteria pollutants (those for which federal ambient air quality standards have been established), including: total suspended particulates, particulate matter smaller than 10 microns in diameter (PM_{10}), carbon monoxide, and ozone. Other pollutants have been monitored intermittently by either the Great Basin Unified Air Pollution Control District or the California Air Resources Board. Air quality within the Mammoth Lakes/Long Valley area can generally be characterized as good during the summer months; however, during winter months federal and/or state air quality standards for ozone, nitrogen oxides, carbon monoxide and particulate matter have occasionally been exceeded (California State Air Resources Board, 1986).

Mono County is currently "unclassified" for most criteria air pollutants; however, it was recently designated a nonattainment area for particulate pollutants (PM_{10}) (Cox, W.G., 1987a). This, in large part, is attributable to limited air circulation during winter radiation inversion periods and the heavy use of wood burning stoves.

The Great Basin Unified Air Pollution Control District monitored PM_{10} and H_2S levels from January 1987 through December 1987 at a monitoring station approximately one mile east of the proposed project site, near the intersection of Hot Springs Road (old Highway 395) and Sherwin Creek Road (Great Basin Unified Air Pollution Control District, 1988). The purpose of the monitoring was to determine baseline concentrations upon which to evaluate the air quality effects of full-cycle geothermal resource development on the populated areas within Long Valley. The baseline concentrations of these pollutants were found to be well below the applicable ambient standards. For the PM_{10}, the maximum 24-hour average level was 20 micrograms per cubic meter (ug/m^3), and the annual arithmetic mean was 12 ug/m^3, compared to the state standards of 50 ug/m^3 and 30 ug/m^3, respectively. The maximum one-hour average H_2S level was 0.01 ppm, one-third of the ambient standard of 0.03 ppm.

The H_2S levels that were monitored primarily reflect the H_2S emitted by natural vents and hot springs.

3.1.1.2.1 Hydrogen Sulfide

H_2S is a colorless gas often associated with geothermal systems. It is malodorous at relatively low concentrations and can be detected by some persons at concentrations as low as 0.025 ppm. At higher concentrations (50 to 450 ppm) the gas causes throat and eye irritation, and at very high concentrations (greater than 500 ppm) H_2S can result in respiratory paralysis and death. The maximum allowable concentration for an eight-hour occupational work exposure is 20 ppm without protective breathing equipment (8 CAC 5155). There is no federal ambient air standard for H_2S.

Geothermal fluids typically contain naturally occurring gases (noncondensable gases), predominantly carbon dioxide, which may escape from the fluid when it is exposed to the atmosphere. Some of these gases, in particular H_2S, are considered air pollutants. Noncondensable gases contained within geothermal fluids produced from the existing project production well SF 35-32 are typical of those found near Casa Diablo Hot Springs and are identified in Table 3-1.

The state one-hour ambient air standard for H_2S (0.03 ppm) was equalled on two occasions during a one-year monitoring period conducted within the Long Valley Caldera near the Hot Creek Hatchery by the Great Basin Unified Air Pollution Control District (WESTEC Service, Inc., 1986). It is believed that natural geogenic sources, hot springs and fumaroles, in the immediate vicinity of the monitoring station were the principal source of the H_2S. Hot springs and fumaroles in the project vicinity are also believed to be natural sources of H_2S emissions.

3.1.1.2.2 Hydrocarbons

Volatile hydrocarbons represent a broad spectrum of naturally occurring and man made substances. Hydrocarbons are not criteria air pollutants but are recognized as precursors of photochemical oxidants, including ozone, formed through atmospheric photochemical reactions.

TABLE 3-1: NONCONDENSABLE GASES CONTAINED WITHIN WELL SF 35-32/a/

Noncondensable Gases	Concentration (mg/1)
Ammonia	0.26
Argon	0.02
Carbon Dioxide	950
Hydrogen	<0.01
Hydrogen Sulfide	6.04
Methane	<0.001
Nonmethane Hydrocarbons	Not Analyzed/b/
Nitrogen	1.52

/a/ Well flow test September 4 to 6, 1986.
/b/ Total collective nonmethane hydrocarbon content is typically less than the methane content of geothermal fluids.

SOURCE: Pacific Energy

The tendency for different hydrocarbons to enter into photochemical reactions varies widely. This relative tendency is referred to as reactivity. Some hydrocarbons such as methane are nearly inert with respect to photochemical reactions; others such as unsaturated hydrocarbons (olefins) and aromatic hydrocarbons (substances containing one or more benzene rings structures) are very reactive. Sources of reactive hydrocarbons into the atmosphere include vehicular traffic; vegetation, particularly trees (predominantly terpenes and hemiterpenes); and the Mammoth-Pacific I geothermal power plant (MP I). Isobutane is a simple alkane (saturated hydrocarbon) and is considered slightly reactive.

At the MP I plant, sources of fugitive emissions of isobutane resulting from maintenance operations; the turboexpander; and miscellaneous seals, flanges, joints, and valves averaged about 4.6 cubic feet per minute (approximately 1,000 lbs per day) until April 1987 (Asper, W., 1987). Since that time, fugitive emissions have been reduced and are currently 188 lbs/day (Pacific Energy, 1988 Report).

At atmospheric pressure and 15°C (59°F), isobutane is a gas. Other physical characteristics of isobutane are shown in Table 3-2.

TABLE 3-2: PHYSICAL CHARACTERISTICS OF SELECTED HYDROCARBON FLUIDS/a/

Characteristics	Propane	Isobutane
Chemical Formula	$CH_3CH_2CH_3$	$(CH_3)_2CHCH_3$
Formula Weight	4 9 grams	58.12 grams
Form and Color	Colorless Gas	Colorless Gas
Specific Gravity	0.585	0.60
Boiling Point	-42.2°C (-44°F)	-10°C (14°F)
Solubility in Water	6.55 cc/100 cc	Insoluble
Flash Point (Est.)/b/	-156°F	-120°F
Flammable Limits (% Volume in Air)	2.1 to 9.5%	1.8 to 8.4%

/a/ Chemical Engineer's Handbook, Fifth Edition, 1973, Perry, R.H., and C.H. Chilton (eds.), McGraw-Hill Book Company.
/b/ Material Safe Data Sheets, Product Manufacturers.

3.1.1.3 Regulatory Framework

Local air quality must meet both federal and state ambient air quality standards as enforced locally by the Great Basin Unified Air Pollution Control District. Stationary sources of aerial emissions must also satisfy the Rules and Regulations of the Great Basin Unified Air Pollution Control District. The Great Basin Unified Air Pollution Control District has developed specific regulations with respect to H_2S and isobutane emissions from geothermal sources./1/

/1/ The MP I facility is currently operating under a permit to operate issued by the Great Basin Unified Air Pollution Control District. Reportable emissions of isobutane for the initial reporting period ending July 1, 1988, averaged 188 pounds per day within the allowed fugitive losses of 250 pounds per day per unit (Pacific Energy, 1988 Report).

Permits (Authority to Construct) would be required for all geothermal production and injection wells prior to drilling. Permits to Operate the wells would also be required from the District before commercial operation. The potential for unacceptable emissions of H_2S during drilling and testing operations is of specific concern. The Great Basin Unified Air Pollution Control District limits emissions from geothermal wells to 2.5 kg per hour per well (about 5.5 lb per hour per well). The state ambient air quality standard for H_2S is 0.03 ppm. There are no federal emission standards for H_2S.

Similarly, the Great Basin Unified Air Pollution Control District will require a permit for Authority to Construct and a Permit to Operate the PLES I geothermal power plants. The power plant will not be a source of stack emissions; however, the power plant could be a significant source of fugitive emissions of isobutane working fluid from leaking equipment, pipes, flanges, and fittings. While isobutane is not a photochemically reactive solvent as defined by Great Basin Unified Air Pollution Control District Rule 417(J); non-methane hydrocarbons, as a group, are generally considered primary air pollutants because of their role in atmospheric chemical reactions which generate secondary criteria oxidant air pollutants for which both state and federal ambient air quality standards exist. As such, fugitive hydrocarbon emissions in excess of 250 pounds per day may be subject to Great Basin Unified Air Pollution Control District New Source Performance Requirements [Rule 209-A(B.2.a)]. Such sources could be required to employ Best Available Control Technology [Rule 209-A.(D.)] to mitigate fugitive hydrocarbon emissions (Hardebeck, E., 1987).

3.1.2 GEOLOGY, SOILS, AND EROSION

3.1.2.1 Regional Geologic Setting

The project area is located within the Long Valley Caldera, an elliptical depression covering approximately 172 square miles on the eastern front of the Sierra Nevada in southern Mono County, California. The long axis of the ellipse is aligned east-west and measures 19 miles in length; the short axis is eleven miles long. The caldera is bounded on the south and west by Sierran granitic rocks of Jurassic-Cretaceous age and older metamorphosed volcanic and sedimentary rocks present as roof pendants within the granitic rocks. A prominent Tertiary-Quaternary volcanic ridge forms the northern boundary and an unnamed dissected volcanic tableland, also of Tertiary-Quarternary age, forms the eastern caldera margin.

Long Valley proper is a northwest-trending depression in part occupied by the Owens River and Lake Crowley. The primary drainage direction within the caldera is from west to east and from north to south. Most intra-caldera streams are tributaries of the Owens River or flow directly into Lake Crowley.

Volcanism within Long Valley region began approximately three million years ago. A massive caldera-forming event occurred approximately 700,000 years ago with the catastrophic eruption of 600 cubic kilometers of pyroclastic flows and ash falls (Hill D.P., et al., 1985a). The accumulated ash deposits overlie the Sierran basement rock and are known as the Bishop Tuff. Post-caldera rhyolites erupted episodically between 700,000 and 600,000 years ago, accumulating within the caldera and overlying the Bishop Tuff to a thickness of at least 1,500 feet. During this time the west-central part of the caldera floor was uplifted to form a resurgent dome. Between 500,000 and 100,000 years ago, porphyritic rhyolite lavas erupted in the north, south, and west moats on the periphery of the resurgent dome. The resurgent dome is roughly circular in shape (approximately seven miles in diameter), and has been broken by faulting into a complex series of blocks, bounded by normal faults. These faults have an overall northwest trend, paralleling the primary direction of regional faulting (see Figure 3-4, Hydrology Section). Rim eruptions of porphyritic rhyodacites occurred 200,000 to 50,000 years ago. The eruption of basaltic to trachyandesitic lava flows and cinder cones in the south and west moats were synchronous with these rim volcanics. The most recent volcanic activities are the phreatic eruptions at the Inyo Domes and Inyo Craters in the northwest corner of the caldera and beyond the northwest rim (GeothermEx, Inc. 1986). The youngest of these domes is approximately 700 years old, and it has been estimated that the craters were formed about 450 years ago.

3.1.2.2 Local Geologic Setting

The project area is located along the southwestern edge of the resurgent dome of the Long Valley Caldera. Much of the subsurface geology has been determined by geothermal well drilling activities in the area. The surface geology is dominated by post-caldera rhyolite lavas which form the resurgent dome and the moat basalt/andesite. A thin alluvium of 10 to 40-foot thickness covers these flows in most locations. The moat basalts and andesites are dark grey, porphyritic flow rocks with plagioclase and rare olivine crystals contained in aphanitic groundmasses. The basalt's north contact approximately follows Old U.S. Highway 395 in the area near Casa Diablo Hot Springs (Casa Diablo area).

Immediately below these basalt flows is a 1,200 to 1,500 foot thick rhyolitic lava interval. This post-caldera series of rhyolite flows with minor interbeded tuffs is the rock which forms the resurgent dome and constitutes the geothermal reservoir currently being exploited in the Casa Diablo area. Below the rhyolites is an 80 to 140 foot thick "landslide" horizon that is composed of granitic and metasedimentary lithic clasts which may represent a paleosol.

The Bishop Tuff occurs beneath the "landslide" horizon. One deep well drilled in the Casa Diablo area, Union Mammoth #1, penetrated the full thickness (3,250 feet) of the Bishop Tuff and drilled into basement rock.

3.1.2.3 Geothermal Production and Injection Reservoirs

The Casa Diablo geothermal production reservoir interval is approximately 300 to 600 feet below the surface within highly fractured rhyolite lavas. Lost circulation during drilling operations and sudden increases in penetration rate indicate open fractures within the reservoir. The rhyolite appears to be the reservoir lithology mainly because it is brittle and hard, which allows the rhyolite to fracture and to maintain open fractures, as opposed to the overlying basalt and underlying tuffs, which fracture poorly and do not tend to maintain large open fractures.

At Casa Diablo the proposed injection zone is below 1,000 feet, within the uppermost portion of the Bishop Tuff. The zone has uniformly high porosity and low density. During earlier drilling of this zone, penetration rates were very fast, reaching 225 feet per hour. This top zone of the Bishop Tuff apparently has sufficient matrix and fine fracture permeability and continuity to allow fluid injection by the existing MP I injection wells without significant pressure buildup (PLES, 1986).

3.1.2.4 Geologic Hazards

The proposed project area exists within a region of earthquake activity and active volcanism. Discussed below are descriptions of seismic, volcanic, and other geologic hazards present in the project area.

3.1.2.4.1 Seismicity

The proposed project area was subjected to significant ground shaking and minor surface rupture during a series of four earthquakes with magnitudes greater than six (Richter scale) during the period May 25 to May 27, 1980 (WESTEC Services, Inc. 1986). The project area is bounded on the west by the so-called "Taylor-Bryant" fault, which was identified on the basis of an elongated zone of ground rupture which appeared during the series of 1980 earthquakes; and the project area is bounded on the east by the Eastern Graben fault (see Figure 3-1). Extensional cracks up to 64-mm wide occurred along faults near the project area, but most cracks were less than 10-mm wide without vertical offset. However, these observations do not preclude the possibility of greater surface rupture offsets from future seismic events (WESTEC Services, Inc., 1986).

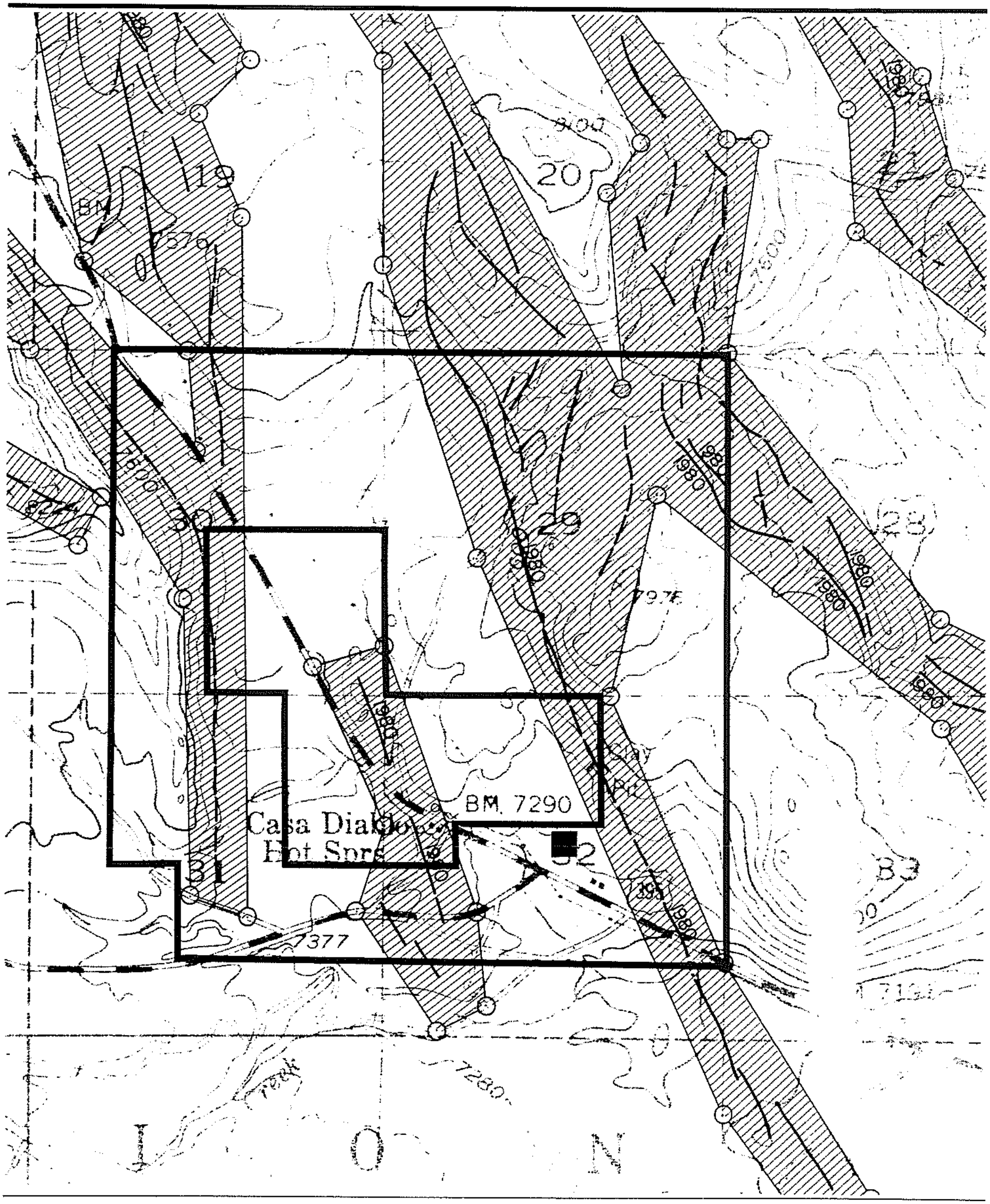
Portions of the project area are near or within the "NW 1/4 Mt. Morrison 15' Special Study Zone" defined as a fault-rupture hazard zone by the California Division of Mines and Geology (Hart, E.W., 1980). As such, those portions of the project area are subject to provisions of the Alquist-Priolo Special Studies Zones Act of 1972 which prohibits construction of structures for human occupancy across the trace of an active fault (California Public Resources Code, Division 2, Chapter 7.5). Neither the proposed, nor the alternate, power plant sites would be located within the special study zones identified by revised fault trace maps (California Division of Mines and Geology, 1982). However, portions of the production and injection well fields may be within the special study zones (see Figure 3-1).

The project area would also be subject to severe ground shaking during a major earthquake. The California Division of Mines and Geology designate the region in a Severity Zone III (high) where the intensity of the maximum expectable earthquake would be IX or X on the Mercalli Intensity Scale (potential that most masonry and frame structures are destroyed, and some wooden structures destroyed). The project area is within Seismic Risk Area 4 as defined by the Uniform Building Code recognized by the state of California, and all buildings and other structural facilities would be subject to zone 4 design and construction criteria (International Conference of Building Officials, 1985./2/ Mono County currently uses the 1985 Edition of the Uniform Building Code for all structural building standards adopted in March 1988 (Mono County Public Works Department, 1988).

3.1.2.4.2 Volcanic Hazard

Geophysical evidence indicates that one or more active magma chambers exist beneath the Long Valley Caldera. The most recent volcanic activity in the Long Valley region is associated with

/2/ The UBC defines seismic zone 4 as those areas in close proximity to major fault systems subject to intensity VII or greater of the Modified Mercalli Scale.



Proposed Power Plant Site

SOURCE: California Division of Mines and Geology

FIGURE 3-1
Identified Faults and Alquist-Priolo Special Study Zones Within the Casa Diablo Area, Mono County, California

the Mono Craters-Inyo Craters eruptive centers, which form a four-km-long, northtrending chain of vents between Mono Lake and the west moat of Long Valley Caldera (Hill D.P., et al., 1985b). This chain of rhyolite volcanoes is about five miles north and west of the Casa Diablo area.

Recent evidence indicating the presence of a magma chamber beneath the caldera includes repeated levelling surveys, which show an inflated area, displaced south of the center of the resurgent dome, which has inflated by approximately 100 cm since the summer of 1979. The steepening of this bulge along the south caldera was correlated with a swarm of earthquake activity during a 1982-83 period (Hill, D.P., et al, 1985a). It was thought that the seismic swarm activity was due to subsurface movement of magma in the south margin of the caldera over a depth interval of three to eight kilometers; however, at this time, after a substantial amount of monitoring, there is no scientific consensus that subsurface movement of magma is actually occurring in the Long Valley area.

3.1.2.4.3 Surface Deformation and Subsidence

A broad pattern of surface deformation in the caldera has been noted since the increase in earthquake activity along the length of the eastern escarpment of the Sierra Nevada range began in mid-1978. Uplift in the Casa Diablo area of nearly 100 cm occurred during the period 1978 to 1984 and is believed to be associated with inflation of the resurgent dome (Hill, D.P., et al., 1985b). Most of this uplift is believed to have occurred during the May 1980 sequence of earthquakes. The U.S. Geological Survey improved the surface deformation monitoring capabilities in the south moat area subsequent to the May 1980 earthquake sequence to include three separate compact trilateration and leveling figures which have since been measured with frequencies that vary from daily to monthly. Since the 1982-1983 swarm of earthquake activity, the measured rate of inflation in the Casa Diablo area has decreased substantially.

Induced surface subsidence can occur when a large volume of fluids is extracted from a shallow subsurface reservoir which is not replenished by natural recharge or injection of fluids. Pore pressures decrease within a reservoir when fluid production occurs, and, if the reservoir rock is compressible, compaction of the reservoir can occur. This reservoir compaction can create a subsidence bowl. A small amount of subsidence could also occur due to thermal contraction of subsurface rocks cooled by the extraction of hot fluids being replaced by cooler fluids.

At Casa Diablo, geothermal production supplying the MP I geothermal power plant has continued since 1984. After three (3) years of continuous commercial production at the existing MP I power plant, located in the same general Casa Diablo geothermal resource area, geothermal fluid drawdown in the existing production wells is negligible, indicating pore pressure within the reservoir has not changed significantly. A broad expanse within the Long Valley Caldera, including the Casa Diablo Hot Springs area, has risen a maximum of 0.15 meters, decreasing to 0.02 meters at 30 kilometers distance, since mid-1983 according to U.S. Geological Survey benchmark data. This is generally associated with the rise of the resurgent dome, which began before the MP I power plant began operation in late 1984. Between mid-1985 and mid-1986, the benchmarks near the power plant did not rise as fast as the other benchmarks in the region. The area generally stabilized between mid-1986 and mid-1987, and some slight subsidence occurred during this time, centered at a location about 1,500 feet south of the MP I power plant, near the intersection of State Route 203 and Old Highway 395. Subsidence at the power plant was about 0.6 centimeters, while subsidence at the intersection was about 1.8 centimeters. Recent survey data relating individual well elevations to the benchmark at the power plant show that the wells themselves have all moved less than 15 centimeters relative to the benchmark since they were originally surveyed (1982, 1983, or 1984). The wells west of the Taylor Bryant fault at the western edge of the well field have risen less than those to the east, suggesting a tectonic relationship, which may have been related to movement during the November 1984 earthquake (Mesquite Group, Inc. 1988).

3.1.2.4.4 Shallow Geothermal Fluids

Resistivity surveys conducted by SEA, Incorporated (1988) identified hydrothermally cemented soil layers which suggest that there may be shallow hot water or steam at the proposed power plant site.

3.1.2.5 Soils and Erosion Potential

Soils within the project and alternate site were field tested by Forest Service personnel when well sites SF 25-32, SF 35-32, and SF 45-32 were proposed as part of the exploration program for PLES I. The soils overlie basalt bedrock but were themselves formed from washed in material of granitic or rhyolitic source rocks. The texture is sand or loamy sand throughout, and soil thickness ranges from 40 inches to more than 60 inches. The disturbed soils are considered highly susceptible to wind and water erosion. As a result of their sandy textures, the soils are also highly susceptible to mechanical erosion by vehicular traffic (BLM, 1986a). Similar soil sampling was done when exploratory wells for the MP II & III project were proposed. Sample locations were near the SCE substation (see Figure 2-1 and Table 3-3). Analysis revealed highly erodible soils similar in character to those described above (BLM, 1986b).

According to a recent resistivity survey conducted at the proposed power plant site (SEA Inc., 1988), six soil units were found overlying bedrock (basalt). Two layers were found to be considerably more resistive than other overlying or underlying layers. These layers, which consist of sinter, a hydrothermally cemented alluvium, were found to be difficult or impossible to penetrate when encountered in auger borings.

According to a biotic survey of the Casa Diablo area, the soils of the entire proposed and alternate power plant sites are undisturbed (Taylor, D.W. and Buckberg, R., 1986).

TABLE 3-3: SOIL INTERPRETATIONS

Site	EHR	EHR Maximum	WEG	AWC (Inches)
SF 25-32	Low-Mod.	High	High	3.0-4.8 (Low)
SF 35-32	Low-Mod.	High	High	2.8-3.9 (Low)
SF 45-32	Low-Mod.	High	High	1.9-2.5 (Very Low)

EHR = Erosion Hazard Rating of the Soil Under its Present Conditions.
EHR Maximum = Erosion Hazard Rating of the Soil When it is Disturbed.
WEG = Wind Erodibility Group is a Measure of the Susceptibility of the Soil to Wind Erosion.
AWC = Available Water Capacity of the Upper 60 Inches of Soil.

SOURCE: Bureau of Land Management. 1986. Environmental Assessment. Serial Number CA-017-P006-37.

3.1.3 NOISE

3.1.3.1 Regulatory Framework

The Noise Element of the Mono County General Plan identifies goals and policies to attain and maintain acceptable noise levels. The Element requires an acoustical analysis prior to construction of any noise-sensitive land uses in areas that are currently exposed to day-night equivalent noise levels (L_{dn}) of 60 or more./3,4/ In addition, the Element requires an acoustic analysis for projects that would generate high noise levels in areas where existing noise levels are less than 60 dBA, L_{dn} (Mono County, 1981). The Element also contains recommendations for mitigating noise, for new noise sources that exceed community noise compatibility guidelines.

Mono County Ordinance 79-479 requires that constructing and grading activities within 500 feet of residential or commercial occupancies, can only occur between 7 a.m. and 8 p.m. Monday through Saturday and between 9 a.m. and 5 p.m. on Sundays. This ordinance is enforced by the Mono County Sheriff.

/3/ Noise is customarily measured in decibels (dB), units related to the apparent loudness of sound. Because the human ear is more sensitive to some frequencies than others, sound measured by an instrument (noise meter) is typically altered electronically so that it approximates what would be heard by the human ear. Units of noise measurement recorded by the meter are termed "A-weighted decibels" (dBA). Noise levels associated with some typical activities are listed below:

Sound Pressure Level (dBA, L_{eq}	Example of Source
110	Jet takeoff at 2,000 feet
100	Shouting in ear
90	Pneumatic drill at 50 feet
80	Freight train at 50 feet
70	Freeway traffic at 250 feet
60	Hospital incinerator at 50 feet
50	Quiet conversation at 10 feet
40	Rural environment at night
30	Soft whisper

SOURCE: Cuniff, P.W., 1977; Honour, W.W., 1979.

/4/ Because environmental noise levels fluctuate with time, a time-averaged noise level in dBA is used to characterize the acoustic environment at a given location. The "day-night equivalent noise level" (L_{dn}) is a 24-hour time-averaged noise measurement to which a 10-dBA "penalty" is added between 10:00 p.m. and 7:00 a.m. to account for greater nighttime noise sensitivity.

The U.S. Geological Survey, Conservation Division, has issued seven Geothermal Resources Operational (GRO) Orders. These operational orders have been adopted into federal regulation and pertain to all geothermal lessees on federal lands. GRO Order No. 4 calls for noise to be measured according to specific procedures, with equipment that meets performance specifications. Muffling devices for noise attenuation are also defined. Under GRO Order No. 4, the lessee must comply with federal occupational noise exposure levels or state standards for protection of personnel, whichever are the more restrictive. Unless a more restrictive level is set by the authorized officer, the maximum noise exposure levels are set at an energy-equivalent noise level (L_{eq}) of 65 dBA for all geothermal-related activity, as measured at the lease boundary or at 0.8 kilometers (one-half mile), whichever is greater (U.S. Geological Survey, Conservation Division, 1976)./5/

3.1.3.2 Noise Sources and Levels

Twenty-four-hour average noise levels were measured on the proposed project site between the 8th and 11th of January, 1987 (see Table 3-4). The major noise source in the project area is the existing MP I geothermal power plant located about 800 feet to the west of the proposed power plant site.

Operation of the MP I plant produces a continuous high level hum which has been measured at 63-66 dBA L_{eq} at 150 feet. Major sources of noise from the plant include the expander turbines, the air-cooled condenser fans, and the piping between the expanders and condensers.

Noise control retrofitting of the MP I plant resulted in 10 to 12 dBA, L_{eq} noise reductions. The current noise level recorded at 0.5 mile distance is approximately 40 dBA. The noise level adjacent to the MP I plant along Hot Springs Road is 69dBA (Asper W., 1987a).

Vehicular noise in the project area is negligible. Hot Springs Road, which passes through the project area, is lightly travelled (no traffic counts have been taken since plant construction). The closest heavily travelled highway is Highway 395, approximately 3,500 feet to the south of the proposed power plant site. Noise from this source was observed to be inaudible during a January site visit by ESA staff, due to distance attenuation and the higher sound levels generated by the nearby MP I plant (see Table 3-3).

/5/ The "energy equivalent noise level" (L_{eq}) is the average noise intensity over a given period of time.

TABLE 3-4: 24-HOUR NOISE LEVELS NEAR CASA DIABLO HOT SPRINGS/a/

Proposed Power Plant Sites	Time Period	Noise Levels dBA, L_{eq}	Noise Levels dBA, L_{dn}/b/
PLES I/c/	07 p.m. to 10 p.m.	75	78
	10 p.m. to 07 a.m.	76	
	07 a.m. to 07 p.m.	75	
MP II and III/d,e/	07 p.m. to 10 p.m.	60, (59)	
	10 p.m. to 07 a.m.	60, (60)	66, (66)
	07 a.m. to 07 p.m.	59, (58)	

/a/ All measurements were taken between January 8th and 11th, 1987 with a Metrosonic model dB-306A Metrologger noise meter with wind screen calibrated prior to each use.
/b/ The L_{dn} is based on the L_{eq}, but incorporates a 10-dBA penalty for noise levels measured between 10 p.m. and 7 a.m.[1]
/c/ Measurement was made 200 feet south of Hot Springs Road and 50 feet east of an access road which separates the MP I site from the proposed PLES I site.
/d/ Measurement was taken about 35 feet northeast of Union Mammoth Well No. 1.
/e/ Two measurements were taken at this site; the calculated L_{dn} for both measures was identical.

SOURCE: Environmental Science Associates, Inc., 1987

Intermittent aircraft noise is probably audible due to low-flying aircraft approaching and departing from Mammoth/June Lakes airport and about four miles to the east of the project site. Other sources of intermittent noise may be recreational vehicles (noise from which is controlled by the State Vehicle Code, Section 38365-A) and wood-cutting activities, which are controlled by use permits.

3.1.3.3 Noise-Sensitive Land Uses

The closest noise-sensitive concentrated land use is the Sherwin Creek Campground one and one-half miles southwest of the project area. The closest residence is at Chance Ranch, one and one-half miles to the east. Residences at the Hot Creek Hatchery are about three miles to the east-southeast. County office buildings are located about one and one-half miles to the east. The John Muir Wilderness Area is about 2.5 miles to the south of the project site. Dispersed recreational use (hunting, firewood gathering, target practice) occurs within one mile of the proposed project plant site and within a few hundred yards of the alternate site (see Section 3.3.3, Recreational Resources).

3.1.4 HYDROLOGY

3.1.4.1 Conceptual Models of the Geothermal Reservoir

In order to answer questions about potential interactions between aquifers in the area, a hydrologic model is necessary. Scientists working in the area have proposed two different conceptual models, both of which can be supported by observed data.

One model, called the Lateral Flow Model, is based on the assumption that the geothermal fluid originates deep near the western or southwestern edge of the caldera and moves up and then east in shallow rocks through the caldera towards Lake Crowley. In this model, the hot water migrates up faults until it encounters shallow rock through which eastward flow can be maintained. This model assumes a single deep hot water resource supplying all the thermal features in the area. The characteristics of the water at each feature would be the result of mixing thermal water and meteoric water in different proportions. This model implies that production of hot fluids from one zone and injection into another could result in pressure and/or temperature declines in nearby areas which are hydraulically connected to the same lateral zones.

The second model is called the Upwelling/Fracture Flow Model. Under the scenario proposed by this model, the nearly vertical faults which cut across the area serve as conduits to carry heated water up from deep reservoirs. It has been suggested that fluids move from south to north, roughly along the strike of the major faults (GeothermEx, Inc. 1986). This would suggest poor hydraulic connection between reservoirs for each thermally active area and little potential for interference between the Casa Diablo area and Hot Creek Hatchery or Hot Creek Gorge.

The following discussion of the surface and subsurface hydrologic resources briefly summarizes the current knowledge about the area. It is a summary of a report on the hydrology of the project area written by Berkeley Group Incorporated (BGI). The report is included as Technical Appendix C in this document. Details and additional references can be found in the BGI report.

3.1.4.2 Surface Resources

The proposed project and alternative location sites are contained entirely within the Mammoth Basin, an area of approximately 60 square miles, which is defined by the surface watershed of Mammoth and Hot Creeks (including Sherwin and Laurel Creeks). These creeks flow across the Long Valley Caldera to the Owens River and then into Lake Crowley. Other small creeks in the vicinity include Dry Creek, Little Hot Creek, and Convict Creek. In addition to the creeks which drain the area, a number of springs contribute to surface flows. Locations of the creeks are shown on Figure 3-2. Flow data, temperatures, and water chemistry analyses are summarized in Table 3-5. The table contains average values which do not reveal seasonal changes. A more extensive summary of chemical analysis is given by Farrar et al., (1985).

The following discussion of surface hydrology describes these features: an unnamed intermittent creek which drains the project site; Mammoth Creek; Hot Creek; and five springs, or groups of springs, which ultimately flow into Hot Creek.

3.1.4.2.1 Creeks

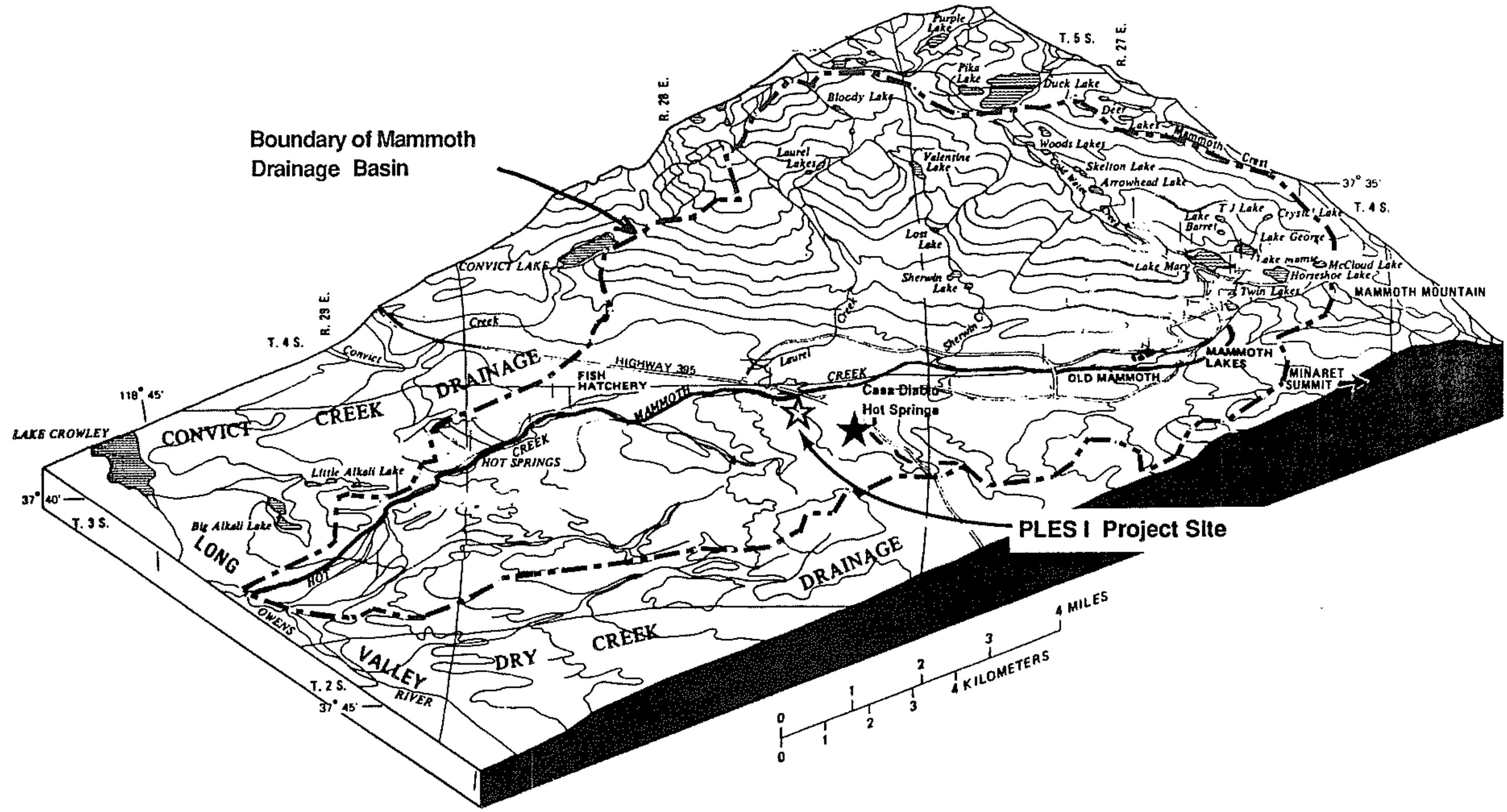
(a) Unnamed Creek Draining Casa Diablo Area

The primary surface drainage feature in the project and alternative site location is an unnamed intermittent tributary to Mammoth Creek. This creek originates near Highway 395, approximately one-half mile northwest of the project site, and joins Mammoth Creek approximately 0.6 mile south of the proposed power plant site. The stream discharge rate varies seasonally from zero to 1.5 cubic feet per second (cfs). Flow rate and fluid chemistry are dependent upon the relative contribution from the Casa Diablo Hot Springs. In years with above normal late season precipitation, the stream flows year-round. An unmeasured amount of creek flow is believed lost into the thin alluvium between Casa Diablo and Mammoth Creek.

There is no known chemical analysis available of the water from the unnamed creek. The chemistry of the steam is likely to vary considerably depending upon the relative influx of hot spring waters. No human consumptive use of the tributary exists.

(b) Mammoth Creek

The flow in Mammoth Creek has been monitored since 1932 by LADWP at a flume (MCF) a short distance downstream from the confluence of the tributary as shown on Figure 3-3



☆ Proposed Site

★ Alternative Site

SOURCE: BGI, 1987

FIGURE 3-2
Surface Drainage Features
of the Mammoth Creek Basin

TABLE 3-5: AVERAGE FLOWRATE, TEMPERATURE, AND CHEMISTRY DATA FOR PROMINENT SURFACE HYDROLOGIC FEATURES

Features	Flowrate (cfs)	Temp. (C°)	Selected Chemical Constituents (mg/l) TDS*	Cl	F	B	Li	Si02
Unnamed Stream at Casa Diablo	<1	---	Variable Chemistry Exists					
Mammoth Creek at Highway 395	22	10 (50°F)	Variable Chemistry Exists					
Below Hot Creek Gorge Flume (HCF)	52	24 (75°F)	Variable Chemistry Exists					
Casa Diablo Geyser (CDG)	0.35	91 (196°F)	1,350	290	13	12.5	3.5	300
Colton Spring (CS)	0.03	93 (199°F)	1,300	260	11	11.5	2.9	250
Hot Creek Hatchery (AB, CD, H1, H2,3)	17-28	13 (55°F)	112	2	0.25	0.009	0.004	36
Hot Creek Spring (HC-2)	---	82 (180°F)	1,140	220	10	10	2.6	140

*TDS = Total Dissolved Solids

SOURCES: California Department of Water Resources, 1967 and 1973; Farrar, et al., 1985 and 1986; Setmire, J.G., 1984; and Clark, M., 1988.

(California Department of Water Resources, 1967 and 1973). Discharge rates vary between 3,000 and 40,000 acre feet per year at this point. During certain times of the year a portion of the flow is lost to shallow ground water in the meadow between Highway 395 and Hot Creek Hatchery. An unknown quantity is diverted during summer months by a local rancher, which may account for some (or perhaps most) of the loss downstream of MCF.

The quality of water in Mammoth Creek is generally very good above Highway 395, but begins to degrade as hot spring discharge adds total dissolved solids and increases the temperature and grazing results in fecal coliform and nutrient inputs.

(c) Hot Creek

Hot Creek originates in the meadow above Hot Creek Hatchery where a group of springs emerge. The spring water flows through the hatchery and continues downstream as Hot Creek. Effluent from the hatchery contributes approximately 17 to 28 cfs to the flow of Hot Creek. This figure was obtained from measurements of flow rate at the springs. Actual flow rates may be higher if there are surface drainage contributions to the creek (Sorey, M.L., 1976; Farrar, et al., 1985).

Hot Creek is also monitored at the flume (HCF) below Hot Creek Gorge. This site has been used to gauge stream flow since 1923 and has most recently been used to collect data on the rate of discharge from the springs in Hot Creek Gorge relative to total stream flow. Stream flow at HCF varies between 25,000 and 80,000 acre feet per year and averages approximately 40,000 acre feet per year (California Department of Water Resources, 1967). Of this total, approximately 7,000 acre feet per year (average 9.5 cfs) is contributed by hot springs along the gorge (Farrar, C.D., 1985).

Chemical analysis of samples taken at HCF indicate that most of the dissolved mineral load is due to discharge from thermal springs along Mammoth and Hot Creeks (California Department of Water Resources, 1967, 1973; Setmire, J.G., 1984). Under the present conditions, the water in Hot Creek at this point (HCF) has some biologic contamination and may not be recommended for human consumption (Setmire, J.G., 1984).

3.1.4.2.2 Thermal Springs

Numerous hydrothermal features are found from the Casa Diablo area to the Hot Creek Gorge area (see Figure 3-3). These consist of springs of various temperatures and discharge rates and gas-emitting fumaroles. Some of these features maintain a relatively constant level of activity from year to year; others are intermittent and may change or disappear entirely. All springs and fumaroles are subject to fluctuation and possible extinction due to seismic activity and natural precipitation of calcium carbonate.

(a) Casa Diablo

There are several surface thermal features in the Casa Diablo area. The most prominent is the Casa Diablo Geyser (CDG) located immediately northwest of the MP I geothermal power plant.

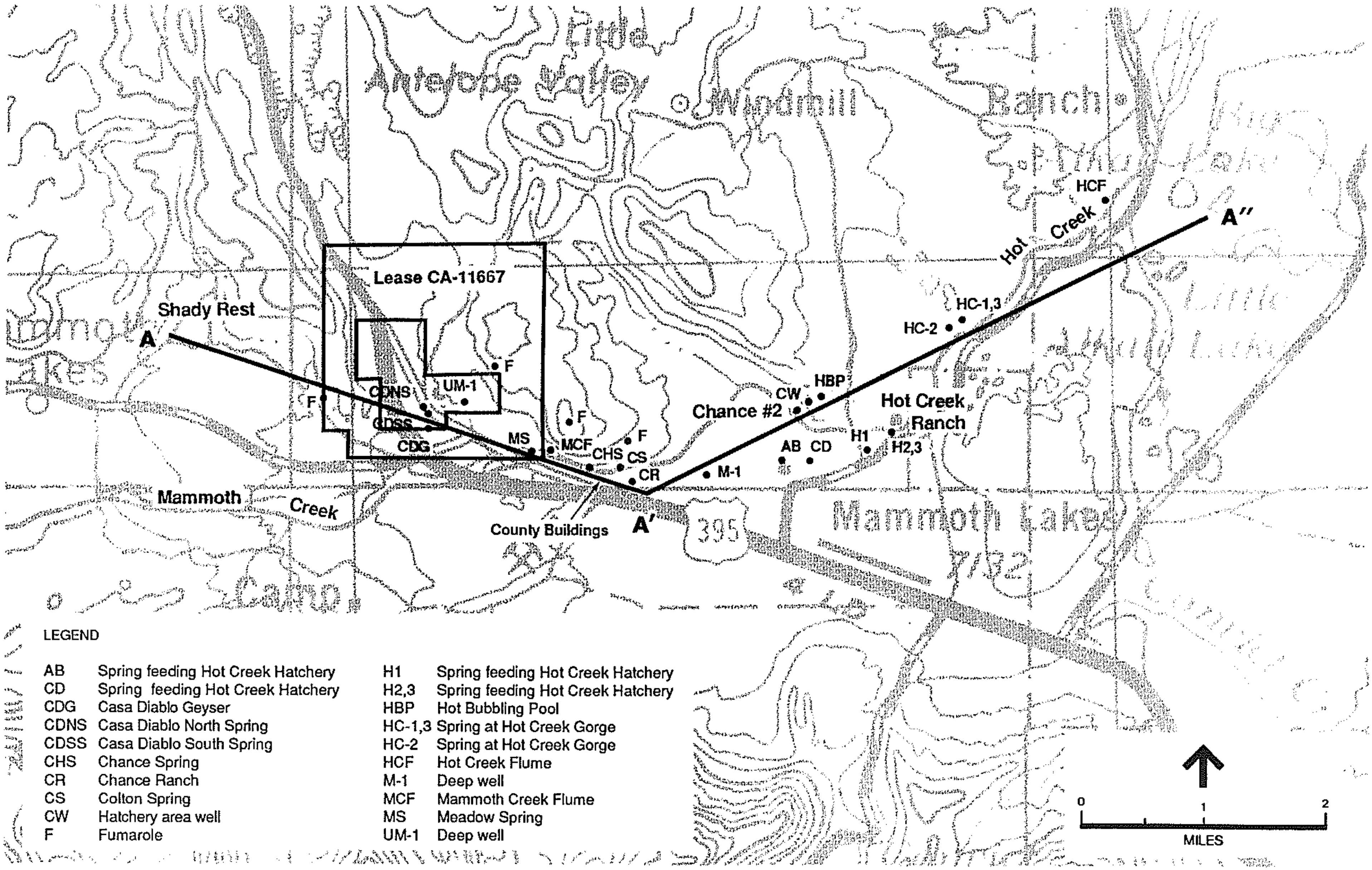


FIGURE 3-3
Location of Faults, Thermal Features and Wells in the Southwest Long Valley Area

SOURCE: BGI, 1987 and ESA

The operators of the MP I plant have cooperated in the monitoring of the springs and fumaroles by the U.S. Goelogical Survey (Farrar, et al., 1985 and 1986). The results thus far indicate a distinct correlation between spring discharge and tectonic strain events, as shown by the large increase in flow rate three weeks before a nearby November 1984 earthquake of magnitude 5.8. Historical observations which date back to the late 1800s report a wide range of activity from "geysering" tens of feet high to no visible discharge (Lawrence Berkeley Laboratory, 1984). Estimates of total spring discharge vary from 0.0 to 1.4 cfs with most of the flow from the main vent (CDG). The temperature measurements range from 80° to 90°C (176° to 194°F); the springs with low flow rates have lower temperatures than the springs which have higher flow rates. Some correlation is shown between existing geothermal well production/injection and the total discharge at CDG and two lesser springs. However, the historically variable flow at Casa Diablo makes the correlation difficult to quantify. When production at MP I began, the flow at CDG decreased somewhat, and briefly, during fall 1985 when production at MP I was interrupted, the geyser flow increased. The general trend over the past two and one-half years has been decreasing spring flow at Casa Diablo. In April 1987 CDG ceased to flow (Sorey, M.L., 1987a).

Hot spring fluids are characterized as sodium bicarbonate-chloride water with a total dissolved solids content of 1,000 to 1,400 mg/l. The alkalinity of CDG (382 to 469 mg/l) is between the alkalinity of the springs supplying Hot Creek Hatchery, (70 to 110 mg/l) and the geysers at Hot Creek Gorge (471 to 490 mg/l). The data indicate that the chemistry of each spring is affected by discharge rate and temperature. Boiling near or on the surface concentrates constituents in the fluid, which may then partially re-mix with the condensate. Published analyses also indicate a complex relationship with possible mixing of cooler, less saline, shallow groundwater (Mariner, R.H. and L.M. Wiley, 1976).

<u>Spills at Casa Diablo</u>: Approximately 760 gpm of fluid from Casa Diablo wells was allowed to flow into the intermittent stream for 39 days in 1962 by a former operator. While this caused concern about effects of long-term discharge and potential buildup of trace elements in the potable water supply at Crowley Lake, no catastrophic or lasting effects to the creeks or lake were documented (California Department of Water Resources, 1967 and 1973; Setmire, J.G., 1984). Before the geothermal fluid could have reached Mammoth Creek, its volume would have been reduced by infiltration and evaporation.

In June 1984, during installation of a pump, a block valve on a well was not completely closed by the crew at quitting time, allowing brine to flow onto the ground overnight. No fluid reached the intermittent stream draining the area (Asper, 1988). During the period July 15 to July 18, a fumarole (i.e., steam not hot water) erupted near and finally at well MPP-2. No brine flowed and the well was quenched by pumping cold water into it. The well was plugged and abandoned on September 12, 1984 (Asper, 1988). On September 29, 1984, endogenous well #2 blewout. Condensing steam plus some water flowing from the well flowed into the intermittent stream, causing erosion and degradation of water quality in the intermittent stream. No fish were killed and the Forest Service weir on the intermittent stream was not damaged by the blowout (Asper, 1988).

(b) Colton Spring Area

There are three groups of small springs located in the Colton Spring vicinity, approximately one mile southeast of Casa Diablo, along Mammoth Creek. They are Meadow Springs, Chance Spring, and Colton Spring. Their combined discharge is small and there is no consumptive use. The discharge from Colton Springs is now continuously monitored. The three springs differ markedly from each other in temperature and chemical composition and are of interest as indicators of the local hydrothermal system. Colton Springs (CS) is similar to CDG with respect to temperature (about 90°C or 194°F) and chemical species (C1 is about 260 mg/l). Meadow Springs (MS) is cooler (56° to 64°C or 133° to 147°F) with low, intermittent discharge; chloride content (C1 ranges from 170 to 210 mg/l) and ionic ratios indicate that it could result from the mixing of water similar to CDG and local, near-surface groundwater. Chance Spring (CHS) is still cooler (17° to 18°C or 63° to 64°F) and has relatively high discharge. Its composition (C1 ranges from 30 to 55 mg/l) is closer to meteoric water than the other springs, suggesting a minor thermal component (Farrar, et al., 1985).

(c) Hot Creek Hatchery Area

The four major spring groups in the hatchery area (AB, CD, H1, and H2,3 located on Figure 3-3) discharge from the edge of a basalt flow. These are the only sources of water for hatchery operations. The water chemistry suggests a two to three percent thermal component. Effluent from the Hot Creek Hatchery (from all four spring groups) contributes up to 40% of the flow in Hot Creek above the gorge annually.

Hot Creek Hatchery spring discharge and temperature was stated to be relatively constant in the Joint EA/EIR (p. 3-29). However, data recently acquired from Fish and Game and monitoring by the Mammoth/Chance developer suggest rather wide fluctuations related to yearly precipitation and runoff. No adverse impacts to hatchery operations are reported to have occurred due to these conditions. Graphs of temperature and flow for springs AB, CD, H1, and H2,3 groups are in Appendix C. During this 11-year period of record for the AB springs, the temperature at the hottest spring group has varied in a given year from as much as 4°F to as little as 1°F, with an overall range of 5°F (2.8°C) for the entire 11-year period. Flowrate data at the AB springs have been collected by the Mammoth/Chance project for background monitoring since 1985. Peak flow increased up to 70% above average during the wet year of 1986 (with accompanying temperature decline), but the peak was only 12% above average during a dry year, 1987.

Similarly, the CD, H1, and H2,3 spring groups show temperature variation, though to a lesser extent. These springs may be more susceptible to a reduction of the thermal component as a result of mineral precipitation in fractures due to their lower flow rates and near surface cooling.

The most sensitive hatchery operation with regard to temperature is considered to be the broodstock ponds which currently use approximately 53°F water from the H1 spring. The temperature plots show that the temperatures in H1 have varied from under 52.5°F to slightly over 56°F at that spring. The lowest temperature spring in the cold water source area to the west is at Laurel Spring, 11.8 - 12.0°C (53.2 - 53.6°F).

(d) Hot Bubbling Pool

Another surface feature of the note in the area is the Hot Bubbling Pool (HBP), located approximately one-half mile north of Hot Creek Hatchery (Figure 3-3). This spring-fed pool is of interest because its fluid characteristics are markedly different from the springs at Hot Creek Hatchery; yet, its distance from Casa Diablo is approximately the same.

(e) Hot Creek Gorge Springs

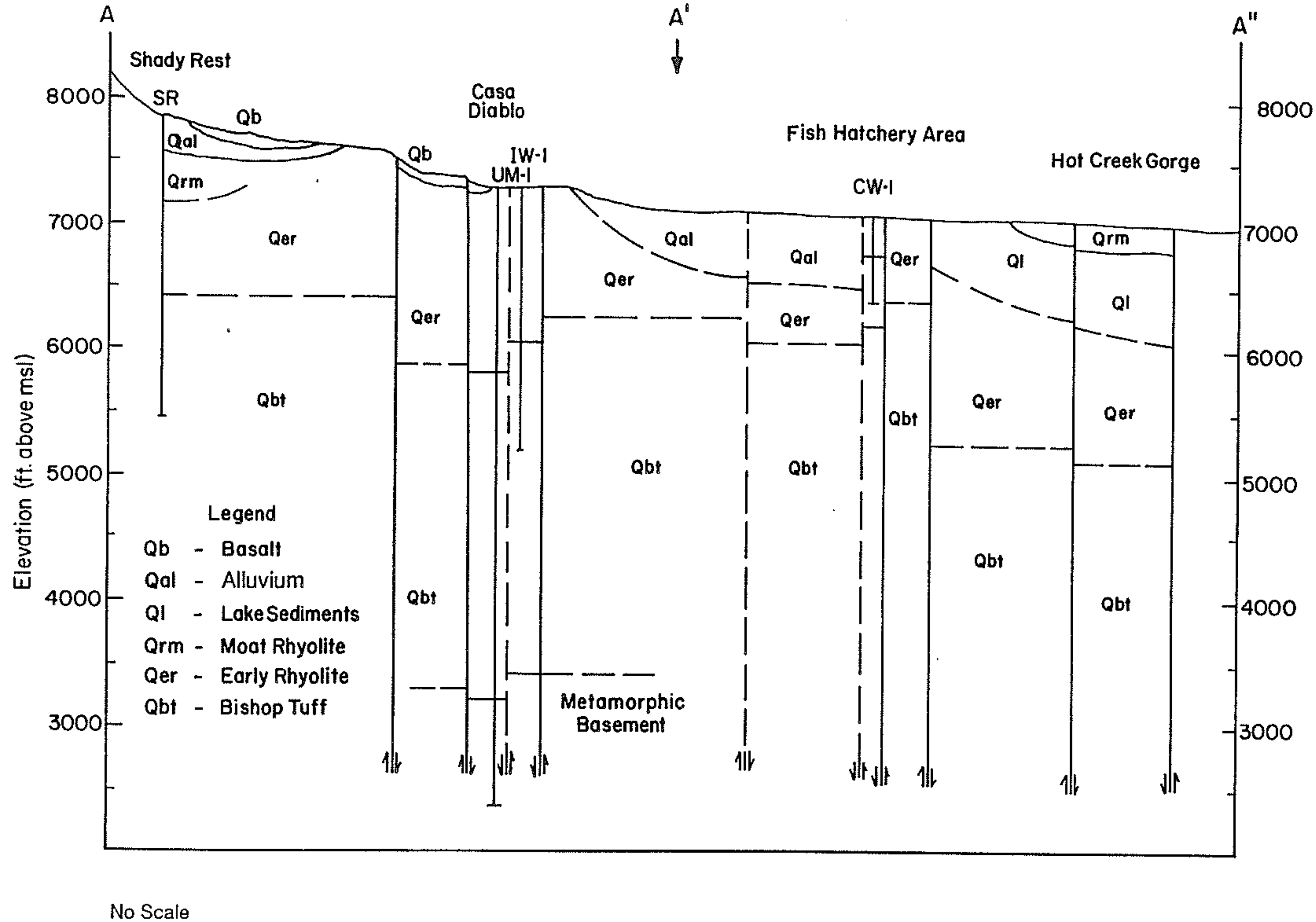
Several springs discharge at varying rates along Hot Creek Gorge (HC-1; -2; -3). These occur along two unnamed faults. Seasonal spring temperatures have varied from 90° to 94°C (194° to 201°F) at HC-1, 76.2° to 92°C (169° to 198°F) at HC-2; and 88.3° to 92.8°C (191° to 199°F) at

HC-3 during a 1983 to 1985 monitoring period. Measured fluctuations may result from spring conduit clogging and resulting flow losses. Total spring flow from this area cannot be measured directly since the major contributing vents are submerged in the creek bed. However, a close estimate of flow rate can be made from chemical flux correlation using the total flow of Hot Creek and its chemical load, measured at the U.S. Geological Survey maintained flume (HCF) below the gorge (Farrar, et al., 1985; Sorey, M.L. and M.D. Clark, 1981). Such calculations have yielded an average for total Hot Creek spring discharge of 9.5 cfs with a high of 11.6 cfs in 1980, attributed to seismic activity at that time. Increases in total flow, apparently due to tectonic strain relationships, appear suddenly and slowly die-off returning to normal flow patterns. Recent chemical analyses of the major vents are shown in Table 3-5. They display similar chemical compositions. The ionic compositions and ratios are comparable to the Hot Bubbling Pool and Casa Diablo Area springs. The isotope ratios show significant differences. No changes in temperature, flow rate, or chemistry have been seen in the Hot Creek Gorge springs which can be attributed to MP I power plant operations.

3.1.4.3 Subsurface Resources

Drilling and geophysical studies in the Long Valley Caldera have indicated the presence of thermal fluids at various depths and locations in the south and southwest areas, including the Casa Diablo area in general and the project site in particular. Deep drilling has been done at Inyo Craters (Unocal 44-16) and at Shady Rest. The depths and water chemistry are summarized in the following discussion. Figure 3-4 is an idealized cross-section (along line A-A'-A" in Figure 3-3) showing the relative locations of geologic units, faults, and selected wells from Shady Rest to Hot Creek Gorge.

Subsurface hydrologic resources in the Casa Diablo area are characterized by shallow localized cold groundwater at zero to 40-foot depth, underlain by a thermal production zone at a depth of 300 to 600 feet where temperatures range from approximately 330° to 350°F. A second thermal zone is located at depths of 2,000 to 2,600 feet (with temperatures about 305°F). The highest temperatures are found within a fractured rhyolite complex named the Early Rhyolite, located between zero and 1,500 feet in this area. The base of the Early Rhyolite also contains the cooler zone separating the upper and lower thermal aquifers. The Bishop Tuff underlies the Early Rhyolite at an approximate depth of 1,500 to 4,100 feet in the Casa Diablo area. The Bishop Tuff unit contains the second high temperature zone and displays steadily decreasing temperatures below this zone (Figure 3-4, Well UM-1). Well UM-1 penetrated the Bishop Tuff into the metamorphic basement complex.



SOURCE: BGI, 1987

FIGURE 3-4
Geologic Cross-Section Along A-A'-A" Showing the Location of Selected Wells

The major faults bounding the graben at Casa Diablo have apparently provided an avenue for the hot fluids to circulate from depth to near the surface, consistent with the Upwelling Fracture Flow Model. Higher temperatures are found in the Shady Rest well at a greater depth from the surface than at Casa Diablo, and the elevation of the high temperature zones is approximately 400 feet lower at Shady Rest than at Casa Diablo.

Two recently drilled wells in the Casa Diablo area have been helpful in defining reservoir extent. The first was production well SF 35-32, which showed that equivalent static pressures are found south of the existing MP I wells near the proposed production well field. Pump testing at rates of up to 2,100 gpm showed higher productivity than in the existing MP I Production wells with a small pressure drop in SF 35-32 and no measurable interference with existing wells (Mesquite Group Inc., 1986). Chemistry, pressure, and temperature data suggest that the well SF 35-32 is producing from the same reservoir as the MP I wells. The second well was SF 65-32 which was drilled for monitoring purposes only under recommendations from the LVHAC and required by the BLM. Temperature <u>and chemistry</u> data from SF 65-32 are similar to other Casa Diablo wells. Pressure data indicate communication with the production zone, though the monitoring well is only 250 feet deep.

3.1.4.4 <u>Summary of Hydrologic Data from Wells</u>

3.1.4.4.1 Pressure Data

Pre-1988 pressure measurements in wells currently used for production at Casa Diablo were not accurate enough for the detection of small scale trends. Although the well test done at SF 35-32 provided useful data, it did not allow analysis of small scale effects for calculation of reservoir parameters. New test data is available since completion of well SF 65-32 and post-1988 monitoring equipment upgrades. This data shows a distinct pressure response in each well due to shut in and start up of MP I wells. These data have allowed more accurate calculation of reservoir parameters which are used to estimate impacts in Chapter 4.

3.1.4.4.2 Temperature Data

Temperature data from wells in the Casa Diablo area show a localized high temperature zone in the production interval at Casa Diablo. A high temperature zone exists at depths <u>below</u>

1,100 feet in the Shady Rest well, and subsurface warm zones similar to those at Casa Diablo are found near the Fish Hatchery and Hot Creek Gorge. It is possible that fluid could be flowing laterally from Shady Rest through the Casa Diablo area to the Hot Creek Gorge area, cooling along the way. This is the basis for the Lateral Flow Model, it implies fluids move through or around major faults at Casa Diablo and across fault and stratigraphic boundaries toward Hot Creek Gorge. The extent of fracturing in the stratigraphic units would significantly influence fluid movement. An alternative interpretation based on the Upwelling/Fracture Flow Model is that Casa Diablo and Hot Creek are recharged by upwelling fluids from different major faults.

3.1.4.4.3 Chemical Data

Table 3-6 shows chemical and physical characteristics from wells in the Casa Diablo area. Chemical analyses may be used to suggest the source of spring waters based on the characteristics of the discharge and subsurface water. These efforts at correlation have been based on comparison of prominent chemical species that are conserved during mixing and boiling, such as: chloride (C1) lithium (Li), and boron (B).

C1/B and C1/Li ratios indicate that the ionic ratios in various spring waters are comparable between the different thermal spring areas. The data also show a trend of decreasing ionic concentration away from Casa Diablo, but with ionic ratios preserved (Shevenell, et al., in press). These data have been used to support the Lateral Flow Model describing a single source of fluids for the springs at Casa Diablo, Hot Creek Gorge, and Hot Creek Hatchery.

The stable isotope data for the same springs show large differences between the Casa Diablo springs, deep wells, and CDG. A combination of boiling and mixing of thermal and non-thermal fluids has been used to account for the isotopic data. These results may support the Lateral Flow Model based on generally NW to SE flow. However, another explanation has been proposed based on a multiple-source or Upwelling/Fracture Flow Model. It attributes differences in fluid chemistry between the thermally active areas to each having a different source of fluid that is upwelling from great depth.

At Casa Diablo, the chemistry of the reservoir fluids and the chemistry of the Casa Diablo springs, such as CDG are similar. In particular, the analyses of ionic ratios and stable isotope groups (regardless of the suggested degree of mixing by cold, near-surface, groundwater) show

TABLE 3-6: REPRESENTATIVE GEOTHERMAL FLUID CHEMICAL AND PHYSICAL CHARACTERISTICS FROM WELLS LOCATED IN OR ADJACENT TO THE PLES I PROJECT AREA

	Unflashed Samples (mg/L)				
Parameter	Well MBP-1/a/	Well MBP-3/a/	Well MBP-4/a/	Well MBP-5/a/	Well SF35-32/b/
Total Dissolved Solids (TDS)	1392	1376	1381	1382	1553
Silica Dioxide (SiO_2)	254	255	240	240	275
Calcium (Ca)	3.1	1.3	1.8	6	6.1
Magnesium (Mg)	0.13	0.12	0.1	0.1	<1
Manganese (Mn)	—	0.05	—	—	<0.50
Sodium (Na)	352	350	340	340	382
Potassium (K)	35	36	35	31	39.6
Bicarbonate (HCO_3)	355	345	360	360	460.7
Sulfate (SO_4)	108	112	110	110	115
Chloride (CL)	260	253	270	270	251
Fluoride (F)	11	10.2	10.5	10.5	11.6
Boron (B)	11	10.7	11	7.8	—
Lithium (Li)	2.7	2.6	2.6	2.7	2.6
Iron (Fe)	—	0.23	—	—	0.23
Mercury (Hg)	—	0.0016	—	—	0.0023
Lead (Pb)	—	0.003	—	—	<0.05
Arsenic (As)	—	0.95	—	—	1.47
Cadmium (Cd)	—	<0.002	—	—	<0.13
Titanium (Ti)	—	<1.8	—	—	<0.25
Aluminum (Al)	—	<1.0	—	—	<1.28
Strontium (St)	—	—	—	—	0.22
pH	—	6.1	—	—	6.08
Total Dissolved Gases/c/	1015	1380	1120	840	—
Noncondensable Gases	Parts Per Million by Weight (ppm/w)				
Hydrogen Sulfide (H_2S)	4.5	3.0	7.5	1.6	7.0
Ammonia (NH_3)	2.5	3.0	4.0	1.8	0.3
Carbon Dioxide aq. (CO_2)	1003	1370	1095	821	832
Hydrogen (H_2)	0.1	0.1	0.4	0.4	—
Argon (Ar)	0.3	—	0.3	0.1	0.02
Nitrogen (N_2)	3	3	10.0	12.0	1.5
Methane (CH_4)	0.9	0.5	0.9	0.8	—

/a/ Farrar, C.D., et al, 1986.
/b/ Mesquite Group, Inc., 1986.
/c/ The Ben Holt Company, 1986.

SOURCE: PLES I Final EIR.

close agreement between data from the producing reservoir and from surface springs. A preliminary analysis of fluid from the Shady Rest well also indicates a composition very similar to that of the Casa Diablo wells, but with a far higher calcium concentration, possibly due to the abundant calcium-rich deposits in fractures observed in the core samples. Differences in fluid chemistry of surface hydrothermal features eastward of Casa Diablo have been explained by a combination of boiling of geothermal fluids and mixing with water of meteoric composition (Sorey, M.L., 1987). There are exceptions: for example, the ionic composition of fluids from the hatchery area well, CW-2, requires mixing and boiling fractions that are different from the other wells to account for its ionic composition.

3.1.4.5 Shallow Groundwater Use at Casa Diablo

There is one well at MP I capable of producing 50 gpm. It is used to supply on average 3,000 gallons per month for sanitary facilities and 500 gallons per month for irrigation. Irrigation use would be concentrated in the period May to October.

3.2 BIOLOGICAL ENVIRONMENT

The climate, altitude, and vegetation of the proposed goethermal project area include two distinctive life zones common to the eastern Sierra Nevada region: Upper Sonoran zone (at lower altitudes) and Transition zone (at upper altitudes). Each of the life zones contains distinctive plant communities which provide characteristic habitat for wildlife species.

A site-specific biological inventory and assessment of the Casa Diablo Hot Springs area and vicinity (the survey area outlined in bold on Figure 3-5) was conducted during the last quarter of 1986 (Taylor and Buckberg, 1986). The 630-acre survey area includes the proposed and alternative sites. A rare plant survey was done in the same area during June 1988 (Taylor and Clifton, 1988). Except where noted, the following site-specific information is from these biological survey reports. Both reports are included in Appendix D.

3.2.1 VEGETATION

Both mountain and desert plants characterize the flora located in the Casa Diablo Hot Springs area. More than 90 species of vascular plants were observed within the survey area during the surveys.

3.2.1.1 Plant Communities

Two principal habitat types were found in the survey area: (1) forest/woodland vegetation with Jeffrey pine (Pinus jeffreyi) and pinyon pine (Pinus monophylla) dominating; and (2) shrub vegetation with sagebrush (Artemisia tridentata ssp. vaseyana) dominating. However, ten different habitat types were observed and mapped within the survey area (see Figure 3-5). The habitat types identified within the survey area are as follows:

(a) Jeffrey Pine Forest

This habitat type is moderately dense (30-60% canopy cover) forest stand type, with a single overstory dominant, Jeffrey pine, that covers much of the survey area. Most of the stands are young (less than 80 years old). The understory in this forest consists of a dense to moderately open shrub layer, mostly sagebrush, bitterbrush, tobacco bush and low grass cover.

(b) Jeffrey Pine - Pinyon Pine Woodland

This habitat type consists of a successional stage forest and is intermediate in composition and structure with Jeffrey pine becoming established within Pinyon-Juniper Woodland. Jeffrey pine will eventually dominate unless subsequent disturbance, such as wildfire, occurs.

(c) Pinyon - Juniper Woodland

This woodland, with 20 to 40% canopy cover, is located on the steep slopes on the eastern portion of the Survey area. The understory in this woodland is similar to the Jeffrey Pine Forest but with greater abundance of rabbit brush and a variety of forbs and grasses. Canopy cover is generally less than 35 feet.

(d) Sagebrush Scrub

Stands of sagebrush scrub habitat cover the southwestern portion of the Survey area and a substantial portion (approximately three-fourths) of the proposed geothermal project area. Shrub cover averages about 30 to 50%. Other shrubs in this habitat include bitterbrush, rabbitbrush, horsebush and sulfur-flower, with moderate cover of cheatgrass. Canopy height ranges from two to four feet. A diverse assemblage of annual herbs could also be present in this area during years with good spring rains.

(e) Black Sagebrush Scrub

Although this scrub type is relatively uncommon in the vicinity of the survey area, several patches of black sagebrush (Artemisia nova) scrub do occur on basaltic rocks in the extreme southwestern portion of the site. Canopy cover and associated flora in this community is similar to sagebrush scrub, but canopy height is much lower, averaging less than two feet.

(f) Rhyolite Buckwheat Scrub

This distinct habitat is restricted to present, or former, thermally affected soils and is essentially limited to the region. Scrub cover is low, with large clumps of Rhyolite Buckwheat predominant. Associated herbs include Pussy-paws, locoweed and cheatgrass.

(g) Thermal Marsh

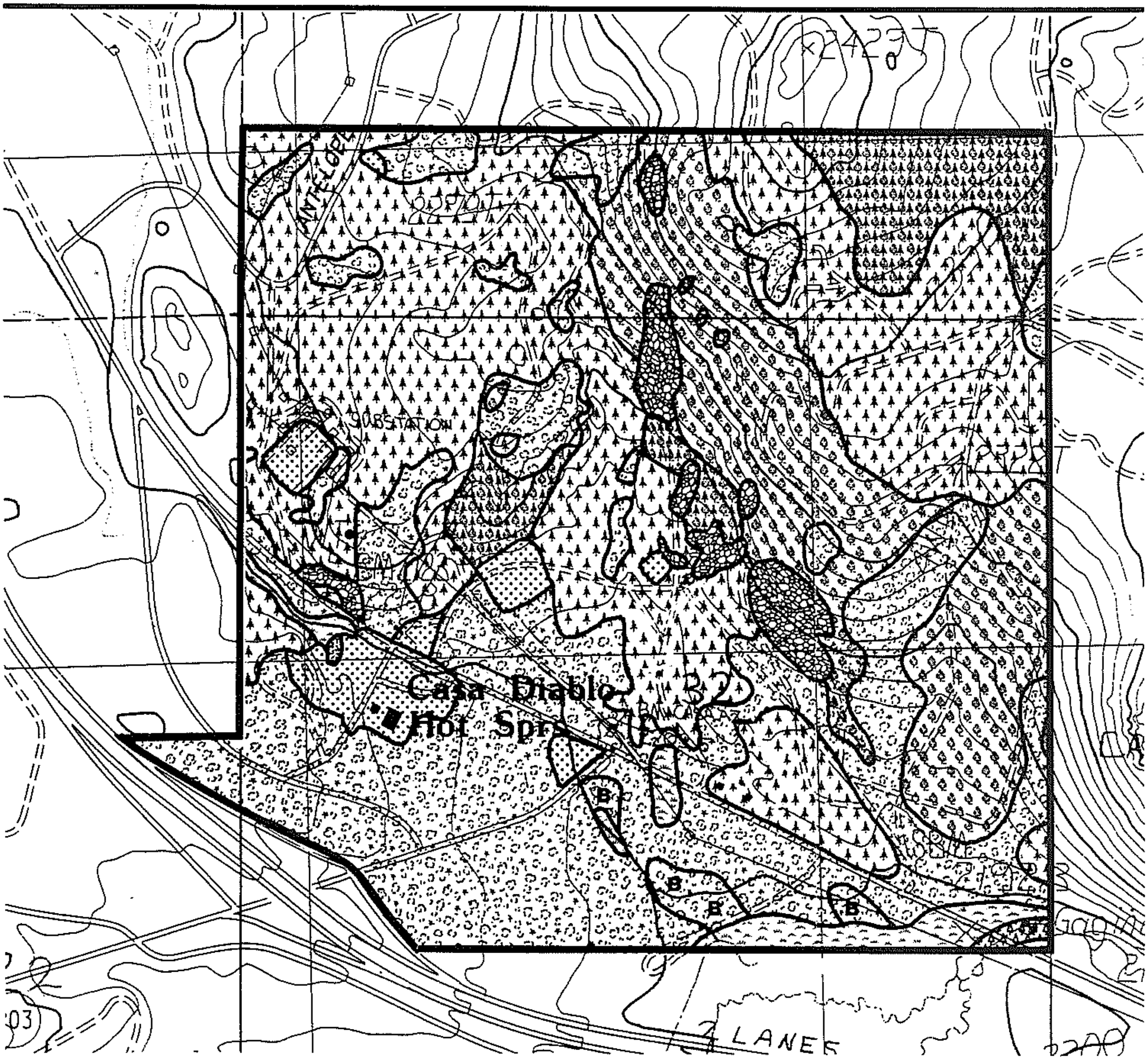
This marsh community is composed of sedges, rushes and grasses and is found around many of the thermal springs in the Mono Basin, Long Valley, and Owens Valley region. Height of the canopy is less than two feet, but cover is dense except where excessive evaporite deposits, or open water, limit vegetation.

(h) Yellow Willow Riparian

This vegetation type is composed of yellow willow, sandbar willow, Great Basin wild rose, and a lush and diverse herbaceous understory. This plant community occurs only in a small area near the southeastern corner of the survey area, along Mammoth Creek. At the time of the survey most of the understory species were dormant or so heavily grazed that identification of species was difficult.

(i) Nebraska Sedge Meadow

A large wet meadow exists near the southern boundary of the survey area. Vegetation of the meadow is dominated by Nebraska sedge, with Great Basin iris and rush as important condominants.



- Jeffrey Pine Forest
- Jeffrey Pine-Pinyon Pine Forest
- Pinyon-Juniper Woodland
- Sagebrush Scrub
- Black Sagebrush Scrub
- Project Area
- Rhyolite Buckwheat Scrub *
- Willow Riparian Thicket
- Nebraska Sedge Meadow
- Thermal Marsh *
- Disturbed
- * Botanically Sensitive Areas

0 850 1700
FEET

SOURCE: Biosystems Analysis Inc., Jan. 1987

FIGURE: 3-5
Habitat Type Map

(j) Ruderal and Disturbed Weed Field

Sparsely vegetated areas of recent or frequent surface soil disturbance occur along highway shoulders and sites of old buildings in the area. Plants that do occur in these areas include cheatgrass, dandelion, peppergrass, and crested wheatgrass. Floristic elements of this habitat are the initial colonists of sites where revegetation has been attempted.

Just west of the survey area is a group of ephemeral lakes with wetland vegetation. The stream draining the project area originates in these lakes.

3.2.1.2 Rare Plants

Twelve plants, considered rare or endangered by the California Native Plant Society (CNPS), could potentially occur in the vicinity of the proposed project. These plants include: Mono milkvetch (Astragalus monoensis), Howell's locoweed (Astragalus johannis-howellii), Fish Slough milkvetch (Astragalus lentiginosus var. piscensis), Nevada centuray (Centaurium namophilum), Mono buckwheat (Eriogonum ampullaceum), hot spring sedge (Fimbristylis spadicea), Mono Lake lupine (Lupinus duranii), pumice bush lupine (Lupinus montigenus), Mammoth lupine (Lupinus sublanatus), scalloped lousewort (Pedicularis crenulata var. candida), Pine City stonecrop (Sedum pinetorum) and Owens Valley checkermallow (Silacea covillei).

Both the geography and availability of habitats for rare plants within the survey area are such that potential habitat for several candidate species is absent. Habitat suitable for the A. monoensis, sterile pumic soils with moderate to sparse sagebrush cover, exists within the northern portion of the survey area, but A. monoensis, is absent. No rare or endangered vascular plant species were observed during the plant surveys conducted in the winter and spring in the proposed project area (Taylor and Buckberg, 1986, and Taylor and Clifton, 1988).

Both surveys are included in Appendix D. Earlier thorough botanical investigations and botanical collecting trips at the Casa Diablo Hot Springs found no rare or endangered species there.

3.2.1.3 Botanically Sensitive Areas

Two habitat types occurring in the survey area, thermal marsh and rhyolite buckwheat scrub, are considered botanically sensitive (Holland, 1986). Both habitat types are sensitive owing to their limited distribution and association with thermally affected soils. Several patches of these botanically sensitive habitats were found within federal geothermal lease CA-11667 (see Figure 3-5).

There are no state or federal regulations which provide for listing a habitat, as distinct from a species, for protection. Generally, federal and state agencies informally recognize the importance of botanically sensitive habitat areas and make efforts to protect them (Holland, 1988).

3.2.2 TERRESTRIAL WILDLIFE

The plant communities of the region provide habitats for a diversity of resident and migratory wildlife. Over 400 species of terrestrial vertebrates have been recorded in the Inyo National Forest. Some species are restricted to single habits, while other species range over almost all the habitats of the region. Similarly, major streams and spring drainage areas in the region provide unique aquatic habitats for native and introduced species.

Pine forest and sagebrush shrub are the principal wildlife habitats found within the survey area. Some meadow vegetation and rock outcrops are also located in the survey area. Jeffrey and pinyon pine provide both food and nesting sites for mammals and birds.

There are eight migrant or resident species of concern that could potentially inhabit or use the Casa Diablo Hot Springs area. These species are considered important due to their recreational value, protected status, or as habitat management indicator species. The species of concern include the bald eagle (Haliaeetus leucocephalus); peregrine falcon (Falco peregrinus); Northern goshawk (Accipiter gentilis); sage grouse (Centrocercus urophasianus); mule deer (Odocoileus hemionus); and three cavity nesting bird species, the pygmy nuthatch (Sitta pygmaea), Williamson's sapsucker (Sphyrapicus thyroideus), and hairy woodpecker (Picoides villosus). In addition, an important riparian indicator species, the yellow warbler (Dendroica petechia), may occupy a small section of riparian habitat near the southeast corner of the survey area approximately one-half mile southeast of the project site.

(a) Bald Eagle

This bird species is listed as endangered by the U.S. Fish and Wildlife Service and Fish and Game. Bald eagles use the Owens River Valley during the winter migration. Eagles perch, roost, and hunt within these areas. While most foraging occurs along the river, there is some limited use of dry land/sagebrush habitat. Roost sites, typically in large saw timber or old growth stands, are a primary component of the eagle's winter range (November - April). A single eagle was observed in flight approximately one mile away from the survey area during the Taylor and Buckberg field survey. There are no roosting or feeding sites within the survey area or in the immediate vicinity.

(b) Peregrine Falcon

This bird species is listed as endangered by the U. S. Fish and Wildlife Service and Fish and Game. Reintroduced peregrine falcons may use the survey area for occasional foraging and as dispersal routes for juveniles. However, the lack of open water and the relative scarcity of waterfowl, columbids, and other avian prey species favored by the peregrine falcon decrease the potential that the survey area is used for foraging. The survey area is also poorly suited for peregrine falcon nesting habitat.

(c) Northern Goshawk

This fully protected species, regarded as a sensitive species by the Forest Service, is a bird of mature forests characterized by relatively closed overstory and a dense understory of seedlings of non-uniform height. It prefers mid- to high-elevation coniferous forests. The Jeffrey pine forest within the survey area is relatively young with only sparse understory of occasional pinyon pine and is judged to be largely unsuitable for goshawks. However, an occasional goshawk may forage within the survey area given that it can feed in forest, meadows, and range types.

(d) Sage Grouse

These large upland game birds are year round residents in the Mammoth Lakes region. Sage grouse populations in the area severely declined approximately ten years ago. In 1982, the sage grouse hunting season was closed and, since that time, the local grouse population has approximately doubled. Sage grouse are dependent on sagebrush stands for nesting, thermal cover, hiding cover, and feeding during the fall and winter; and they are used as a management indicator species by the Forest Service for sagebrush plant communities. Wet meadows and other grassland habitats are used heavily for feeding during spring and summer when seeds, insects, and succulent vegetation area available. The southern portion of the survey area provides limited amounts of moderately suitable sage grouse habitat (see Figure 3-5).

Grouse use large open areas in the sagebrush for strutting grounds (leks) during the breeding season. Leks are traditional sites in which grouse congregate and where the males perform courting displays. After mating, females disperse to nest and raise the young. Leks are an important part of the habitat needed by grouse. Major areas of sage grouse leks are in the Lake Crowley and Bodie areas. There are no leks in the immediate vicinity of the survey area.

(e) Cavity Nesting Species

The Williamson's sapsucker, pygmy nuthatch, and hairy woodpecker are fully protected bird species. Parameters for optimum habitat were developed for each of the species by McCarthy and Hargis (1984). Owing to the lack of lodgepole pine cover type and other parameters the habitat in the Casa Diablo survey area is believed inadequate for Williamson's sapsucker. The forest habitat within the survey area meets most of the habitat parameters for the pygmy nuthatch and hairy woodpecker except for optimum snag density. Thus, the survey area was characterized as of intermediate importance for these species.

(f) Yellow Warbler

The yellow warbler is used by the Forest Service as a management indicator species for riparian habitats. The Yellow warbler is dependent upon riparian communities typical of that found along Mammoth Creek. A short segment (about 500 feet) of Mammoth Creek, and associated riparian community, winds through the southeastern corner of the survey area, approximately one-half mile southeast, and downstream, of the proposed project area. However, there is no riparian habitat within, or adjacent to, the proposed project site.

(g) Mule Deer

This migratory game species is recreationally important to the region and is of special interest because of the statewide decline in mule deer numbers over the past 20 to 30 years (Forest Service, 1986). Three herds (Casa Diablo, Sherwin, and Buttermilk, as defined by Fish and Game) are known to occupy the Mammoth Lakes area; each is addressed in a management plan jointly adopted by the BLM, Inyo National Forest, and California Department of Fish and Game. Seasonal migratory movements are tied to weather patterns and food resources. The breeding biology of the deer is adapted to their movements, and the spring and fall migration corridors, and both summer and winter range, are vital links in the life histories of these herds.

A relatively rapid winter migration typically begins after the first major snowfall. However, the 1986 fall migratory movement was atypical owing to the mild onset of winter, and the herds migrated more leisurely than usual (Kucera, T., 1987a). Most of the Casa Diablo herd, which numbers about 1,500 deer, is believed to migrate north of the survey area and winter east of the Owens River, from Casa Diablo Mountain north and east to the California-Nevada border. Truman Meadow, Marble Creek, and a narrow strip of habitat between Black Rock Mine and Casa Diablo Mountain are the major wintering areas for this herd. The Sherwin Grade herd, which numbers an estimated 2,300 to 2,400 animals, winters in the area west of U.S. Highway 395, north of Pine Creek, generally south of Sherwin and Swall Meadows, and east of Wheeler Ridge. The Buttermilk herd winters near the Sherwin Grade herd and numbers about 3,000 (Thomas, R.D., 1986a and 1986b).

With the onset of spring, deer from both the herds begin a leisurely migration west and up the Sierra slope toward summer range. Generally migration occurs between mid-April and mid-June. The routes, defined by the rugged topography of the Sierra, are traditional: young deer learn the routes from their parents and other members of the herd. Solitude Canyon, Mammoth Pass, and Duck Pass are the key migration routes over the Sierra crest used to reach the summer range. To reach the passes, deer from the Sherwin herd move north from the wintering grounds, generally staying west of U.S. Highway 395 and east of the base of the Sierra. Some deer from the Sherwin herd are thought to cross U.S. Highway 395 and use the habitats around Casa Diablo Hot Springs, and some deer from the Casa Diablo herd are thought to cross the survey area as they migrate upslope toward the Sierran summer range.

Habitat within the survey area is of moderate value for mule deer. Thermal cover is also of moderate value because crown closure is, in general, less than 75%; however, relative to the valley floor of low sagebrush and grassland habitat, portions of the survey area provide good thermal cover and would likely be favored in times of thermal stress.

Mule deer have been observed within the survey area and evidence of mule deer in the Casa Diablo Hot Springs area were observed during the Taylor and Buckberg survey (see Figure 3-6). Results of spring, summer, and fall 1987 track surveys indicate a dispersed pattern of deer activity in and movement through the project area (Kucera, 1987). Two survey reports together provide an estimate of relative deer numbers and areas of concentration. The reports are provided as Appendix E. The number of deer using the 630-acre survey area during the spring migration period was estimated to be approximately 70 animals (Kucera, T.E., 1987b). Deer use of the study area during the summer was moderate, perhaps six to ten animals. The normal fall migration typically occurs between mid-October and mid-November. The fall 1987 migration was probably atypical due to the lack of a major fall storm, the event which normally triggers the migration to winter range, so even crude estimates of the number of animals passing through on a fall migration could not be performed. This deer movement does not appear to be concentrated in any localized portion of the survey area, but is dispersed throughout it.

3.2.3 AQUATIC RESOURCES

3.2.3.1 Aquatic Habitats and Species of Concern

The major waters in the project area consist of thermal springs, cold springs, and surface streams. No perennial streams are found within the project area itself, but the southwestern portion is crossed by a small intermittent stream approximately two to six feet wide which drains the site. Because of the stream's size, chemical and thermal characteristics, and its ephemeral nature, no riparian vegetation is connected with the stream, and no salmonid aquatic species are believed to exist within the stream.

The project area is within the watershed of Mammoth Creek, a perennial stream, located approximately one-half mile southeast of the project site. Mammoth Creek is fed by rainfall, snowmelt and springs and flows north and east to its confluence with Hot Creek. Water temperatures in Mammoth Creek range from 10° to 14°C (50° to 57°C) (WESTEC Services, Inc., 1986). Water quality is influenced by construction and waste inputs from human activity near the city of Mammoth Lakes and from livestock grazing along its streambanks.

Approximately three miles east of the project site, three spring groups form the headwaters of Hot Creek. Both thermal and nonthermal waters are believed to contribute to spring discharge (see Section 3.1.4, Hydrology). Average spring temperatures range from 11° to 16°C (52° to 61°F) (WESTEC Services, Inc., 1986). Hot Creek Hatchery is situated immediately downstream of the springs and takes advantage of this water source in its hatchery operations. A fourth hot springs enters into Hot Creek below the hatchery facility. Downstream from this point Mammoth Creek is called Hot Creek. The creek, as it flows east and north towards the Owens River, gradually increases in temperature as inflow from hot springs within the stream channel and along its bank augments the stream flow and raises its temperature. Aquatic invertebrates in Mammoth Creek are dominated by caddisflies, stoneflies, and mayflies. Hot Creek invertebrate fauna consists primarily of amphipods and caddisflies (Forest Service, 1986). Studies are underway which would describe various endemic snail species dependent upon springs with

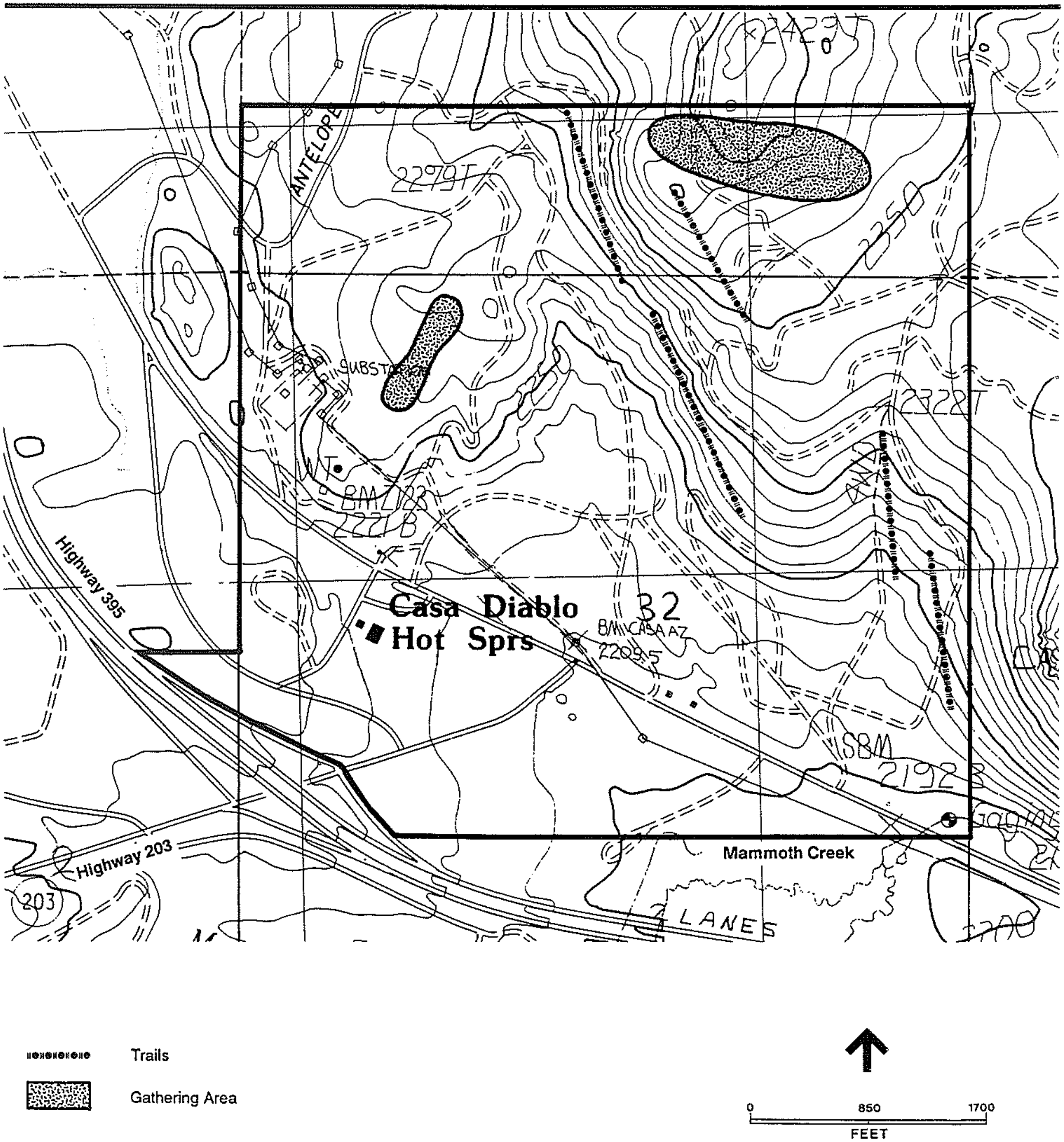


FIGURE 3-6
Deer Observations

minor thermal components (Wong, 1988). There is no complete survey of aquatic invertebrates for the project vicinity, although fragmentary information is available from individual collectors.

One recent study, which surveyed for tiny, gill-breathing spring snails in the Mono, Adobe, Long, Benton, and Owens Valleys as well as the eastern Sierra Nevada from Little Lake through Indian Wells Valley, located one species of spring snail, Stryonia protea, in a relatively pristine area along Hot Creek in Long Valley (Hershler, 1987).

Both Mammoth and Hot Creeks support naturally spawning populations of rainbow and brown trout. Fish and Game Department stocks trout in Mammoth Creek upstream of Highway 395. Hot Creek is one of only two state-classified wild trout fisheries in the Inyo National Forest (Forest Service, 1988). The brown trout in Hot Creek upstream from the Hot Creek interpretive site exhibit exceptional growth which is attributed to geothermal warming of the stream water. The slightly elevated temperatures increase primary and secondary productivity, in the form of aquatic plants and numerous insects, as well as raising the metabolic rates of resident trout. Based on current knowledge of trout physiology, rainbow trout will survive temperatures of 32°F to 82°F, with optimum temperatures for growth and completion of most life history stages at 55°F to 70°F (Moyle, P.B., 1976). Temperatures of 45°F to 66°F are optimum for rapid growth of brown trout, with preference of temperatures on the upper end of this range. Brown trout are able to withstand short exposures to temperatures in excess of 81°F.

Below the confluence of Mammoth Creek and Hot Creek, California fishing regulations allow only artificial dry flies on barbless hooks to be used, and any fish caught must be released unharmed. These restrictions are strictly enforced and apply through the Hot Creek Ranch property, a private, commercially operated fishing facility, and downstream to the Owens River.

The Hot Creek headwater springs also provide a unique habitat for the state and federally listed endangered Owens tui chub, (Gila bicolor synderi). The Owens tui chub was formerly abundant throughout the Owens River drainage and represents one of the four fish species native to the areas. The distribution of this subspecies of tui chub has been gradually restricted by the development of dams, subsequent water withdrawals within the Owens River watershed, and competition with non-native species. It now exists in scattered refugia in the Owens River drainage area, specifically below Long Valley Dam and at the Headwater Springs of Hot Creek (Thomas, T., and R. Feldmeth, 1987). To date, the recovery plan for this fish has not been adopted. However, a draft recovery plan is being used by the Fish and Wildlife Service and Fish and Game which includes preserving existing habitats and developing multiple new refugia for the species.

The U.S. Fish and Wildlife Service and Fish and Game are concerned that current flows and water quality characteristics at the headwater springs of Hot Creek are maintained.

A biological assessment for review and approval by the U.S. Fish and Wildlife Service was prepared in compliance with federal regulations for implementing Section 7 of the Endangered Species Act [40 CFR Part 402.12(f)]. The report concluded that it is reasonable to suggest that the Owens tui chub population in the Hot Creek headwater springs has adapted physiologically to the almost constant thermal and mineral regime of that particular habitat. However, data on thermal and salinity tolerance recently obtained from the Mohave tui chub suggest the species can adapt to modified environments. Additionally, Owens tui chub taken from Hot Creek headwater springs were successfully transported to the Owens Valley Native Fish Sanctuary where they have been able to tolerate a seasonal temperature regime that ranges from 10° to 26°C (50° to 79°F) (Thomas, T., and Feldmeth, R., 1987).

3.2.3.2 Hot Creek Hatchery

The Hot Creek Hatchery is managed by the Fish and Game. The Hot Creek Hatchery is one of the oldest fish hatcheries in the state. It was brought into operation in the 1930's and operations include production of trout eggs for other state hatcheries; rearing of fingerlings and catchable trout for stocking in Sierran streams, lakes, and reservoirs; and production of brood stock for future egg production. Approximately 22 million eggs are produced per year from this hatchery, about 1.25 million fingerlings are taken to other Fish and Game regions for stocking, and at least 700,000 catchable trout (nine to ten inches) are stocked in Alpine, Madera, and Mono County waters (Eichmann, J., 1987a).

The operation of Hot Creek Hatchery is dependent on the predictable temperature and reliable flows of the several springs which supply the facility. Two sets of springs feed the production, or rearing, ponds. The upper springs, AB springs ranged from 59.5°F to 64.5°F and CD springs ranged from 55°F to 60°F during the period 1976 to 1987. Fish and Game states that an average decrease of greater than two degrees Fahrenheit from the present temperature regime would slow fish growth and result in higher costs to the hatchery program because of the additional feed needed and the larger number of ponds and water which would be required to hold the fish for a longer period of time until they reached suitable planting size (Eichmann, J.L., 1987c).

The broodstock facilities are fed by smaller springs at the lower (east) end of the hatchery grounds. These springs are probably the most critical to the hatchery program as they supply water to the egg producing facilities, and fish within these ponds are the most sensitive to temperature variation. Temperatures of the springs feeding the Hatchery 1 broodstock pond complex, temperatures ranged from 52.5°F to 56°F. At Hatchery 2-3 brood stock pond complex, temperatures ranged from 50.8°F to 54.2°F. Within these complexes, up to seven strains of wild and domestic cutthroat, rainbow, brook, and golden trout are spawned on a staggered schedule throughout the year. Under natural conditions, trout spawn in the spring; however, the Coleman strain of rainbow trout is of particular importance because it spawns after the Hot Creek strain (e.g., November through January versus July through September) and before trout raised at other facilities, thus enabling the hatchery to plant trout year-round. The Coleman strain accounts for about 40% of the eggs and about 20% of fish raised at the hatchery (Boone, 1988).

In order to produce 20 million eggs annually, trout must be held for at least six months before spawning in waters not exceeding 56°F, but preferably not above 54°F. A temperature increase to 57°F would result in a decrease in fertility; whereas, a temperature 58°F would severely impact the hatchery operation (Eichmann, J.L., 1987b). A reduction of 2°F in the present temperature range would delay spawning until spring due to the increased time necessary for egg maturation which would, for all practical purpose, eliminate the Coleman and Hot Creek strains and severely impact the hatchery's statewide trout planting program. However, because the lower range temperature of these springs is equal to non-thermal springs in the area, removal of the thermal component would not result in a reduction below the current lower range temperature of these springs.

3.3. SOCIAL ENVIRONMENT

3.3.1 CULTURAL RESOURCES

3.3.1.1 Cultural Setting

Results from numerous archaeological investigations suggest the Owens-Long Valley region was once inhabited and used, for subsistence purposes, by numerous groups of hunter-gatherers over a period of 8,000 to 9,000 years. The latest peoples to inhabit the region were Numic-speaking groups. Ethnographic evidence indicates that Numic-speaking Mono Lake Paiute and Owens Valley Paiute territories bordered, and perhaps resided in, Long Valley. Linguistic evidence also indicates that Numic-speaking western Sierra Mono and Penutian-speaking central and southern Sierra Miwok may have inhabited the general Long Valley area at one time. Estimates of previous northern Paiute populations in Owens Valley range from 1,000 to 2,000 and it is believed districts of Paiutes may have been located as close as 37 km to the Casa Diablo Hot Springs (Hall, M.C., 1986).

Prehistoric cultural remains frequently found in the eastern Sierras include flaked stone debitage, particularly fragments of ground stone tools. Also pieces of pottery and ceramic vessles and organic refuse often characterize these cultural remains. Many of the artifactual remains suggest significant commerce between the various prehistoric hunter-gatherer groups but numerous questions regarding various aspects of the cultural systems belonging to these groups remain.

3.3.1.2 Native American Values

Any site which Native Americans consider sacred is very sensitive to impacts. The types of places deemed sacred include sources of residual sacred power, creation sites, and other sites named after or closely identified with powerful sacred persons or happenings. These are usually mountain tops, caves, rock shelters, springs (especially hot or mineral), or rock art sites. Also judged to be sensitive to impact are sites with ritual association. In addition to the types of sites just mentioned, ritual sites may also include burial and cremation sites, places used for prayer and meditation, for healing, and for training shamans, and places where plants, animals or minerals for sacred use are gathered. Sites named in traditional songs and other literature and sites to which people came to trade, visit, recreate, or process foods also may be considered sacred. In addition, Native American trails, the sites of villages (with those most recent being more sacred), traditional food collection areas, and animal species whose ecosystems are endangered are of special concern to Native Americans (Bean, L. and S. Vane, 1987).

Springs and other sources of water, especially hot springs or springs where healing rites are performed, are especially sensitive, having sacred connotations. It is considered that hot springs are connected underground with sources of power, which can be dangerous, but also can be tapped for healing purposes (Bean, L. and S. Vane, 1987).

Some hot springs and associated vegetation and soils within the Long Valley area continue to be utilized for traditional Native American cultural and religious values (Reynolds, L., 1987). Contemporary Native American concerns to impact on the previously mentioned areas are highest in areas which they presently use, or which have a direct historical connection with living people (Bean, L. and S. Vane, 1987). Thus, Casa Diablo Geyser and other hot springs and fumaroles in the project area could be considered important, although no sites near the proposed project have been identified as sacred by Native Americans.

3.3.1.3 Site-Specific Cultural Resources

Site-specific cultural resources surveys were conducted, in conformance with requirements of the United States Forest Service, on Federal lease CA-11667 which contains the proposed project area (Hall, M.C. 1986). The following discussion summarizes the survey results with regard to cultural resources identified within lease CA-11667 during the three referenced cultural resources investigations.

(a) Cultural Resource Site-1

The initial cultural resources surveys discovered a single, previously unreported, Cultural Resource Site-1 southeast of the MP I power plant (Hall, M.C., 1986). The survey unveiled a low density scatter of obsidian flaked stone debitage (two to four pieces per square meter) and two use-modified obsidian flakes. No evidence of a subsurface cultural deposit was observed at Cultural Resource Site-1. The site was tested for significance and eligibility for inclusion on the National Register of Historic Places by a four-person team of archaeologists (Hall, M.C., 1986).

A 900-square meter grid (30 x 30 meter provenance grid) subdivided into four contiguous 15 x 15 meter units each comprised of nine separate "quads" was established. Excavation of four arbitrary 1 x 1 meter units revealed that the majority of the cultural deposits at Cultural Resource Site-1 are surficial. During this testing program 185 items were collected, including 171 unmodified pieces of flaked stone debitage (168 consisting of obsidian flakes), eight obsidian edge-modified flakes, two obsidian biface fragments, two obsidian flake tools, a large mammal bone fragment, and a single piece of ochre. Eighty-six of these items were discovered on the surface, 53 in two 5 x 5 x 0.2 meter surface scrapes and 46 in the four 1 x 1 meter excavation units. All but 17 of the 171 unmodified pieces of flaked stone debitage were attributed to the local Casa Diablo source although it is possible some, but not all, of these 17 flakes also originated from the Casa Diablo source.

Dating done by hydration analysis of 21 obsidian artifacts recovered during data recovery suggest Cultural Resources Site-1 was occupied by humans between 9,500 and 250 years B.P., principally between two distinct periods, 3,400-3,100 B.P. and 1,900-100 B.P. These results are reported to indicate prehistoric cultural activity at the site during several brief occasions between the present and 11,000 years B.P. (Hall, M.C., 1986). This activity most likely consisted of stoneworking the obsidian nodules from the Casa Diablo obsidian source areas surrounding the site. These results and subsequent interpretations are consistent with the land-use activities of the hunter-gatherer populations known to have inhabited the Owens Valley and adjacent areas.

Five other cultural resources sites (not including 1) were also discovered on Federal lease CA-11667. Brief descriptions of each of these five sites are given below.

(b) Cultural Resource Site-3

This site may represent previously recorded archaeological location. This site consists of an approximately 20 x 20 meter scatter of obsidian flaked stone debitage at a surface density of approximately three flakes per square meter.

(c) Cultural Resource Site-5

This site may represent a previously recorded archaeological location. It consists of an approximately 30 x 85 meter scatter of obsidian flaked stone debitage at a surface density of approximately two to four flakes per square meter.

(d) Cultural Resource Site-6

This site consists of an approximately 20 x 37 meter scatter of obsidian flaked stone debitage at a surface density of approximately two flakes per square meter.

(e) Cultural Resource Site-10

This extensive "site complex" covering more than 250,000 square meters includes three previously recorded archaeological locations, which are connected by a low-density scatter of obsidian flaked stone debitage located on the lower slopes and flats beneath the rhyolite domes immediately east of Casa Diablo Hot Springs and north of Mammoth Creek. Prehistoric archaeological remains included obsidian flakes (surface density of approximately two or more flakes per square meter), several obsidian blank/biface production loci (including one locus where the obsidian flakes appear to have been struck from natural obsidian nodules) and a bedrock mortar locus. Historic remains included tin cans, bottle and metal automobile fragments, and various wood and rubber items.

(f) Cultural Resource Site-11

This extensive "site complex" covering more than 200,000 square meters includes four previously recorded archaeological locations. Obsidian flaked stone debitage (surface density of approximately two flakes per square meter) connect the previously recorded sites although numerous loci of high densities (up to 50 or more) or obsidian flakes also occur within Cultural Resource Site-11. Other prehistoric archaeological remains, such as obsidian tools, were also observed.

3.3.2 RANGE RESOURCES

The proposed project area is located within the Long Canyon Unit of the Hot Creek Grazing Allotment. This allotment is under permit to Miller and Wood and is administered by Inyo National Forest. On a unit-wide average, 6.1 acres of land are required to support one animal for one unit month's time, an animal unit month (AUM). Each AUM returns approximately $1.36 to the Federal Government. Approximately 37 animals graze the Long Canyon unit, generally between August 15th and August 25th, resulting in an AUM output for the entire unit of approximately 91 AUM's. Land within the project area is considered less suitable for grazing than the average land within the unit as a whole (Forest Service, 1988).

3.3.3 RECREATIONAL RESOURCES

The project area is three miles east of the Town of Mammoth Lakes, which has approximately 5,000 permanent residents. Located at the junction of the Great Basin and the Sierra Nevada Mountains, the beauty and recreational resources of the area have made Mammoth Lakes a popular resort. The nearby Mammoth Mountains Ski Area has become the largest in the country, attracting over 19,000 skiers at one time during peak ski season (Morse, M., 1987).

Summertime recreation uses in Mammoth Lakes are estimated to attract over 1.5 million visitor-days per year (Forest Service, 1988). Outdoor recreational activities include backpacking, camping, fishing, mountaineering, swimming, boating, and sightseeing. There are two campgrounds near the proposed project site. The Sherwin Creek Campground is 1.5 miles southwest of the site and Shady Rest Campground is three miles west of the site. There are approximately 32,700 visitor-days at Sherwin Creek and 91,200 visitors-days to Shady Rest annually (Lloyd, J., 1987).

Hot Creek Hatchery, known for developing a unique strain of rainbow trout, is three miles east of the site at the headwaters of Hot Creek. These trout are spawned in the fall, and by the following spring their progeny have grown to approximately six inches in length and area ready for stocking in local streams and lakes. Hot Creek Hatchery raises over 700,000 catchable size trout and 1.25 million fingerling trout for stocking in the Inyo-Mono area annually (Eichmann J., 1987a). Immediately east of the hatchery, Hot Creek Ranch offers trophy trout fishing from May 1st to October 30th. Nine to eleven cabins are available at the ranch each season with five-person occupancy. During the fishing season the ranch averages 15,000 to 20,000 visitor-days (Millikan, G., 1987). The Hot Creek recreational area also contains Hot Creek Gorge, where hot springs emerge in Hot Creek. It is a favorite recreational spot for visitors to the Mammoth area and is open to the public throughout the year from sunrise to sunset. All totaled, Hot Creek averages 95,000 recreational- visitor-days a year (Lloyd, J., 1987).

Dispersed recreational activities in the project vicinity include camping, shooting, wood collecting, jogging, bicycling, snowmobiling, and deer hunting. The area bounded by Hot Creek, Highway 395, Route 203, the Sherwin Creek recreational area, and Convict Lake was visited by approximately 3,000 game hunters during the 1986 season (Morse, M., 1987). No developed recreational facilities are located within the project site. However, Antelope Springs Road and scenic Highway 395 and Route 203 are near the project site and serve as the main access roads for the various dispersed recreational activities in the Little Antelope Valley located about four miles northeast of the project and alternate sites.

3.3.4 TIMBER RESOURCES

The proposed project site and the alternate power plant site are located on the southern edge of an area within the Inyo National Forest which is managed for commercial timber production. Species which are managed for timber harvest include Jeffrey pine, red fir, white fir, western white pine, and lodge pole pine. There are scattered Jeffrey pine and pinyon pine on the western portion of the project site and a denser stand of Jeffery pine and pinyon pine on the eastern end of the proposed project location. Some Jeffrey pine on the eastern end of the project site may have commercial value; however, the proposed project site is not located on land currently managed for commercial timber production. Merchantable timber available at the site is sparse and of poor quality. Young growth is targeted for transplanting, so the Forest Service determined that timber should be valued as fuel wood and estimated the volume at approximately 3.6 cords.

3.3.5 TRANSPORTATION AND SITE ACCESS

The proposed project area is located at the intersection of Hot Springs Road (Mono County Road No. 346A) and California State Route 203. It is immediately accessible from the Mammoth Lakes offramp (Route 203) from existing U.S. Highway 395 (Highway 395) (see Figure 2-1).

The portion of Highway 395 in the project area is a four-lane divided highway with seasonally heavy traffic, particularly during the winter ski season. Highway 395 is the major north-south highway along the eastern Sierras. California State Route 203 is currently a two-lane paved road east of Highway 395 and a four-lane divided highway west of Highway 395 which serves as the principal access to the Town of Mammoth Lakes from Highway 395. Traffic on route 203 is typically light except during the winter ski season. Substantially less traffic utilizes the small portion of Route 203 east of Highway 395 than uses the part west of Highway 395.

Hot Springs Road is a very lightly travelled, two-laned, paved road maintained by Mono County which crosses the proposed project site. Hot Springs Road intersects the unpaved Forest Road 3S05, maintained by the Inyo National Forest, approximately one-half mile northwest of the proposed power plant site. Antelope Springs Road provides access to dispersed recreation in the Little Antelope Valley area. A one-laned paved road (Casa Diablo Cut Off Road) is immediately west and southwest of the existing MP I power plant and together with Hot Springs Road and Route 203 circumscribes the proposed production wellfield.

The proposed project and the alternative location would make use of existing unpaved access roads within the Inyo National Forest. The alternate power plant site would be reached by traveling Hot Springs Road to the unpaved substation road which accesses the alternate site (see Figure 2-6).

3.3.6 VISUAL RESOURCES

3.3.6.1 Existing Programs, Plans and Policies for Managing Visual Resources

(a) BLM Policies

Geothermal Resource Operational Order No. 4 (U.S. Geological Survey, Conservation Division, 1976) requires lessees of geothermal resource areas under federal jurisdiction to reduce the visual impact of geothermal development through careful site selection and through sensitive design and construction of facilities.

(b) Forest Service Plans and Policies

The Forest Service's Environmental Concern Maps in the environmental analysis for the Geothermal Lease Sale Area #1, Inyo National Forest, identify the proposed project site, as Visual Resource Constraint Level 2. This constraint level indicates that where surface occupancy should be limited to controlled off-road vehicle use, and surface occupancy for geothermal activities should be excluded unless surface management concerns can be mitigated.

Furthermore, the Land and Resource Management Plan, Inyo National Forest (Forest Service, 1988) designates visual quality objective for the project site for "Retention." Management policy for an area designated for Retention is to manage the area so that its natural appearance is maintained. The Management Area Directions for visual resources include "mitigate the visual impacts of existing major uses in the area seen from U.S. 395 and State Route 203 east of the town." The visual resource policies in the Management plan were developed using the Forest Service's Visual Management System (VMS), a system developed as part of its National Forest Landscape Management program (Forest Service, 1974). It should be recognized that the Forest Service Visual Quality Objectives are management guidelines and not regulatory standards and can be changed through an environmental analysis process. The VMS applies to all management activities on National Forest lands.

The intent of the VMS is to identify the visual character of the landscape, catalog its visual quality, and analyze in advance the visual effects of resource management actions.

The VMS methodology consists of: (1) identifying the character type and inventorying variety classes of the landscape and its subdivisions; (2) preparing a Sensitivity Level inventory which addresses both visibility and relative number of viewers; and (3) using the Variety Class and Sensitivity Level inventories to identify Visual Quality Objectives (VQO) which define acceptable degrees of alteration of the natural landscape. The VQOs for the Casa Diablo vicinity are shown in Figure 3-7.

3.3.6.2 Sensitive Receptors

All people exposed to the landscape proposed for modification are considered to be sensitive receptors. Expectations and aesthetic concern varies with the viewer, so that the response of a particular viewer is highly subjective. In general, the Forest Service considers recreationists to be the major viewing population, but for purposes of analyzing visual impacts in the project area, the Forest Service does not distinguish between first-time viewers and repeat viewers or resident and non-resident viewers (Rickford, E. B., 1987).

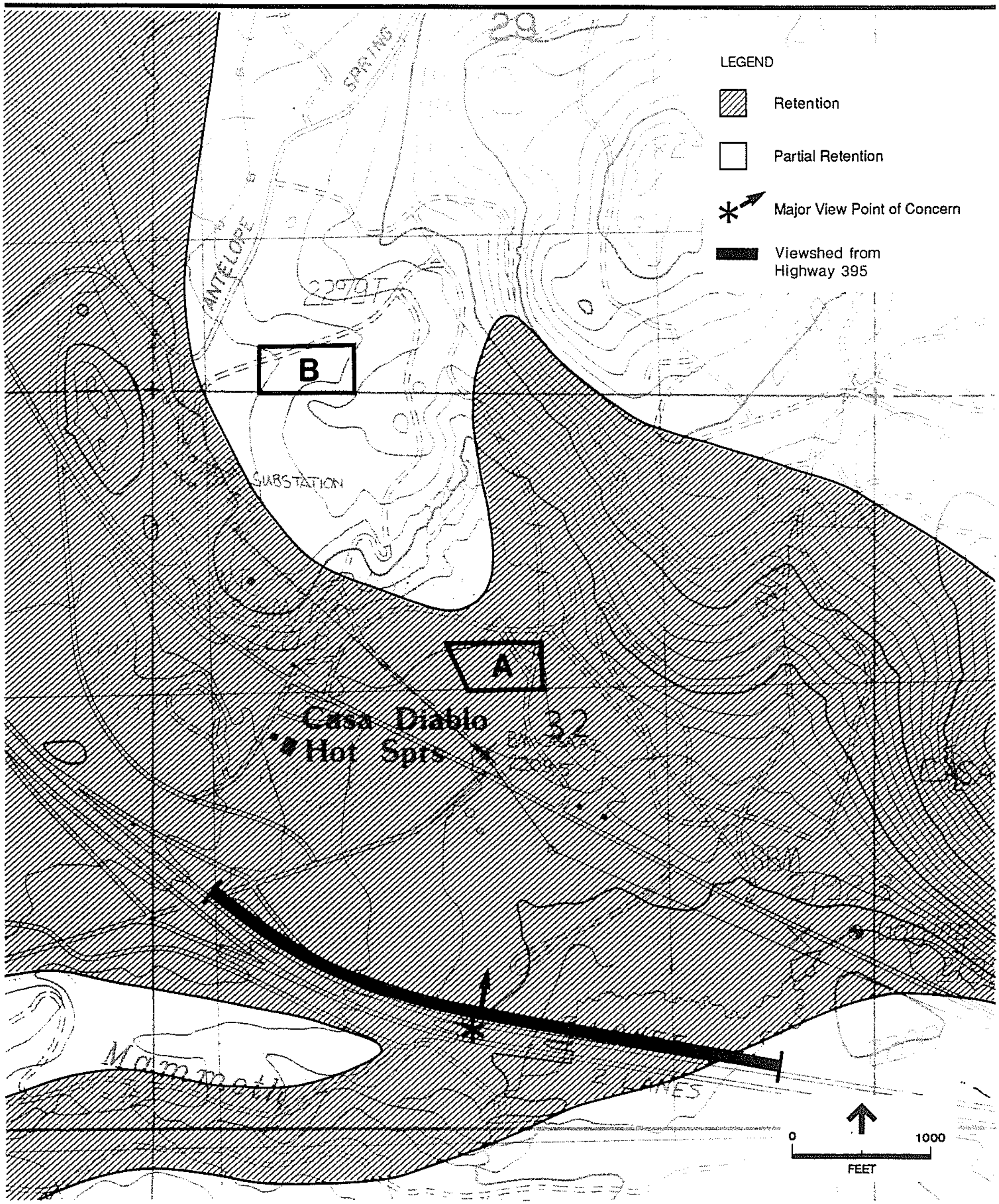
3.3.6.3 Regional Setting

The visual character of the project vicinity is dramatic and is one of the primary attractions for visitors to the Mammoth Lakes area. The project site lies on the edge of Long Valley on the eastern side of the Sierra Nevada. The snow-capped peaks of the Sierra Nevada, several of them over 14,000 feet in elevation, rise abruptly to the west from a base elevation of about 7,500 feet. The rugged topography and the young geology of the region provide several visual resources of particular scenic value, including Mammoth Mountain, Mammoth Rock, Crystal Crag, the Minarets, and Long Valley. Long Valley is a large, sparsely vegetated basin that drops away from Highway 395 to the east, affording sweeping vistas. Devil's Postpile National Monument, Ansel Adams Wilderness, and John Muir Wilderness are local natural areas with high-quality visual resources preserved for the enjoyment of the general public.

The vegetation and wildlife of the region contribute to its high visual quality. Overall, the variety of vegetation and topographic features is high with patches of pine forest and meadow, barren rock outcrops and avalanche slopes, chapparal and sagebrush and varied textures and colors. Low ridges and isolated hills break the view and create contained views of distinctive landscapes. Wildlife is abundant in the area and views of deer, hawks, eagles, rabbits, and other animals greatly enhance the aesthetic experience both for those pursuing recreational activities in the more isolated portions of the region, and for residents and visitors traveling local roads and highways. The water of streams, lakes, seeps, and snow is an attractive visual element common in landscapes visible from key viewpoints.

3.3.6.4 Proposed Project Site

The project site is a gently sloping area of primarily sagebrush scrub and scattered pine trees on the northeastern side of Highway 395 near the terminus of Route 203. Hot Springs Road provides access to geothermal development the projects in the Casa Diablo area. The existing geothermal development, MP I, is west of the project site.



A Proposed Site
B Alternate Site

SOURCE: U.S. Forest Service, 1987.

FIGURE 3-7
U.S. Forest Service Visual Management Objectives for the Casa Diablo Hot Springs Area

The power plant site lies about 2,200 feet northeast of Highway 395 and about 400 feet north of Route 203, at their nearest approaches. The project site is open to view by motorists traveling northeast on the Mono County extension of Route 203 east of Highway 395. Traffic volumes on the County extension of Route 203 are small and, thus, public exposure to the site from this viewpoint is minor. The site is visible from portions of State 203 west of Highway 395, but the power plant site itself cannot be distinguished from adjacent areas at these distances. Portions of the project site are also open to view from Highway 395 from about 5,000 feet southeast of its junction with State Route 203 to within 1,000 feet of the junction.

The clearest views of the proposed power plant site along Highway 395 are from the northbound travel lanes from about 4,400 feet southeast of its junction with State Route 203 to the junction. A long, low forested ridge to the north of the project site provides a backdrop, as viewed from Highway 395, that serves to minimize the visibility of individual features of the site and of the existing MP I geothermal development northwest of the site.

Highway 395 itself, local roads, the County buildings and impound yard, Mammoth Ski Area, the Mammoth-June Lakes Airport, electric transmission lines, fences, the existing geothermal development, and gas and propane storage tanks -- with their regular outlines, even texture, and colors atypical of the natural environment -- can be seen from the major viewpoint located south of the project site on Highway 395. Mining activities and roads providing access to mining claims and recreational areas also contrast with the generally natural landscape. In the daytime, sunlight reflects from metal and glass surfaces; at night, lights from structures and from cars on Highway 395 can be seen within the generally uninterrupted darkness typical of the natural areas along Highway 395. Night lighting from the existing geothermal plant at Casa Diablo may attract the attention of motorists on Highway 395 and State Route 203.

Major viewpoints in the project vicinity are to the west, away from the proposed project site and toward Mammoth Mountain, the Minarets, San Joaquin Ridge, and Sherwin Bowl.

3.3.6.5 Alternative Power Plant Site

The alternate site is gently sloping wooded area with Jeffrey pine and sagebrush scrub. The site is approximately 0.6 miles north of the proposed site, although the wellfield would be the same as that for the proposed project. Either Substation Road or Antelope Springs Road could be used to provide access to the power plant site, so exposure to viewers is limited. The alternate power plant site is not visible from Highway 395 and is in an area designated for "Partial Retention".

3.3.7 SOCIOECONOMICS

3.3.7.1 General Setting

The population of the Mammoth Lakes region has been steadily increasing over the last two decades. The population grew from 2,213 in 1960 to 4,016 by 1970 and more than doubled to 8,577 by 1980. The rate of growth has slowed significantly in recent years and is estimated to have reached 9,200 by July 1, 1986 (California State Department of Finance, Population Research Unit, 1987). Most of the population of Mono County resides in the recently incorporated Town of Mammoth Lakes, which has a year-round population of approximately 5,000. Peak population on winter weekends reaches 35,000. Employment is concentrated in the government, retail sales and service sectors, with service employment mostly generated by tourism (Hawley, B., 1987). No residents live on or immediately adjacent to the project area.

3.3.7.2 Current Land Use

Current land uses within the vicinity of the proposed project include the following:

- Mammoth Pacific I Geothermal Plant (MP I), immediately adjacent to the site;
- Casa Diablo Substation, operated by Southern California Edison Company, about one-quarter mile northwest of the site;
- Mono County buildings and impoundment yard, one and one-quarter mile east of the site;
- A liquid propane facility, one and one-quarter mile southeast of the site;
- Chance Ranch, a private ranch, approximately one and one-half miles east of the site;
- Sherwin Creek Campground, one and one-half miles southwest of the site;
- Mammoth-June Lakes Airport, three to four miles southeast of the site;
- Forest Service Gravel/Borrow Pits, at the north side of the Airport;
- Sierra Quarry, operated by Honeywell, at the south side of the Airport;
- Hot Creek Hatchery, operated by the Fish and Game, three miles east of the site;
- Old Mammoth School, southwest of the Hot Creek Hatchery;
- Hot Creek Ranch, a private trout fishing resort, four miles east of the site;
- Shady Rest Campground, three miles west of the site;
- 115 kV electric transmission lines;
- Chevron gasoline tank battery about one-quarter mile south of the site; and
- U.S. Highway 395; State Route 203; Hot Springs Road, Antelope Springs Road, Casa Diablo Cut Off Road; an unnamed paved road connecting State Route 203 with Hot Springs Road north of Substation Road; and ten unpaved, unnamed, access roads, all within one-half mile of the project site.

3.3.7.3 Economics

Mono County's economy is primarily based on recreation. Retail revenues are highly seasonal, peaking during the winter skiing season, with a secondary peak during July and August. As illustrated in Table 3-7, sales revenues normally peak in the first and fourth quarters of the year then decrease sharply.

Employment peaks in the first and fourth quarters but has been falling since early 1985 (Table 3-8). Events and activities that negatively affect the skiing season (e.g., late or little snowfall, earthquake activity, or the recent concern over renewed volcanism) dramatically affect the region's economy. The economic and employment imbalance between the inter ski-season and off-season periods is a concern to the community. Summer and spring recreational activities are being promoted to achieve a more balanced tourism industry (Hawley, B., 1987).

The unbalanced nature of the local economy due to its heavy reliance on recreational activities is revealed in the 1983 survey of the Mammoth Lakes labor force summarized in Table 3-9. The survey found no employment in the agricultural, mining, or manufacturing sectors; however, 37% of the labor force was employed in the recreational and service sectors. A large construction sector, 3.5 to four times California's state-wide average, was also present (Earth Metrics, 1984). The operating geothermal plant, MP I, provides sixteen full-time jobs, approximately 0.2% of the local labor force. Eleven of these jobs were filled by residents of Mono County (Asper, W. 1987b).

Fish and Game's Hot Creek Hatchery is important to the economics of the state's trout program. One of only three rainbow trout brood stock hatcheries in California, the Hot Creek Hatchery provides approximately 20 million fish eggs for use in the state's year-round trout program and for use by hatchery systems of several other western states. Hot Creek Hatchery is also responsible for the production and planting of 700,000 catchable trout annually in the Inyo-Mono area and handles the major part of backcountry aerial planting in the northern Sierra Nevada. A unique fall spawning strain of rainbow trout, developed at Hot Creek Hatchery, and the relatively constant temperature of the rearing ponds, provides fish of a plantable size up to six months earlier than typical rainbow trout. This gives California the capability to plant trout all year long. Of the 20 million eggs raised annually at the Hot Creek Hatchery, approximately

40% (eight million) are of the Coleman strain, which can be raised in the winter months (Boone, 1988). Current prices for trout eggs range up to $20 per 1,000 eggs both summer and winter (Neilson, 1988). The value of eggs raised at Hot Creek Hatchery may be as high as $400,000 at current prices.

3.3.7.4 County Fiscal Considerations

Mono County receives revenues from a variety of sources. Total revenues for fiscal year 1985 to 86 were $13,517,524. Approximately 41.6% came from state, federal and other government sources. The remaining 58.4% was from local sources with taxes accounting for 43.2% of total revenues. Charges for county services, licenses and permits accounted for 11%. Income from the use of money and property amounted to about 1.9%. The remaining 2.3% came from miscellaneous sources. The actual dollar amounts of revenues from each of the above sources are summarized in Table 3-10. Geothermal activities accounted for about 6.3% of the revenues. Through possessory interest the county benefits from ad valorem (property) tax revenues paid on the value of geothermal facilities even when the facilities are located on federal land. When the geothermal lease occurs on federal lands, the state receives 50% of the federal lease royalties and rentals and redistributes 20% of the original amount to the county. In addition, geothermal activity at the existing MP I plant supported purchases from local (Mono/Inyo County) merchants totaling $159,000 in 1986 and a direct payroll of $451,173 in 1986 which indirectly increased sales tax revenues (Asper, W., 1987b).

The county expenditures for fiscal year 1985-86 equaled $13,517,824. The largest category of expenditures (30.7%) provided for the general function of the county (i.e., legislative and administrative services, finance services, elections, property management, insurance, and other miscellaneous general services). The next largest categories of expenditures were public protections (22.7%), public ways and facilities (21.1%), and health and sanitation (12.2%). The remainder (13.3%) was spent on public assistance, education and recreation, and reserved for operating contingencies. The dollar amounts for the County of Mono 1985 to 86 budget are presented in Table 3-11. Geothermal lease and royalty revenues from federal lands to the county are channeled into the Geothermal Lease Fund. These monies are used to fund 40% of the County's Energy Management Department and for community improvement purposes largely related to geothermal and recreational facilities. The Fund's balance as of December 31, 1986 was $903,000 (Lyster, D., 1987a).

TABLE 3-7: TAXABLE SALES - MONO COUNTY

Time Period	Sales Revenues
1st Quarter, 1982	$23,133,000
2nd Quarter	16,847,000
3rd Quarter	20,916,000
4th Quarter	22,742,000
1st Quarter, 1983	$24,345,000
2nd Quarter	15,260,000
3rd Quarter	20,891,000
4th Quarter	20,467,000
1st Quarter, 1984	$22,226,000
2nd Quarter	16,709,000
3rd Quarter	22,529,000
4th Quarter	21,642,000
1st Quarter, 1985	$22,487,000
2nd Quarter	17,084,000
3rd Quarter	22,736,000
4th Quarter	21,991,000
1st Quarter, 1986	$28,752,000
2nd Quarter	17,825,000

SOURCE: California State Board of Equalization, Taxable Sales in California, First Quarter 1982-Second Quarter 1986.

3.3.7.5 Community Services

3.3.7.5.1 Schools

The Mammoth School District provides local elementary and secondary education for the area. The former Mammoth Elementary School, condemned due to earthquake damage, is located near the Hot Creek Hatchery, east of Highway 395, and is not currently in service. The new elementary school located adjacent to the Mammoth High School opened in March 1987. However, it is not large enough to handle the current elementary school enrollment and six

TABLE 3-8: EMPLOYMENT IN MONO COUNTY

Time Period	Sales Revenues
1st Quarter, 1983	4,658
2nd Quarter	4,575
3rd Quarter	4,817
4th Quarter	4,808
1st Quarter, 1984	4,708
2nd Quarter	4,512
3rd Quarter	4,558
4th Quarter	4,675
1st Quarter, 1985	5,100
2nd Quarter	4,550
3rd Quarter	4,542
4th Quarter	4,583
1st Quarter, 1986	4,467
2nd Quarter	4,233
3rd Quarter	4,100

SOURCE: California State Employment Development Department, California Labor Market Bulletin, January 1983 to October 1986.

portable classrooms will remain in operation. The district is currently planning to build another wing on the elementary school to relieve the overcrowded conditions. Both elementary and secondary students (as of January 31, 1987) attend classes at Mammoth High School. Many of the classes are conducted in temporary facilities.

The sixteen full-time employees of the MP I geothermal plants have five children attending Mammoth School District and five children attending school in Inyo County (Asper, W., 1987b).

In addition to the problem of overcrowding, the district is also affected by the influx of "transient" students during the winter season. The enrollment level as of January 1987, was

TABLE 3-9: DISTRIBUTION OF MAMMOTH LAKES' LABOR FORCE BY EMPLOYMENT SECTOR 1983 SURVEY

Sector	Percent of All Employees
Agriculture, Forest, Fish	0
Mining, Manufacturing	0
Construction	14
Transportation, Utilities	3
Restaurant, Bar	10
Wholesale, Retail Trade	16
Finance, Insurance, Real Estate	6
Recreation	25
Services	12
Government	6.5
Lodging, Property Management	10
Total Number of Employees	5,559

SOURCE: Earth Metrics, Inc. Mammoth Lake Housing Study Needs, 1984.

TABLE 3-10: GENERAL REVENUES FOR MONO COUNTY

Source	Value
Total Taxes	$5,836,321
Licenses and Permits	146,838
Fines, Forfeitures and Penalties	194,385
Use of Money and Property	252,781
Aid from Other Governmental Agencies	5,625,084
Charges for Current Services	1,343,740
Other Collected Revenues	118,375
Grand Total Revenue	$13,517,524
(Geothermal Revenues)	($793,883)

SOURCE: Mono County Final Budget, 1986 to 1987.

TABLE 3-11: APPROVED EXPENDITURES FOR MONO COUNTY

Category	Amount
General Functions	$4,154,649
Public Protection	3,064,873
Public Ways and Facilities	2,853,109
Health and Sanitation	1,654,854
Public Assistance	823,932
Education and Recreation	296,922
Contingencies	669,185
Grand Total	$13,517,524

SOURCE: Mono County Final Budget, 1986, 1987.

368 elementary students and 293 secondary students. Enrollment drops off just after Easter when the skiing season ends and seasonal employees move their families away. The 1987 faculty consists of fourteen full-time elementary teachers, one part-time elementary teacher, sixteen full-time high school teachers, two part-time high school teachers, and one district teacher. Staffing is not affected by seasonal variation in enrollment (Martin, M., 1987).

3.3.7.5.2 Police

Law enforcement is provided by the Mono County Sheriff's Department headquartered in Bridgeport. There are total of 37 personnel in the department, 24 sworn officers and thirteen public safety officers. The closest officers to the site are four resident deputies located at Crowley Lake providing coverage on an on-call basis. Priority response time to the site is estimated at five to ten minutes (fifteen minutes in the early morning if no one is on duty). Non-priority response is on an "available" basis. The California Highway Patrol has primary responsibility for traffic control and accident investigation for State Route 203 and county roads. The sheriff's department maintains mutual aid agreements with all surrounding law enforcement agencies (i.e., Forest Service, California Highway Patrol, Mammoth Lakes Police, and Fish and Game). These agencies are called upon only in emergency situations as back-up to the sheriff's department. All arraignments and hearings are held in the Bridgeport courthouse, requiring officers to travel there for testimony and prisoner transfer. No incidents have been reported as of January 26, 1987, at the adjacent MP I geothermal plant (Padilla, T., 1987).

3.3.7.5.3 Medical Facilities

The closest medical facility is the Centinela Mammoth Hospital located in the town of Mammoth Lakes on Sierra Park Road. The Centinela Mammoth Hospital is accredited by the Joint Committee on Hospitals and provides in-patient, out-patient, and 24-hour emergency medical care. The hospital maintains fifteen acute care beds (two in the intensive care unit, thirteen for general services), the structure and equipment for emergency room services, a complete diagnostic materials center, and a local clinic which provides staffing. The staffing level varies with the season, peaking with 75 personnel in the winter and lowering to 50 in the summer. Ten year-round physicians are on the staff. On a year-round basis, the hospital only operates at 30% of capacity. However, the hospital often operates at near-peak capacity during winter weekends. The second and third nearest hospitals are Mono General Hospital in Bridgeport and Northern Inyo Hospital in Bishop. Ambulance service is provided by the Mono County Paramedics for which the Centinela Mammoth Hospital serves as a base station. Additional ambulance service is provided by the centinela Mammoth Hospital, Ground-Aegis Ambulance Service and the Bishop Sierra Ambulance Service, the latter two located in Bishop. Emergency transportation services are provided for by the Care Flight, based at Washoe Medical Center in Reno, Nevada. Burn victims who require treatment beyond local capabilities may be transported to burn centers in Las Vegas, or Sherman Oaks, California (Jacobsen, T., 1987).

3.3.7.5.4 Fire Protection

Local fire protection is provided by the Long Valley Fire Protection District. The district operates three triple-combination pumper engines (two capable of delivering 1,000 gallons per minute and the third capable of 750 gallons per minute) and one automobile out of the Hilton Creek Station located above five miles from the site. Staffing consists of twelve volunteer firefighters and one full-time Chief of Staff. Emergency response time to Casa Diablo, when a crew is available, is estimated at twelve to fifteen minutes. Due to its proximity, the Mammoth

Lakes Fire District, located on State Route 203 near the intersection of Pine Crest, responds to calls in the vicinity. The response time from Mammoth Lakes is approximately seven minutes. The Mammoth Lakes fire station is staffed by a full-time Chief, Assistant Chief and 50 volunteer firefighters. The surrounding Inyo National Forest lands are protected by the Forest Service. Mutual aid agreements are in effect for all surrounding jurisdictions and an automatic aid agreement with the Mammoth Lakes Fire Department. The principal fire concerns in the Casa Diablo area are the use of isobutane at the MP I geothermal plant, the distance from the fire stations, and the limited water supply. In the event of a fire at Casa Diablo, nearby areas of concern are the traffic on adjacent Highway 395; three 10,000-gallon gasoline storage tanks owned by Lloyd Petroleum, located one-quarter mile south of State Route 203 and one-eight mile east of Highway 395; and the 100,000 to 150,000 gallons of propane stored in six tanks owned by Cal-Gas, Petro-Lane, and Turner, located approximately one mile east of the site. Fire safety requirements governing construction are contained in the 1976 and 1982 Uniform Fire Code, with amendments, and special fire protection district provisions (Malby, B., 1987). A fire protection plan for the PLES I Project was prepared by Pacific Energy and approved by the Long Valley Fire Protection District on May 27, 1988 (Lucas, G., 1988).

3.3.7.5.5 Street and Road Maintenance

Street and road maintenance is provided by the county for all non-state and non-federal county roadways. This responsibility includes road repair, maintenance, and snow removal. Snow removal requires up to two-thirds of the total maintenance and improvement budget (WESTEC Services, Inc., 1986). Private roads are maintained by owners.

3.3.7.5.6 Wastewater

The Mono County Water District operates a community sewage system and sewage treatment facility for residents of the Mammoth Lakes and the Lakes Basin areas. The system does not extend to the site area.

3.3.7.5.7 Solid Waste

Mammoth Disposal Service, a private carrier, provides bin service on a contractual basis. The nearest sanitary landfill, a site leased from the Los Angeles Department of Water and Power, is located at Benton Crossing road and is designated Class II, handling normal household refuse and construction debris. The Benton Crossing landfill has a projected lifespan of 25 to 30 years (WESTEC Services, Inc., 1986).

3.3.7.5.8 Utilities

The site is located outside of the water service area of the Town of Mammoth Lakes. A well which supplies non-potable water is located at the adjacent MP I site. The MP I plant receives electricity from the Southern California Edison Company. During 1986, the electrical substation serving the immediate area had a combined designed capacity of approximately 79 megawatts. The site area is currently served by the Continental Telephone Company (Contel) which has general offices and maintenance and switching facilities in Mammoth Lakes (WESTEC Services, Inc., 1986).

3.3.8 HAZARDOUS MATERIALS

Three 10,000-gallon gasoline storage tanks are located approximately one-quarter mile southeast of the project site, and an estimated 100,000 to 150,000 gallons of propane are stored in six tanks located about one mile east of the site (Malby, B., 1987). Both gasoline and propane are considered hazardous because of their characteristic ignitability. Gasoline is also considered hazardous because it is composed of individually toxic chemicals.

The existing Mammoth Pacific I geothermal power plant is located approximately 800 feet west of the proposed PLES I power plant site and stores about 20,000 gallons of isobutane as a working fluid for the binary geothermal heat extraction process. Isobutane is also considered hazardous because of its characteristic ignitability. Physical characteristics of selected hydrocarbon fluids are provided in Table 3-2, Section 3.1.1.2.2. Small volumes of miscellaneous lubricants, paints, and solvents are also stored at the MP I power plant during normal operations.

3.3.9 GEOTHERMAL RESOURCE LEASE

The project area is located entirely on federally administered land within federal geothermal lease CA-11667. The lease was originally issued to Magma Energy, Inc. on March 1, 1982, in what was then known as parcel #12 in the Mono-Long Valley Unit Area. The lease was subsequently acquired by Santa Fe Geothermal, Inc. (SFGI). SFGI became unit operator of the newly designated Long Valley East Unit Area, effective May 10, 1985. Pacific Energy assumed responsibility as agent for exploration activities within the lease from Santa Fe Geothermal on May 8, 1986.

The lease conveys the right to the lessee to explore for geothermal resources within the lease, and the right to develop and use the geothermal resources, if such resources are found to exist; unless, such proposed activity would result in significant, unmitigatable, environmental impacts.

Exploration activities were undertaken by Pacific Energy in 1986 under an approved Plan of Exploration. Those activities confirmed the existence of a commercial geothermal resource within the lease, and Pacific Energy submitted Plans of Operation - Development, Utilization, and Injection to the U.S. BLM for the PLES I Geothermal Development Project, which is the subject of this environmental impact statement.

4.0 ENVIRONMENTAL CONSEQUENCES

Project-specific impacts for all alternatives and cumulative environmental impacts are identified in this section. Measures incorporated in the project to reduce impacts are listed immediately before the mitigation measures and described in each section. The same measures which are included in the project would also be included in the alternatives. Suggested mitigation measures are also provided where appropriate and are numbered sequentially within each major subsection. A qualitative statement and, where information is available, a quantitative statement as to the effectiveness of the suggested mitigation measures and a brief indication of potential environmental impacts are also provided following each suggested mitigation, or group of related mitigations. The anticipated cumulative impacts for each resource are evaluated using a likely scenario for development in the vicinity. The development scenario, which includes a variety of projects in the Mammoth Lakes/Casa Diablo/Hot Creek area, is described in Appendix F.

4.1 PHYSICAL ENVIRONMENT

4.1.1 AIR QUALITY

4.1.1.1 Particulate Emissions

4.1.1.1.1 Proposed Project Impacts

Impact: Particulate emissions, in the form of fugitive dust, would be generated during construction of well sites, the power plant site, and new access roads. Vehicular traffic on unpaved roads would also contribute to fugitive dust emissions. Faster moving vehicles generate more dust than slowly traveling vehicles. The EPA has estimated that about 1.2 tons per acre per month of fugitive dust are generated from construction activities (WESTEC Services, Inc., 1986). About 13 acres of surface would be disturbed by grading and surface disturbance during construction activities, so an estimated 16 tons per month of fugitive dust could be anticipated during the peak construction period. These increases in fugitive dust emissions are expected only to occur near the power plant site during daylight hours when the nine-month power plant construction period is scheduled. A large fraction of the particulate matter generated by construction activities would settle out of the atmosphere rapidly and would not create a public health problem or affect the air quality of nearby Class I areas.

The proposed project includes the following measures to reduce impacts:

- Soil wetting for dust control would be undertaken as necessary to prevent nuisance violations as defined by the Great Basin Unified Air Pollution Control District. Frequency of wetting would vary dependent upon meteorological conditions, area of disturbed surface, and frequency of traffic across distributed surfaces.
- Unpaved roads would be surfaced with four inches of compacted surface coarse aggregate. Although the paving of all access and surface roads to well sites would further limit fugitive dust emissions from vehicular traffic, it would make reclamation of the site upon abandonment more difficult.
- Disturbed areas would be revegetated, paved, or covered with gravel to limit long-term dust generation.

These dust control measures should reduce particulate emissions to acceptable levels.

<u>Mitigation</u>:

(1) Post and enforce speed limits of <u>15</u> mph on unpaved access roads to reduce fugitive dust emissions from vehicular traffic.

<u>Effectiveness/Impact</u>: Vehicles traveling less than <u>15</u> mph <u>may</u> reduce fugitive dust emissions <u>slightly</u>. No additional environmental impacts would be associated with this mitigation.

4.1.1.1.2 Alternative Location Impacts

<u>Impact</u>: Particulate emissions would be generated during construction. About 15 acres of surface disturbance would result in an estimated 18 tons per month of fugitive dust during the peak construction period. The timing of the impact would be the same as for the proposed project, as would control measures included in the action.

<u>Mitigation</u>: See mitigation (1) for the proposed project.

4.1.1.1.3 Smaller Power Plant Impacts

Impact: Particulate emissions from about 12 acres of surface disturbance would be an estimated 14 tons per month during the peak construction period. The timing of the impact would be the same as for the proposed project, as would control measures included in the action.

Mitigation: See mitigation (1) for the proposed project.

4.1.1.1.4 No-Action Alternative Impacts

The existing conditions would be unaffected by construction activities.

4.1.1.1.5 Abandonment and Reclamation Impacts

Impact: The power plant operator would be required to plug the wells, remove structures, recontour the ground surface, and revegetate the disturbed areas when the operator determines that field and power plant have reached the end of their commercially useful life. About eight acres would be disturbed in the reclamation process, generating an estimated 10 tons per month of particulate matter. The reclamation process would be accomplished in a much shorter time than the nine-month construction period. See measures included in the proposed project to reduce construction emissions.

Mitigation: No mitigation is recommended.

4.1.1.1.6 Cumulative Impacts

Impact: Intermittent increase in particulate emissions from construction activities would degrade air quality in the Long Valley airshed. A large fraction of the particulate matter generated by construction activities would settle out of the atmosphere rapidly and would not create a public health problem. Smaller particulate matter (PM_{10}) would remain suspended for a longer period of time and may create a health hazard or degrade visibility in nearby areas. If no more than one geothermal project were under construction at one time, the projects would intermittently contribute an estimated 15 to 20 tons per month of fugitive dust during the 36 months of construction. The other construction projects listed in the cumulative scenario, would disturb approximately 700 acres and would contribute corresponding amounts of dust. The proposed project would contribute less than 2% of the total particulates.

Mitigation:

- Wet soils for dust control on roads and graded areas; surface roads with gravel; and revegetate, pave, or cover disturbed areas to limit long-term dust generation.

Effectiveness/Impact: Particulate emissions would be reduced to acceptable levels.

4.1.1.2 Heavy Equipment Emissions

4.1.1.2.1 Proposed Project Impacts

Impact: Heavy diesel-powered equipment, typically used during construction activities, and diesel-powered drilling equipment would be temporary diesel exhaust emission sources. Estimates of aerial emissions from one piece of heavy equipment operated eight hours a day, five days a week, are provided in Table 4-1. Emissions from diesel-powered heavy equipment would be intermittent and temporary. Great Basin Air Pollution Control District rules would limit NO_x emissions from diesel-powered drilling equipment to less than 250 lb/day per rig.

TABLE 4-1: TYPICAL EMISSIONS FROM A DIESEL-POWERED HEAVY EQUIPMENT ENGINE

Pollutant	Emissions (lbs/week)
CO	16.6
HC	6.3
NO_x	90.8
SO_x	5.7
Particulate	5.6

SOURCE: WESTEC Services, Inc., 1986.

Mitigation: No mitigation is recommended.

4.1.1.2.2 Alternative Location Impacts

Impact: Diesel exhaust emissions would be slightly greater for the alternative location action than for the proposed project because a larger area would be cleared and graded for the power plant and longer pipelines would be required to carry fluid to and from the power plant. The emissions from diesel-powered equipment would be intermittent and temporary.

Mitigation: No mitigation is recommended.

4.1.1.2.3 Smaller Power Plant Impacts

Impact: Diesel exhaust emissions would be slightly less for the smaller power plant alternative than for the proposed project because a smaller area would be graded and cleared for the power plant and fewer wells would be drilled. The emissions would be intermittent and temporary.

Mitigation: No mitigation is recommended.

4.1.1.2.4 No-Action Alternative Impacts

Existing conditions would not be affected.

4.1.1.2.5 Abandonment and Reclamation Impacts

Impact: Diesel equipment would be used in abandonment and reclamation activities, contributing temporary emissions.

Mitigation: No mitigation is recommended.

4.1.1.2.6 Cumulative Impacts

Impact: All construction projects listed in the scenario would require the use of diesel powered heavy equipment. Assuming that heavy equipment usage is proportional to acreage disturbed, the proposed project would account for less than 2% of the total emissions.

Mitigation: No mitigation is recommended.

4.1.1.3 Hydrogen Sulfide Emissions

4.1.1.3.1 Proposed Project Impacts

Impact: Noncondensable gases encountered during drilling operations would be vented to the atmosphere. The noncondensable gases could include hydrogen sulfide (H_2S) a malodorous gas for which a California ambient air quality standard of 0.03 ppm exists, principally to prevent nuisance odors.

There is also an eight-hour permissable exposure limit (PEL) of 10 ppm for H_2S which restricts the concentration of H_2S to which a worker may be exposed during a given work day. There is no federal ambient air standard for H_2S.

During proposed short-term well testing and clean out operations (two to four hours), geothermal fluid would be produced into tanks open to the atmosphere. Noncondensable gases, including H_2S, dissolved within the geothermal fluid would escape as aerial emissions. Mass balance calculations indicate that up to about one kilogram per hour of H_2S would be generated during any given well test or clean out operation (PLES, 1986b). This level of H_2S would be detectable by odor in the immediate vicinity of the well testing or clean out operation but would not be expected to result in concentrations in excess of the H_2S PEL for workers.

The proposed project includes the following measure to reduce impacts:

- A H_2S emergency contingency plan for well drilling and testing operations which includes detection monitoring, training, and emergency response actions for reacting to unsafe concentrations of H_2S (see Appendix A). This measure should protect workers from exposure to unanticipated excess concentrations of H_2S.

Mitigation: No mitigation is recommended.

Impact: A small potential also exists for a rupture in the geothermal production or injection pipelines as a result of a major accident or natural disaster. A worst case estimate of the volume of geothermal fluid which would be spilled before the wells could be shut-in is projected to be the entire production volume of 5,000 gallons per minute for a period of approximately five minutes. Conservatively assuming that the entire H_2S content of the geothermal fluid would be released to the atmosphere, it is estimated that the H_2S emissions from the incident would total approximately 0.76 kilograms. This rate of emission when averaged over the four production wells, is less than the Great Basin Unified Air Pollution Control District H_2S emission limit of 2.5 kilograms per hour per well.

A well blowout could result in H_2S aerial emissions. Circumstances which could cause a well blowout vary significantly, and the length of time necessary to regain control of a well cannot be easily estimated. During the period of time a well is out of control, a worst-case event assumes the entire content of H_2S entrained in the geothermal fluid would be released to the atmosphere. The maximum credible sustained flow from a well blowout in the area is approximately 685 gallons per minute (Pacific Energy, 1988). This would result in H_2S emissions of approximately 1.2 kilograms per hour, again less than the per well H_2S emission rate allowable under existing Great Basin Unified Air Pollution Control District regulations.

The proposed project includes the following measures to reduce the potential of well blowouts:

- the wells would be cased and cemented from the surface to the production zone; and
- wellhead control would consist of remotely operated, annular blind rams and pipe rams, and manually operated gate valves

Mitigation: No mitigation is recommended.

4.1.1.3.2 Alternative Location Impacts

Impact: Noncondensable gases encountered during drilling operations would be produced at the same rate as for the proposed project but drilling would continue for a longer period since one additional well would likely be drilled.

Mitigation: No mitigation is recommended.

Impact: A rupture in the pipelines carrying geothermal fluid could release the entire production volume of 6,000 gallon per minute for approximately five minutes. Conservatively assuming that the entire H_2S content of the geothermal fluid would be released to the atmosphere, an estimated 0.91 kilograms of H_2S could be released. This is less than the Great Basin Unified Air Pollution District limit of 2.5 kilograms per hour per well.

Mitigation: No mitigation is recommended.

4.1.1.3.3 Smaller Power Plant Impacts

Impact: Noncondensable gases encountered during drilling operations would be produced at the same rate as for the proposed project, but drilling would be carried out over a shorter time period if fewer wells were required.

Mitigation: No mitigation is recommended.

Impact: A rupture in the pipelines which could release the entire production volume of 3,800 gallons per minute for approximately five minutes. If all the H_2S were released to the atmosphere, an estimated 0.58 kilograms would be released. This is less than the Great Basin Unified Air Pollution Control District limit of 2.5 kilograms per hour per well.

Mitigation: No mitigation is recommended.

4.1.1.3.4 No-Action Alternative Impacts

No impacts would occur from the no-action alternative.

4.1.1.3.5 Abandonment and Reclamation Impacts

Impact: Plugging of all wells would eliminate the possibility of H_2S release from the operation. During the process of well abandonment and plugging, there could be short term releases of H_2S from geothermal fluid. BLM requirements for well abandonment would apply.

Mitigation: No mitigation is recommended.

4.1.1.3.6 Cumulative Impacts

Impact: Intermittent H_2S emissions from well drilling, testing, and clean-out operations would cause short-term air quality degradation near Casa Diablo. This would be added to the H_2S emitted from the naturally occurring springs and fumaroles in the vicinity. Assuming that no more than two wells would be drilled or tested at any given time, releases of H_2S would be less than five pounds per hour and would not be significant.

Mitigation:

- No more than two wells shall be tested to the atmosphere at one time, unless it can be demonstrated that the State ambient air quality standard for H_2S will not be exceeded..

Effectiveness/Impact: H_2S emissions would not be significant. No further impacts would be expected from implementation of this measure.

4.1.1.4 Hydrocarbon Emissions

4.1.1.4.1 Proposed Project Impacts

Impact: Fugitive isobutane emissions would occur from miscellaneous leaks in the heat exchanger system. Based on current performance of the existing MP I power plant, fugitive emissions could be expected to amount to less than 250 pounds per day per generating unit, on an annual average basis, as required by Great Basin Unified Air Pollution Control District Permits to Operate.

The proposed project includes the following measures to reduce impacts:

- addition of a gas odorant to each fill of isobutane working fluid to facilitate leak detection;
- routine inventory analysis of isobutane losses;
- periodic leak detection surveys with portable detection equipment;
- repair or replacement of significantly leaking equipment;
- installation of block valves and compressors to evacuate isobutane from the system prior to maintenance operations; and
- use of hydrocarbon leak detection sensors and alarms.

The leak detection program proposed by the project proponent would be expected to assure that fugitive gas emissions would satisfy the Great Basin Air Pollution Control District. Best Available Control Technology would be required by the Great Basin Unified Air Pollution Control District if emissions exceeded the established limits.

Mitigation: No mitigation is recommended.

Impact: A small potential exists for a substantial instantaneous loss of isobutane up to the entire contents of the heat exchanger system, should a catastrophic rupture in the system occur as a result of a major accident or natural disaster. If the entire containment system should empty in this worst-case scenario, up to 20,000 gallons of vaporized isobutane could be lost to the atmosphere. If it were accidentally released during low wind conditions, it would form a visible vapor cloud at ground level. The vapor would irritate the eyes and, if inhaled, could cause dizziness, breathing difficulties, and loss of consciousness. In concentrations from 1.8% to 8.4% with air, the cloud could be ignited. Ground-level isobutane concentrations calculated using a Gaussian "puff" model indicate that immediately downwind of the source, concentrations could be within this concentration range.

The proposed project includes the following measures to reduce impacts of complete or partial loss of isobutane:

- condenser fan drafts would dilute and disperse leaked vapors;
- hydrocarbon sensors and odorant in the isobutane would alert personnel of the event; and
- relief valves and discharge valves would be closed to reduce the quantity of released isobutane.

Strict compliance with applicable building and safety codes and appropriate engineering design and construction would be required by law.

Mitigation: No mitigation is recommended.

4.1.1.4.2 Alternative Location Impacts

Impact: Isobutane emissions and emergency conditions would be the same as for the proposed project. Great Basin Unified Air Pollution Control District permits would limit operating emissions to 250 pounds per day per generating unit. The power plant for each action would have three generating units. The total volume of isobutane in the system would also be the same for both actions. See the discussion in Section 4.1.1.4.1 which describes measures included in the proposed project to reduce impacts.

Mitigation: No mitigation is recommended.

4.1.1.4.3 Smaller Power Plant Impacts

Impact: Potential isobutane emissions would be approximately two-thirds those of the proposed project, because two generating units would be employed instead of three. Great Basin Unified Air Pollution Control District requirements would limit emissions to less than 500 pounds per day. The total volume of isobutane stored on-site also would be less for the smaller power plant than for the proposed plant. See the discussion in Section 4.1.1.4.1 which describes measures included in the proposed project to reduce impacts.

Mitigation: No mitigation is recommended.

4.1.1.4.4 No-Action Alternative Impacts

The only source of isobutane in the project area would be the existing MP I power plant.

4.1.1.4.5 Abandonment and Reclamation Impacts

Isobutane would not be used or stored on the site after abandonment.

4.1.1.4.6 Cumulative Impacts

Impact: The existing MP I power plant and all currently proposed geothermal projects would be binary facilities utilizing a hydrocarbon working fluid to extract heat from the geothermal fluid. Recent fugitive isobutane emissions at MP I have averaged less than 200 pounds per day. Assuming all five geothermal power plants would have similar fugitive emission rates, then approximately 1,400 pounds per day of fugitive hydrocarbon emissions into the Long Valley airshed could result.

The Great Basin Unified Air Pollution Control District recognizes hydrocarbons as precursors to photochemical oxidant air pollutants and has indicated that new binary power plants would be required to obtain Authorities to Construct and Permits to Operate from that agency. Those power plants with hydrocarbon emissions totalling more than 250 lb/day per generating unit would be required to meet New Source Performance Requirements and utilize Best Available Control Technology to minimize hydrocarbon emissions (Hardebeck, E., 1987).

Isobutane is only slightly reactive in atmospheric photochemical reactions; photochemical reactions in the airshed are believed to be limited, not by hydrocarbons, but by relatively low atmospheric concentrations of NO_x in the airshed. It is therefore likely that fugitive hydrocarbon emissions from geothermal development would not significantly increase photochemical oxidant pollution in the air basin.

Estimates based on a simplified model of ground-level concentrations of isobutane from several geothermal power plants indicate that isobutane would not reach dangerous levels from fugitive emissions during normal operations of the five power plants.

Mitigation:

- Adopt hydrocarbon fugitive emission control procedures for all future binary geothermal power plants projects similar to those discussed for the PLES I project (see Section 4.1.1.4.1).

Effectiveness/Impact: The measures would reduce the fugitive hydrocarbon emissions to levels acceptable to the Great Basin Unified Air Pollution Control District. No further impacts of implementation of the measure are anticipated based on current practices.

4.1.2 GEOLOGY, SOILS, AND EROSION

4.1.2.1 Geologic Hazards

4.1.2.1.1 Proposed Project Impacts

Impact: Power plant and wellfield facilities are located in a major active earthquake fault zone and would be subject to severe groundshaking during a major seismic event. All facilities of the proposed project would be designed and constructed in compliance with Uniform Building Code criteria for Seismic Zone No. 4 areas. This measure would be adequate for most seismic events but would not necessarily prevent significant structural damage from a major earthquake centered in the immediate area.

Mitigation: No mitigation is recommended.

Impact: Geothermal water may be near the surface at the proposed power plant site, so that warm artesian water and/or fumaroles could be encountered during grading. This is most likely to occur at the site of the water tank where the deepest cuts would be made during grading. The presence of shallow or surficial warm water or stream would limit the ability to carry out revegetation.

(2) Install piezometers to a depth of 20 feet in order to monitor groundwater levels. Pump groundwater to lower the water table locally if, after construction, it rises to levels sufficiently shallow to damage foundations or otherwise compromise the integrity of the facility.

Effectiveness/Impact: Direct effects of the shallow water or steam on the facility could be mitigated. Disposal of the water could be a problem if it could not be used for irrigation, although injection into the injection reservoir would be an option. The local groundwater table would be lowered which may affect shallow-rooted vegetation. Extensive pumping of groundwater could cause subsidence.

(3) Design foundation and subbase to accommodate shallow groundwater and passively drain the subbase.

Effectiveness/Impact: Direct effects of shallow water would be mitigated. Pumping of shallow groundwater would not be required, minimizing potential impacts to vegetation.

Impact: The project area is located within a volcanically active region. If a major eruption should occur in the region during the life of the project, it could result in a catastrophic spill of geothermal fluids and/or isobutane.

Mitigation: No mitigation is recommended.

Impact: Long-term production of geothermal resources could result in surface subsidence in the area of the production wellfield. A one kilometer long section of the resurgent dome across Casa Diablo subsided at a rate of 15 mm/year near the intersection of Hot Springs Road and Highway 203 in the period between 1986 and 1987 (Savage, 1987). It has not been determined whether this is related to production at MPI or is caused by tectonic activity along nearby normal faults. If it is due to nearby production of geothermal fluids, then the rate of subsidence would likely increase with increased production.

Subsidence can cause structures to sink or tilt and can cause changes in surface drainage. Generally, changes larger than those observed near Casa Diablo would be required to noticeably affect structures or drainage.

The power plant operator is required by the BLM (per GRO Order No. 4 and included in the Plan for Baseline Data Collection) to construct subsidence monuments throughout the project area, to tie them into the established local and regional networks, and to periodically survey the project subsidence network. This activity would detect any significant surface deformation and provide an opportunity to implement mitigation measures in addition to those identified in GRO Order No. 4, if necessary.

Mitigation: No mitigation is recommended.

4.1.2.1.2 Alternative Location Impacts

Impact: Groundshaking impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

Impact: The alternate location action may be located within a fault zone subject to ground rupture or creep, but detailed geotechnical studies have not been done on the alternate power plant site to evaluate seismic hazards.

Mitigation: Perform site-specific studies and relocate those portions of the power plant if necessary if an active fault is found.

Impact: Shallow warm artesian water or fumaroles could be a hazard, but there have been no studies done which suggest this is likely. The presence of relatively tall pine trees on the site suggests that the geothermal water is not shallow enough to inhibit their growth.

Mitigation: If detailed geotechnical work were to indicate shallow warm water or fumaroles were likely, then follow mitigations (4) and (5) for the proposed project.

Impact: Volcanic hazards would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

Impact: Subsidence impacts, if caused by pumping geothermal fluids, would be greater than for the proposed project since approximately 20% more fluid would be produced for the power plant in the alternative location. The same requirements under GRO Order No. 4 would apply to this alternative as to the proposed project.

Mitigation: No mitigation is recommended.

4.1.2.1.3 Smaller Power Plant Impacts

Impact: Groundshaking impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

Impact: Groundrupture and creep impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

Impact: Shallow geothermal fluids may be near the surface at the power plant site. The smaller power plant could be relocated as much as 80 feet and remain within the proposed power plant site. Therefore, the impact could be slightly less for the smaller power plant.

Mitigation: See mitigations (2) and (3) for the proposed project.

Impact: Volcanic hazards would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

Impact: Subsidence impacts, if caused by pumping geothermal fluids, could be less than from the proposed project because less fluid would be pumped for the smaller power plant. The same requirements under GRO Order No. 4 would apply to the smaller project as to the proposed project.

Mitigation: No mitigation is recommended.

4.1.2.1.4 No-Action Alternative Impacts

The present conditions would continue.

4.1.2.1.5 Abandonment and Reclamation Impacts

There would be no facilities to be impacted by geologic hazards.

4.1.2.1.6 Cumulative Impacts

Impacts at Casa Diablo would apply to the one existing and three proposed geothermal projects, and in general, each would be subject to geologic hazards independently of the other projects, except for subsidence.

Impacts: If the recently observed subsidence is indeed caused by production of geothermal fluid either due to collapse of pore space or thermal contraction, then the rate would likely accelerate markedly with the increased production (3,800 gallons per minute increasing to approximately 19,000 gallons per minute). If it is due to tectonic activity alone, then geothermal production would have no impact on subsidence.

Mitigation:

- Recommend that Mono County and the California Division of Oil and Gas adopt the standards contained in GRO No. 4.

4.1.2.2 Soils and Erosion

4.1.2.2.1 Proposed Project Impacts

Impacts: Construction of the power plant, access road, well pads, pipelines and transmission lines would result in soil disturbance. Total site development would result in the temporary disturbance of about 13 acres. After construction, the dirt access roads, cleared areas around wells, and power plant site would constitute about 7.4 acres of unvegetated land which would remain unvegetated for the life of the project.

Disturbance of soil reduces its productivity. In addition, grading or clearing is likely to remove soil from some areas, leaving behind an area difficult to revegetate.

The erosion potential from the proposed surface disturbance will increase if proper precautions are not taken. Receptors for sediment transported from the project include Mammoth Creek and subsequently Hot Creek. Surface water leaving the site flows through the unnamed intermittent creek draining the Casa Diablo area for about 0.6 mile before reaching Mammoth Creek. Under present conditions this provides sufficient time for silt and sand to settle before reaching Mammoth Creek. During intense thunderstorms or when runoff would be extraordinarily high, silt could be carried further and might reach Mammoth Creek, although the capacity of the existing culverts under Route 203 and Hot Springs Road could limit flows and allow some settling to occur.

The proposed project includes the following measures to identify and/or reduce impacts:

- The approved Plan for Baseline Data Collection requires monitoring of the unnamed stream above and below the proposed site to determine effectiveness of erosion control measures.

- Berming well sites during production and injection field drilling and testing activities to contain minor spills on location. Grading sites to direct runoff to sedimentation basins or the mud/reserve pit.

- Diking the power plant site and draining it to a permanent catch basin to collect site runoff. The catch basin would also serve as an emergency containment basin in the event of a significant geothermal fluid spill.

- Constructing all roads to Forest Service standards.

- Following Forest Service "Best Management Practices" for control of erosion based on Forest Service jurisdiction over non-point discharges. This could include using hay bales and filtration fences to remove sediment from runoff before it reaches Mammoth Creek.

- Topsoil from areas which are planned for severe disturbance would be stockpiled for use in revegetation efforts.

- Installing an emergency spill containment system, which is designed to contain any and all discharges from within the project boundaries and which would also be utilized for sediment control during project construction.

- The plant site catchment basin and the emergency spill containment basins would be two separate facilities. The emergency spill containment basins would be of sufficient size to contain approximately forty times the amount of geothermal fluid expected from the maximum credible spill or upset condition.

<u>Mitigation</u>: No mitigation is recommended.

Impact: The spill containment plan (see Appendix A) states that the sluice gates on the spill containment basins would be closed during well drilling and construction activities before the automatic system would be installed. Closure of the sluice gates when the unnamed intermittent stream is flowing could cause an unnecessary accumulation of water.

Mitigation:

(4) Maintain the sluice gates in an open position when the intermittent stream is flowing, except during emergency conditions.

Effectiveness/Impact: The spill containment basins would not accumulate normal stream flow except during emergency conditions. This measure would require manual closure of the valve if the intermittent stream were flowing during construction and a spill occurred large enough to overflow the bermed areas around drill pads and the plant site. This would increase slightly the risk that spilled fluid would reach Mammoth Creek.

4.1.2.2.2 Alternative Location Impacts

Impact: A total of about 15 acres would be disturbed by construction of the power plant at the alternative location. Runoff from the power plant site would travel several hundred yards overland to the unnamed stream and then over a mile to Mammoth Creek. Gulleying could be severe in the highly erodible soil. Without detailed topographic maps of the area it is unclear whether fluids leaving the power plant site would flow north or south of the hill between the site and Highway 395. If the flow were to go north, it could conceivably reach the ephemeral lakes, causing erosion and damaging vegetation en route. Wildlife using the lakes could be impacted.

Mitigation:

- Construct berms so that runoff leaving the site would flow away from the ephemeral lakes.

Effectiveness/Impact: The ephemeral lakes would be protected from additional sedimentation; however, there would be additional soil disturbed and more revegetation and erosion control measures would be required.

Impact: Impacts from closed sluice gates would be the same as for the proposed project.

Mitigation: See mitigation (4) for the proposed project.

4.1.2.2.3 Smaller Power Plant Impacts

Impact: A total of 12 acres would be disturbed. Impacts would be very much like those of the proposed project.

Mitigation: See mitigation (1) for the proposed project.

4.1.2.2.4 No-Action Alternative Impacts

There would be no soil disturbance from the no-action alternative.

4.1.2.2.5 Abandonment and Reclamation Impacts

Impact: About eight acres would be graded and contoured after project abandonment. This area would contribute sediment until the revegetation efforts provided protection.

Mitigation:

- Require erosion control measures to be incorporated in the reclamation plan.

Effectiveness/Impact: Sediment load in Mammoth Creek would be maintained at levels of insignificance. No other environmental impacts would be expected from implementation of this measure.

4.1.2.2.6 Cumulative Impacts

Impact: Each of the proposed development projects (see Appendix F) could contribute to soil erosion during their respective construction phases. About 60 acres would be disturbed by construction of the geothermal projects. Snow Creek, Sherwin Bowl, and Juniper Ridge could involve disturbance of about 400 acres. Doe Ridge may directly impact another 200 acres. These projects would account for about 700 acres of disturbance; PLES I would represent less than 2% of the total.

Mitigation:

- Erosion control measures should be emplaced prior to surface disturbances so that increases in sediment load in the streams are minimized. Revegetation programs should be promptly executed.

Effectiveness/Impact: Careful execution of project-specific mitigation measures during and after construction could be expected to reduce the potential impacts. Revegetation programs would reduce the long-term impact. Emplacement of sediment barriers described in the proposed action prior to surface disturbance would reduce the increment of impact due to PLES I to insignificance.

4.1.3 NOISE

4.1.3.1 Construction Noise

4.1.3.1.1 Proposed Project Impacts

Impacts: Noise from construction-related activities can be divided into noise from heavy machinery used at the site and noise from transporting equipment and workers to and from the site. Construction of the PLES I facility is expected to last nine months. During this period, heavy equipment would generate noise levels similar to those shown in Table 4-2. The peak noise level of 89 dBA, L_{eq}, due to excavation would be attenuated by distance alone to 47 dDA, L_{eq}, at the closest sensitive receptors, the county office buildings, about 1.25 miles to the east. Given existing topography and vegetation, noise from construction activities at the project site would be below ambient levels at the nearest sensitive receptors.

Mitigation: No mitigation is recommended.

Impacts: Pacific Energy anticipates that a maximum of 82 worker would be employed during one month of the construction period. Many of these workers would live in Mammoth Lakes during the construction period and would travel State Route 203 and Hot Springs Road to the project site. This increase in traffic would increase noise levels temporarily when individual vehicles traveled along these roads to about 60 dBA at 10 feet. This would mainly affect cyclists or runners along the State Route 203 and Hot Springs Road in the project area.

TABLE 4-2: TYPICAL CONSTRUCTION NOISE LEVELS AT 50 FEET FROM COMMERCIAL/INDUSTRIAL CONSTRUCTION ACTIVITIES (dBA, L_{eq})/a/

Construction Phase	Average Noise Level (dBA, L_{eq})
Ground Clearing	84
Excavation	89
Foundations	78
Erection	85
Finishing	89

/a/ The L_{eq} is the average noise intensity over the measurement period. Its value tends to be influenced by loud intrusive noises.

SOURCE: Boilt, Beranek, and Newman. 1971. Noise Construction Equipment and Operations, Building Equipment, and Home Appliances. U.S. Environmental Protection Agency.

Mitigation:

(5) Carpooling or busing of workers shall be encouraged.

Impacts: Well drilling noise results from a variety of sources including diesel engines, mud pumps, and electric generators. Drilling equipment would be operated 24 hours per day for twelve to sixteen days at each of eight planned wells. Noise levels from well drilling have been estimated to reach 77 dBA, L_{eq}, at 100 feet (WESTEC Services, Inc., 1986). It is unlikely that more than one well would be drilled at any one time; but, as many as two wells may be drilled simultaneously, and noise levels as high as 80 dBA, L_{eq}, could be produced at 100 feet. This noise level could be annoying to wildlife and people in the vicinity, but would be attenuated by distance to 66 dBA, L_{eq}, at 500 feet and to approximately 44 dBA, L_{eq}, at the county office buildings one and one-quarter miles to the east. Terrain and vegetation would further attenuate these temporary noise levels.

After being drilled, each well would be cleaned out by pumping fluids for two to four hours. Well clean-out would be followed by flow testing for about five days. Noise levels from clean-out and flow testing would probably range from about 75 to 79 dBA, L_{eq} at 100 feet (WESTEC Service, Inc., 1986). Attenuated noise levels would be similar to those described above for well drilling.

Mitigation: No mitigation is recommended.

4.1.3.1.2 Alternative Location Impacts

Impact: Construction noise levels on each site would be the same for the alternate location as for the proposed project; however, the power plant site where most construction activity would take place is located further from the county buildings and Chance Ranch than the proposed power plant site. People using the informal target-shooting area would be affected more by noise from the power plant in the alternate location than at the proposed site. However, since target-shooting itself is a noisy activity, the power plant is unlikely to disturb people using the target shooting area.

Mitigation: No mitigation is recommended.

4.1.3.1.3 Smaller Power Plant Impacts

Noise impacts from construction of the smaller power plant would be the same as those from the proposed project.

4.1.3.1.4 No-Action Alternative Impacts

Noise levels would remain at existing levels.

4.1.3.1.5 Abandonment and Reclamation Impacts

Impact: Heavy equipment used for well plugging, reclamation, and revegetation would generate noise levels comparable to those generated during construction, but for a shorter period.

Mitigation: No mitigation is recommended.

4.1.3.1.6 Cumulative Impacts

Impact: The cumulative projects are far enough apart that, except for MP II & III, none would be audible in the Casa Diablo area. Sherwin Bowl, Snow Creek, and Juniper Ridge projects would be audible in the Town of Mammoth Lakes.

Mitigation: No mitigation is recommended.

4.1.3.2 Operational Noise

4.1.3.2.1 Proposed Project Impacts

Noise levels generated by operation of the power plant would be similar to those generated by the existing MP I facility. Noise levels from the MP I power plant have been measured at 63 to 66 dBA, L_{eq} at 150 feet. Footnote 1, in Section 3.1.3.1, lists examples of typical noise levels for comparison. The PLES I facility would operate 24 hours per day, seven days per week, as does the MP I plant. Addition of a second plant with the capacity to generate noise levels similar to those produced by the MP I plant could result in a combined noise level that would be just noticeably louder than the MP I plant (three decibel increase). Distance, topographic, and vegetative attenuation would reduce noise from these facilities to a level below background levels at all sensitive receptors identified in Chapter 3, Affected Environment. Noise muffling devices are included in the design of the facility.

The project as proposed would comply with applicable federal and state Occupational Safety and Health Administration regulations and Geothermal Resources Operational Order No. 4. Noise levels would not exceed 65 dBA during any geothermal operations at the lease boundary line or 0.8 km (one-half mile) from the source, whichever distance is greater.

Mitigation: No mitigation is recommended.

4.1.3.2.2 Alternative Location Impacts

Impact: The alternate power plant site is located about 0.6 mile from the existing MP I power plant. At that distance, noise from MP I would not be noticeable above background levels. Therefore, noise generated at the alternative location power plant would function as a separate noise source, rather than blending with the noise from MP I. Like the power plant on the proposed site, the power plant on the alternate site would be required to meet Geothermal Resources Operational Order No. 4.

The noise would affect recreationists and wildlife in the area north and east of the SCE substation where the existing noise levels are low and the proposed project would not be heard.

Mitigation:

- Locate the power plant at the proposed site.

Effectiveness/Impact: Point-sources of noise would be confined to a smaller area and the noise impacts would be reduced.

4.1.3.2.3 Smaller Power Plant Impacts

Noise impacts would be the same as for the proposed project.

4.1.3.2.4 Abandonment and Reclamation Impacts

After abandonment, operational noise would cease.

4.1.3.2.5 No-Action Alternative Impacts

Noise levels would continue at present levels.

4.1.3.2.6 Cumulative Impacts

Impacts: Noise generated by the non-geothermal projects described in Appendix F would be mostly from traffic along Highway 395 and Route 203 leading to Mammoth Lakes. By contrast, geothermal projects' main contributions to noise would be from operation of power plants. The noise would affect people and wildlife near Casa Diablo and in the meadow near the Mammoth / Chance geothermal project. PLES I's contribution to total noise would be localized in effect and small compared to other projects.

Mitigation: Mitigation measures should be determined by responsible agencies on a project-by-project basis.

Effectiveness:

"Discussion of mitigation measures to deal with the cumulative impacts from traffic noise resulting from other proposed projects is best reserved to environmental assessments for those projects which generate substantial traffic and to regional planning documents such as the Noise Element of the Mono County General Plan and the Inyo Forest Management Plan."

Impact: Assuming that each new geothermal power plant would have noise generating and abatement capacities similar to those documented for the existing MP I plant, geothermal-related noise levels would not be audible above background noise at the closest existing sensitive receptors. This analysis is based on (1) a worst-case noise level of 75 dBA, L_{eq}, at 100 feet generated by each power plant unit (noise level without noise muffling devices), and (2) a noise attenuation of three dBA, L_{eq}, at 100 feet generated by each power plant unit (noise level without noise muffling devices). The combined worst-case noise level of the four plants would be 81 dBA, L_{eq}, at 100 feet, which would be attenuated by distance alone to 55 dBA, L_{eq}, at 2,000 feet and to 45 dBA, L_{eq}, at the closest sensitive receptors (Mono County Offices) 1.25 miles to the east. As such, even the combined worst-case noise level, without muffling devices, would not be audible above background noise at the closest sensitive receptors. No noise-sensitive development is currently planned for areas within one-half mile of the project site (Lyster, D., 1987a).

Mitigation: No mitigation is recommended.

4.1.4 WATER QUALITY AND HYDROLOGY

This section is summarized from the separate report on hydrology written by BGI and included as Appendix C.

4.1.4.1 Surface Water Quality

4.1.4.1.1 Proposed Project Impacts

Impact: Spills of geothermal fluid could result from a large pipeline rupture or a well blowout. Temperature effects, though likely to be short-term, would be the most significant impact. The chemical content of the spilled geothermal fluid could cause short-term changes to local creek water chemistry, but would not enter Mammoth Creek due to spill containment structures. The chemical content of the fluid is low in total dissolved solids (TDS) and would not likely have a significant impact for a short-term event. Approximately 760 gpm of fluid from Casa Diablo wells was purposely directed to the creeks for 39 days in 1962 by a former operator. While this caused concern about effects of long-term discharge and potential buildup of trace elements in the potable water supply at Crowley Lake, no catastrophic or lasting effects to the creeks or lake were documented (California Department of Water Resources, 1967 and 1973; Setmire, J.G., 1984).

If a production pipeline carrying the entire plant capacity of geothermal fluid (approximately 5,000 gpm at 335°F) ruptured, a loss of several thousand gallons could result even as various pumps were automatically shut off. This would include spillage from pipes located up-gradient of the broken line which could drain out. If the breakage occurred on the power plant site, the spilled fluid would be contained by a system of dikes and a catchment basin. Outside the plant site, the fluid would flow into the spill containment structure described in Section 2.1.5.1 and Appendix A. Spills from production wells and associated pipelines would drain into the larger basin (design capacity 1,600,000 gallons and maximum capacity 2,180,000 gallons) shown in Figure 2-1. If a production pipeline were to rupture, approximately 15% of the flow would flash to steam as it escaped, while the liquid portion would decrease in temperature to 200°F. The temperature would drop further as the fluid flowed over the ground surface. The larger spill containment basin would be adequate to contain the volume produced by a complete rupture of the largest pipeline flowing for a period of six hours. Well pumping would stop immediately and continuing flow would be reduced to artesian well flow. Artesian wells may continue to flow if automatic valve closures fail, but manual override action would be taken within a probable maximum of one-half hour.

Drainage from three of the four injection well sites (Figure 2-1) would be to the smaller basin (design capacity 92,500 gallons maximum capacity 235,000 gallons). All flow from injection lines would flow onto the ground surface because none of it would flash to steam, but its higher wellhead elevation <u>means that if the pipeline ruptured, the fluid in those parts of the pipeline lower than the break would not drain out, but would remain in the pipeline.</u> Assuming a flow of 5,000 gpm, the smaller basin has adequate capacity to contain the volume of the entire system for about 20 minutes. This would allow ample time for automatic pump shutoff.

Fluid resulting from a well blowout or spill of drilling fluid would also be contained by the basins shown in Figure 2-1. A well blowout could flow unchecked for several days before remedial action (see blowout prevention plan) could be completed. However, the well must first be capable of artesian flow and data thus far indicates a maximum of approximately 700 gpm can be expected. At this rate the larger basin could contain more than 1.5 days flow and the upper basin could contain three hours flow. This estimate is a worst case as it assumes the maximum flow would occur and it does not account for evaporation or percolation losses. The spill containment plans specify that reinjection of the fluid would take place before containment structures are filled. This would allow remedial actions, such as drilling a relief well to be implemented. Any residual fluid or solids remaining on the ground surface would be removed during cleanup operations and should not result in environmental damage.

The proposed project includes the following measures to reduce impacts:

- Follow the Blowout Contingency Plan attached to the Emergency Spill Containment Plan (see Appendix A), including blowout prevention equipment required during drilling (PLES, 1986). During drilling and testing operations store at least 10,000 gallons of cold water on the well site to quench the well should a blowout occur. Another minimum of 220,000 gallons of cold water, stored principally for fire-fighting purposes, should be available during power plant operation.

- Regularly test, maintain and inspect emergency pump shutdown system to ensure proper operation of equipment designed to prevent large spills of geothermal fluid due to pipeline rupture. The testing/maintenance/inspection schedule will be established prior to construction and developed in accordance with GRO Order No. 6.

As a result of these proposed actions, large spills of geothermal fluid within the power plant containment area would be confined to the emergency spill containment basin until it could be reinjected and adverse impacts to Mammoth/Hot Creek would be eliminated.

The spilled fluid would be injected according to the Emergency Spill Containment Plan (see Appendix A). Some percolation of fluid into the local soil would occur; the amount would vary with the season and soil saturation. As long as containment structures were effective, no adverse impacts would occur. Containment structures would not be lined so as to interfere with natural runoff. Should spill containment structures fail, an analysis of the estimated temperature effects for the point at which flow reaches Mammoth Creek is given below.

There is the remote possibility that a catastrophic failure of the road bed of State Route 203 could allow spilled geothermal fluid to leave the larger spill containment basin and flow toward Mammoth Creek before it could cool.

In the worst case, the largest spill would result from a pipeline rupture. Such a spill could last a reasonable maximum of ~~five~~ to ten minutes due to automatic pump shutoff and lack of pumping power. Also, the rupture would have to occur off the plant site since the site itself has sufficient containment capacity behind berms. Off site, a total flowline rupture would allow approximately 4,250 gpm to escape at 200°F. As it traveled toward Mammoth Creek, 0.5 miles distant, significant cooling and percolation would occur which would vary with the time of year. It is difficult to estimate the flowrate and temperature reaching Mammoth Creek, but two limiting impact scenarios are presented:

a) Peak runoff (May-June), high creek flow (82 cfs, 50°F at Mammoth Creek Flume), low percolation (10%), air temperature 65°F (see Appendix C).

   Geothermal fluid, 4,250 gpm (9.5 cfs) x 90% = 8.5 cfs

   Temperature of spilled geothermal fluid at point of entry to Mammoth Creek - 150°F (estimate)

   Temperature of mixed geothermal and stream flow calculation:

   Enthalpy of water at 150°F, 12.5 psi = 118 Btu/lb
   Enthalpy of water at 50°F, 12.5 psi = 17.5 Btu/lb
   (fraction of geothermal fluid x 118 Btu/lbm) + (fraction of creek x 17.5 Btu/lb) = (.104 x 118) + (.896 x 17.5) = 27.9 Btu/lbm

   Mixed Temperature = 60°F

   This temperature is within the yearly range of Mammoth Creek under normal circumstances.

b) Low runoff (8 cfs, 58°F at MCF), high percolation (30%), air temperature 90°F (see Appendix C)

   Geothermal fluid 4,250 gpm (9.5 cfs) x 70% = 6.6 cfs
   Temperature at mixing point = 170°F (estimate)
   Temperature of mixed water calculation:
   Enthalpy of water at 170°F, 12.5 psi = 137.9 Btu/lbm
   Enthalpy of water at 58°F, 12.5 psi = 24.9 Btu/lbm
   (fraction of geothermal fluid x 137.9) + (fraction of creek x 24.9) = (.543 x 137.9) + (.457 x 24.9) = 86.2 Btu/lbm

   Mixed Temperature = 118°F

This temperature effect could last for a maximum of 5 to 10 minutes at the point of entry and be subject to downstream flow and mixing from other tributaries. The contribution from Hot Creek Hatchery (mean flow 17 cfs, 58°F) (Fish and Game, 1988) would allow a reduction to approximately 80°F. No cooling after mixing with Mammoth Creek is assumed. Obviously, some cooling would occur since the air temperature would be 90°F and humidity presumably below 30%.

Mitigation: See mitigation (10) in Aquatic Resources, Section 4.2.3.

Impact: Surface water could be contaminated by runoff from soils previously contaminated by leakage or spills of fuels and other chemical compounds used on the site. The potential for the latter is more likely during well drilling and power plant construction phases due to the presence of machinery, fuels, and chemicals that will be stored and used on site.

The following measures included in the Emergency Spill Containment Plan would minimize the potential for contaminated runoff, from drilling or construction activities, reaching surface waters.

- Immediately remove spilled fluid or contaminated soil for proper disposal.
- Build containment dikes around the spill area of sufficient size to contain the spill until contaminated soils can be removed.
- Begin cleanup immediately.
- Notify appropriate public agencies immediately.

Mitigation: No mitigation is recommended.

4.1.4.1.2 Alternative Location Impact

Impact: Impacts to surface water due to geothermal fluid spills would be greater at the alternative location due to the increased distance the fluid would be piped between the alternative site and the well fields. There may be a potential for contamination of the ephemeral lakes to the west. The proposed containment structures would be in the same location as previously described and a significant amount of cooling and percolation would be likely to occur as the fluid traveled approximately one mile to the basin. Cooling and percolation may reduce temperature and flow to effectively compensate for the additional 1,000 gpm which would be required to run the power plant at the alternate site. All other measures regarding disposal of the fluid, etc., would be the same as for the proposed project (see Emergency Spill Containment Plan, Appendix A).

The wells would be in the same approximate locations so that spills or blowouts in those areas would have a similar effect as described in Section 4.1.4.1 for the proposed project. See that section for an analysis of effects on Mammoth Creek due to failure of containment structures.

Mitigation: See the mitigation in Soils and Erosion, Alternative Location, Impacts, Section 4.1.2.2.2.

4.1.4.1.3 Smaller Power Plant Impacts

Impact: The only difference between this and the proposed project is the reduced pumping rate (down 24% to 3800 gpm) which allows an additional .5 to .75 hours (for a total of 7 hours) for shut down to be completed before the containment structure is filled to recommended capacity. Impacts due to well blowouts or spills during drilling would be the same as described for the proposed project as would measures to reduce impacts.

Mitigation: No mitigation is recommended.

4.1.4.1.4 No-Action Alternative Impacts

Impact: Even under the no-action alternative, potential impacts to surface water quality exist from spill of geothermal fluid and well blowouts because of existing MPI power plant operation. At present, the potential threat of well blowout, drilling fluid or fuel spills is low or non-existent since no new wells are needed, but it would increase if additional drilling were required to maintain production. Existing berms would contain spills from the current wells and plant site.

In the worst case that these structures failed and the fluid reached Mammoth Creek, such a spill could last a reasonable maximum of five to ten minutes due to automatic pump shutoff and lack of pumping power. Also, the rupture would have to occur off the plant site since the site itself has sufficient containment capacity behind berms. Off site, a total flowline rupture would allow approximately 3,230 gpm to escape at 200°F. As it travels toward Mammoth Creek, 0.5 miles distant, significant cooling and percolation would occur which would vary with the time of year. It is difficult to estimate the flowrate and temperature reaching Mammoth Creek. Two impact scenarios are presented:

a) Peak runoff (May-June), high creek flow (82 cfs, 50°F at Mammoth Creek Flume), low percolation (10%), air temperature 65°F.

Geothermal fluid, 3,230 gpm (7.2 cfs) x 90% = 6.5 cfs

Temperature of spilled geothermal fluid at point of entry to Mammoth Creek - 150°F (estimate)

Mixed water temperature calculation:

Enthalpy of water at 150°F, 12.5 psi = 118 Btu/lb
Enthalpy of water at 50°F, 12.5 psi = 17.5 Btu/lb
(fraction of geothermal fluid x 118 Btu/lbm) + (fraction of creek x 17.5 Btu/lb) =
(0.075 x 118) + (.925 x 17.5) = 24.8 Btu/lbm

Mixed Temperature = 57°F

This temperature is within the yearly range of Mammoth Creek under normal circumstances.

b) Low runoff (8 cfs, 58°F at MCF), high percolation (30%), air temperature 90°F (see Appendix C)

Geothermal fluid, 3,230 gpm (7.2 cfs) x 70% = 5.0 cfs
Temperature at mixing point = 170°F (estimate)
Mixed water temperature calculation:
Enthalpy of water at 170°F, 12.5 psi = 1,137.9 Btu/lbm
Enthalpy of water at 58°F, 12.5 psi = 24.9 Btu/lbm
(fraction of geothermal fluid x 137.9) + (fraction of creek x 24.9) = (.38 x 137.9) + (.62 x 24.9) = 67.8 Btu/lbm

Mixed Temperature = 100°F

This temperature effect could last for a maximum of 5 to 10 minutes at the point of entry and be subject to downstream flow and mixing from other tributaries. The contribution from Hot Creek Hatchery (mean low 17 cfs, 58°F) (Fish and Game, 1988) would allow a reduction to approximately 70°F. No subsurface cooling after mixing with Mammoth Creek is assumed. Obviously, some would occur since the air temperature is 90°F and humidity presumably below 30%.

Mitigation: See mitigation (10), Aquatic Resources, Section 4.2.3.

4.1.4.1.5 Abandonment and Reclamation

Impact: During well plugging operations there is a small chance that geothermal fluid could escape from a well. It would be contained in the spill containment basins.

Mitigation: No mitigation is recommended.

4.1.4.1.6 Cumulative Impacts

Of the existing and proposed projects which could have comparable impacts to the PLES I project, five are considered planned to a point at which impacts may be estimated. These five projects are:

1)	MP I	7 MW	
2)	MP II	10 MW	
3)	MP III	10 MW	
4)	Mammoth Chance I	10 MW	
5)	Sandia/Santa Fe Deep Well	0 MW	(test well only, not a power generation project)

The primary threat to surface freshwater resources from the geothermal projects is from spills of geothermal fluid and petroleum products and other chemicals which may be used on-site during construction, maintenance, or drilling activities. The probability of contamination from spills or natural runoff from contaminated soils is low, but increases with each additional power plant in operation or under construction. However, spill containment features constructed at Casa Diablo for PLES I would also catch spills due to MP I, MP II, and MP III (18,800 gpm total geothermal fluid required) and would be capable of doing so simultaneously with sufficient capacity to allow 1-1/2 hours to complete shutdown. Spill containment features are also planned for the Mammoth/Chance I project.

Assumed ruptured pipelines at four power plants operating at Casa Diablo.

a) Peak runoff (May-June), high creek flow (82 cfs, 50°F at Mammoth Creek Flume), low percolation (10%), air temperature 65°F.

Geothermal Fluid (four power plants) = 15,980 gpm after flash.
Volume after percolation - 14,380 gpm (32 cfs).
Temperature at point of entry to Mammoth Creek - 150°F (estimate).

Calculation:
Mixed Temp (45.7 Btu @ 12.5 psi) = 77.8°F.

b) Low runoff (8 cfs, 58°F at M Creek Flume), high percolation rate 30%, air temperature 90°F.

Geothermal fluid, 11,185 gpm (25 cfs)
Temperature at mixing point = 170°F (estimate)
Calculation:
25 cfs x 137.9 Btu/lbm) + 3 cfs 2 24.9 Btu/lbm) = 110.5 Btu
33 cfs
Mixed Temperature (110.5 Btu, 12.5 psi) = 142.7°F

In both cases, further cooling in Mammoth Creek would occur due to lower air and land surface (creek bed) temperatures and mixing from tributaries downstream.

In the event that spills were to occur at the proposed Sandia/Santa Fe Deep Well site, fluids could travel down Long Canyon and into Mammoth Creek three miles away. Significant cooling and percolation into soils would occur en route so that little or no hot fluid is likely to reach Mammoth Creek. In addition, blowout prevention equipment and drilling practices would be required during drilling. This equipment is estimated to be better than 95% successful in preventing blowouts of geothermal wells (Habel, R., 1988). Further, containment requirements and mitigations would be developed for this deep well, as necessary, through the federal permitting process.

Mitigation: No mitigation is recommended.

4.1.4.2 Shallow Fresh Groundwater

4.1.4.2.1 Proposed Project Impacts

The shallow groundwater at Casa Diablo is associated with shallow alluvial material that appears to thin southeast of Casa Diablo. Based on rock outcrops and drill logs at SF35-32, it is likely that the shallow freshwater resource is discontinuous south of the project area. Chance Ranch, Mammoth/Chance, and Doe Ridge projects are in areas with greater thicknesses of alluvium which are likely to contain larger freshwater aquifers. Shallow cold groundwater would be pumped from the existing well at rates less than 2.5 gpm initially and about 0.1 gpm after landscaping were established. No other users of this resource exist and its contribution to the shallow groundwater resource down gradient is likely to be insignificant based on the relative size of the local resource.

Impact: No impacts are expected.

Mitigation: No mitigiation is recommended.

4.1.4.2.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.1.4.2.3 Smaller Power Plant Impacts

Impacts: Slightly less groundwater would be pumped for irrigation because of the slightly decreased area which would be revegetated.

Mitigation: See mitigation (6) for the proposed project.

4.1.4.2.4 No-Action Alternative Impacts

Groundwater use at Casa Diablo would be unaffected.

4.1.4.2.5 Abandonment and Reclamation Impacts

Impact: It is likely that revegetated area would need some irrigation to improve plant survival and growth. Groundwater use would continue until the newly planted vegetation were established. No impacts would be expected.

Mitigation: No mitigation is recommended.

4.1.4.2.6 Cumulative Impacts

Impact: Each power plant at Casa Diablo would need approximately the same quantity of freshwater as MP I, but landscaping requirements would be greater for PLES I, MP II and MP III. Assuming MP III would have irrigation requirements similar to MP II, approximately four times the volume currently produced would be required to support the geothermal projects in the Casa Diablo area during periods of heavy irrigation. The groundwater would be used principally to fill storage tanks for fire-fighting purposes (estimate 96,000 gallons for MP I, 220,000 gallons for PLES I/MP II, and 100,000 for MP III); for sanitation purposes estimated at an average of less than 0.3 gpm (based on actual use at MP I); and for irrigating landscape and revegetation programs (about 8.0 gpm). After vegetation were established, total use would be less than 0.4 gpm for all four projects. Increased non-potable groundwater production, could lower the freshwater table in the immediate area. No other uses of this groundwater supply are known or anticipated. Shallow-rooted vegetation could be affected if drawdown of the local groundwater should occur from excess pumping at Casa Diablo.

Mitigation: Pumping of groundwater could be limited if vegetation is impacted.

Impact: The other potential and active users of shallow fresh groundwater within the Mammoth Creek Basin include four proposed and one existing geothermal power plant (400 acre-feet/year), the Town of Mammoth Lakes (1900 acre-feet/year), Doe Ridge (642 acre-feet/year), and Sherwin Bowl (471 acre-feet/year) (McAlister, D., 1988). It is estimated that the Town of Mammoth Lakes and the Snow Creek Golf courses would each use about 500 acre-feet/year. These cumulative uses of shallow groundwater would amount to over 4,000 acre-feet/year. The five geothermal projects together would account for less than 10% of the use and PLES I would account for less then 2% and therefore is considered incrementally insignificant.

Mitigation:

- Based on a comprehensive groundwater survey, establish an effective groundwater management policy for the Mammoth Creek Basin. This would need to be a multi-agency and multi-project effort.

4.1.4.3 Hydrothermal Resources

The appeal documentation for the Fish and Game appeal of the BLM approval of PLES I includes a report by a private consultant (Papadopulos Associates, 1988) which attempt to analyze the effects that production will have on the geothermal reservoir. The Papadopulos report concludes by identifying the major issues. These and two other hydrologic issues raised by both the Sierra Club and Fish and Game are also discussed below.

The first issue is that monitoring probably will not provide protection against unexpected adverse impacts of the projects because important adverse impacts cannot be detected until irreversible conditions have been created. This is a unique view and one not shared by scientists and engineers with considerable experience in the Long Valley area including those involved with the Long Valley Hydrologic Advisory Committee. It is universally accepted fact that any changes in pressure and temperature will first occur in the production/injection well bores and diminish rapidly with distance from the wells. There will be nothing "unexpected" regarding pressure and temperature declines in the Casa Diablo area. The Papadopulos analysis itself predicts such effects would occur prior to adverse effects impacting Hot Creek Hatchery or Hot Creek Gorge Springs. Standard reservoir engineering management of geothermal reservoirs worldwide involves continuous or periodic measurement of pressure and temperature within the reservoir. The purpose of standard reservoir monitoring is to detect any changes as early as possible so as to prevent declines from rendering the reservoir useless as a resource. Similar monitoring and management practices have been used for years and are common to related industries such as groundwater production, groundwater pollution abatement, and oil and gas production. There is no evidence to support the contention that declines in reservoir temperature or pressure will be sudden. As with other reservoirs, localized declines can be anticipated, but can be controlled through continued reservoir modeling and production injection management. Any changes that could occur would appear in the immediate area of the production/injection wells and could not appear elsewhere first. Four years of production at the MPI plant has resulted in no declines temperature at the MP I production wells or at thermal discharge areas. These factual data are in contrast to the predictions of the Papadopulos models.

The second issue is related to the first, but is specific to the magnitude of expected temperature declines. The Papadopulos report concludes that, based on 37 MW of power production at Casa Diablo and 10 MW at Mammoth Chance, a temperature decline of 7° to 34°C (13°F to 61°F) at the hatchery and 34° to 68°C (61°F to 122°F) at Casa Diablo can be anticipated after 20 years. This estimate, while based on sound principles, is faulty due to use of an unreasonably low estimate of reservoir size ($3.55 \times 10^9 m^3$) and heat in place (1×10^{17} calories). A more realistic heat in place is considered to be 10×10^{17} calories (Sorey, 1988), which would increase the reservoir volume and reduce the calculated temperature decline in the Fish Hatchery area to less than 4°C after 20 years (see Appendix C). Less conservative estimates of heat in place have ranged from 50×10^{17} calories (USGS, 1980) to 186×10^{17} calories (USGS, 1975). Further, experience with other producing geothermal reservoirs indicates that recharge to the production reservoir is inevitably greater than the combined surface discharge. In fact, in all areas of geothermal production in the western United States inflow and throughflow of geothermal fluids in the system far exceeds surface discharge. Some commercial geothermal resource areas have no surface discharge.

The idea of significant recharge is shared by those scientists familiar with the Long Valley system, though its path, whether vertical or horizontal, is the subject of some debate. Recharge equal to the current production at Casa Diablo in addition to total surface discharge is not unreasonable to assume. This contention is based on current MPI production, pressure drawdown, and reversals in pre-startup temperature profiles. If this amount were input input to the heat balance calculations it would significantly lower the predicted declines.

In addition, based on water chemistry of Hot Creek Hatchery Springs, two to three percent of the total flow is of thermal origin (Sorey, 1976). Even under very low estimate of 1 $x10^{17}$ calories of stored heat in the hydrothermal system and no recharge, the anticipated change to Hot Creek Hatchery spring temperature is three percent of 7°C (13°F), equal to or 0.2°C (0.36°F). This is well within the natural temperature variation of each spring (see Appendix C).

The third issue is that the hatchery operations would be lost should geothermal production cause a decline in spring temperatures. Spring flows and temperatures fluctuate widely (see Appendix C) according to records kept since 1976. No reasonable scenario suggests that flow will be cut off, but in the worst case, the flowrate and temperature may be reduced two to three percent. Also, the lowest temperature possible could not be less than 11°C (51.8°F), corresponding to the lowest freshwater spring temperature in the source area to the west. This temperature will allow fish hatchery operations to continue, but may reduce productivity.

Fourth, concerns have been raised regarding potential increases in temperature of the hatchery springs. No temperature increases are predicted by any model or calculation as described below: pressure increases in the thermal reservoir beneath the Hatchery area are predicted to equal less than 1.5 feet of water head and cannot be considered likely to increase flow or temperature. Pressure and temperature are related by the laws of thermodynamics. Where pressure increases, which could cause temperature increases, are predicted by the calculations, temperature decreases are predicted by a separate calculation. The exact relationship between temperature and pressure at depth in the thermal reservoir cannot be calculated on the basis of current data.

4.1.4.3.1 Proposed Project Impacts

Potential impacts of geothermal power production on subsurface resources in the Casa Diablo area have been assessed using three independent commonly used techniques. These calculations use conservative values of reservoir parameters in order to obtain predicted reservoir temperature and pressure declines which are larger than are expected. Results approximate a worst-case scenario of reservoir pressure and temperature changes. There is evidence to suggest the assumptions for input data used in these calculations are reasonable, particularly in light of recent drilling and testing since the PLES I EA/EIR. In addition, the power plants are assumed to operate at 100% capacity for the entire 30-year project life. Actually, geothermal power plants operate at 85-95% of capacity. The existing MP I plant has operated at greater than 90% of capacity.

All three methods are employed using the assumptions described in detail in Appendix C. The most important is that a shallow (less than 2000 ft. deep) direct hydrologic communication exists throughout the south Long Valley Caldera. This assumption relates to the Lateral Flow model and provides a worst-case analysis. This model is, as yet, unproven and predicted impacts would be lowered to insignificance if the actual conditions more closely approximate the Upwelling Fracture Flow Model. See Appendix C for details and the rationale for assumptions regarding reservoir parameters used for calculations.

Simulated Reservoir Performance Calculations

The three different methods used to estimate the effects of production and injection were:
a) Pressure response modeling, b) Bulk-modeling, and c) Heat (energy) balance analysis.

a) Pressure Response Modeling

This method uses a computer to calculate the reservoir pressure response at a specified location using input data on production and injection well locations and reservoir parameters such as permeability, storage, and fluid viscosity. The program is commercially available and has been used for prediction, test analysis, and management of fractured geothermal reservoirs in the Imperial Valley and the Geysers in California, Steamboat Springs in Nevada, Wairakei in New Zealand and in the Kakkonda, Mistui, and Sugawara fields in Japan. The results in this case were calculated based on a reservoir with uniform characteristics in all directions, without recharge but with pressure communication between injection and production wells. The calculations, in effect, approximate unlimited lateral communication without the benefit of pressure support through recharge. Power plant start dates of 1985 for MP I and 1990 for PLES I were assumed.

The results are summarized below:

Predicted Pressure Response (psi) in Reservoir

Area	After 10 years	20 years	30 years
Casa Diablo	+2.2	+2.2	+2.2
Hot Creek Hatchery	+0.55	+0.55	+0.55
Hot Creek Gorge	+0.39	+0.39	+0.39

The results show a slight increase in pressure for areas to the east of Casa Diablo. Similar calculations performed for areas to the west show declines on the same order of magnitude (i.e.,< five psi). The calculation chosen for the Casa Diablo area is based on a location southeast of the production area toward the hatchery. The pressure responses to the east are all expected to be positive since all injection would take place on the east side.

Any response, whether positive or negative, less than 10 psi in the producing area of Casa Diablo is not considered significant. For most commercial power plant operations, reservoir pressures may change 10s to 100s of psi over the life of the project. Overall, the results of this calculation (run for 0 to 30 years) are consistent with recent testing and observed pressure response at Casa Diablo. No changes have been detected in the hatchery or Hot Creek Gorge area wells. The pressure response stabilizes after approximately two years of power plant operation due to 100% injection.

This calculation includes MP I startup in 1985 (3,800 gpm) and assumes a 1990 start up for PLES I (5,000 gpm). The pumps are assumed to operate 24 hours a day for 30 years. A lesser impact would result if a realistic plant operation factor (85-95%) were used.

The model results indicate that the 100% injection of fluids on the east side of Casa Diablo prevents pressure in the reservoir from declining at the Hot Creek Hatchery or Hot Creek Gorge areas. The calculation predicts subsurface reservoir pressure changes. The actual effects on surface features in the worst case would be a linear extrapolation of the reservoir response to the surface. Thus, a 1 psi change in the reservoir would result in approximately 2.5 foot change in the static water level measurement in a geothermal well at the surface. At the hatchery area, about half that pressure change could occur and would not be expected to affect the estimated 97% fresh water component of the springs.

(b) Bulk-Model Calculation

A second calculation was performed in an attempt to estimate the distance that the cooler injected fluid would move from Casa Diablo and therefore, predict the potential for interference of cooler injected fluid with hot regions beneath springs. This calculation is based on assumptions of thermal properties and porosity of the rock and reservoir fluid and that the displacement of fluid would be outward in an approximately uniform cylindrical front. An injection fluid temperature of 175°F into a 300°F zone and a reservoir thickness of 500 feet were also assumed for this calculation. Continuous injection of 3,800 gpm for MP I and 5,000 gpm for PLES I were assumed with startup dates of 1985 and 1990, respectively. Appendix C gives a full description of methods and assumptions used for this calculation. The differences between the input data required for this calculation and the other two calculation methods are also given in Appendix C.

Results of the Bulk Model calculations are:

Distance of Thermal Front from Project Area		
After 10 years	After 20 years	After 30 years
730 feet	1030 feet	1260 feet

The hydrodynamic front would expand outward at a faster rate than the thermal front. The calculated position of the thermal front indicates that the distance cooled fluid moves away from the injection wells is approximately 1,260 feet in 30 years.

This calculation is simplistic, but useful for comparison with other models. In reality, fractured rock could allow preferred flow paths to carry injected fluid far beyond the calculated fronts. However, experience in fluid injection indicates distortion of the fronts is limited in pervasively fractured geothermal reservoirs. An extremely abnormal flow pattern would be required for the lower temperature fluid to travel as far as Hot Creek Hatchery (approximately three miles distant) or Hot Creek Gorge (about five miles distant). It is also significant that gravity segregation has not been accounted for in this calculation. This effect allows colder fluid to sink deeper into the reservoir, decreasing the probability of near surface consequences.

A porosity of 5% was used for these calculations. Estimates of porosity at Casa Diablo are currently twice that amount but the above approximates a worst-case scenario. A high porosity, such as the 15% used in the heat balance calculation below, would reduce significantly the distance the front would travel. A low porosity value gives worst-case results for the bulk model but the opposite is true for the heat balance method (see below and Appendix C). It is also possible that the effective injection zone thickness is greater than the 500 feet assumed for this calculation. A greater thickness would cause a decrease in the radial extent of the hydrodynamic and thermal fronts, hence the lower value of 500 feet is also a worst-case assumption.

A separate calculation related to distortion of the bulk-model thermal front was performed. It is based on the subsurface hydraulic gradient which may induce lateral west-to-east flow. The effect of this gradient would be to cause greater movement of the injected fluid down-gradient to the east and this is not accounted for in the bulk-model. A rough estimate of its possible effect can be calculated from the regional geothermal/groundwater gradient. A fluid velocity of 0.06 feet per day was calculated based on the same horizontal permeability value used in the computer model and a value for the local geothermal/groundwater gradient map of 0.0135 feet/foot, estimated from the water (including geothermal water) level contour map of Farrar, C.D., et al. (1985).

The results indicate that fluid moving from Casa Diablo would take about 100 years to reach Hot Creek Hatchery and 150 years to reach Hot Creek Gorge. These results are based on the assumption that lateral west-to-east subsurface flow occurs in the region, with no provision made for the effect of preferred flow paths, features often associated with fractured reservoirs. However, calculation of the movement of fluid in the subsurface induced by the local groundwater gradient did not take into account reheating of injected fluid through contact with hot reservoir rock and this effect would cause the fluid moving through the rocks to warm by conduction as it moved from west to east. In addition, fluid in preferred flow paths represents a relatively small volume of fluid with a large surface area which allows rapid reheating to occur thus reducing the likelihood of temperature changes in spring flow by this mechanism.

Even if injected fluid reaches the subsurface zones below the surface springs, it would not necessarily result in cooling of springs or decreasing flow rates. The estimated position of the thermal front, including some distortion by lateral flow, indicates breakthrough of cool injection fluid is not likely to be a potential threat to existing springs.

c) Heat (Energy) Balance

A third method was used to calculate the potential for temperature impacts on the reservoir in the area of concern, particularly the hatchery and Hot Creek Gorge areas. This approach is used in the Mammoth/Chance EIR (WESTEC, 1987) and in a report by S.S. Papadopulos and Associates in an attempt to evaluate the impacts of geothermal development (Papadopulos, 1988). The analysis here, taken from Appendix C, instead of the low value of heat in place of 1×10^{17} calories and high porosity of 35% that the Papadopulos report uses, values of 10×10^{17} calories and 15% porosity were used for this analysis. This analysis can be considered a worst-case scenario when combined with assumptions of 100% plant operation and no recharge to the system except that equal to measurable surface discharge. The equations, assumptions, and volumes considered are given in detail Appendix C.

The results of this analysis which includes existing MP I and proposed PLES I are summarized below:

	Predicted Temperature Change in Reservoir		
Area	After 10 years	20 years	30 years
Casa Diablo	-5.6°C (-10.1°F)	-10.7°C (-19.3°F)	-15.4°C (-27.7°F)
Hot Creek Hatchery	-0.5°C (-0.9°F)	-1.9°C (-3.4°F)	-2.6°C (-4.7°F)
Hot Creek Gorge	-0.0°C (0.0°F)	-1.0°C (-1.8°F)	-2.0°C (-3.6°F)

Most producing geothermal reservoirs, like those listed below, show little surface discharge in relation to their reservoir heat capacity and geothermal power potential. Therefore, the heat balance approach does not provide an accurate indication of subsurface conditions.

Geysers, California	1800 MW
Imperial Valley, California	100 MW
Steamboat Springs, Nevada	10 MW
Wairakei, New Zealand	150 MW
Larderello, Italy	365 MW
Cerro Prieto, Mexico	200 MW

Impact: It is difficult to predict the effects on surface thermal features resulting from production/injection operations at the proposed PLES I Project and the existing MP I power plant. The model calculations described here indicate that the potential for measurable subsurface impacts to extend three to five miles to Hot Creek Hatchery and Hot Creek Gorge is very low. Special circumstances exist at each area, such as those at the hatchery springs, where it is estimated that approximately 2% to 3% of the flow is thermal water. The temperature of the thermal fluid component of these springs is unknown; but it is estimated that a loss of the entire thermal component could result in a lowering of average spring temperature of 2° to 3°C (Sorey, M.L., 1976). No effects have been measured at Hot Creek Gorge or hatchery springs to date and none would be anticipated on the basis of the reservoir measurements at Casa Diablo.

The project includes the following measures, also listed in Section 2.1.1, item 23, to identify and reduce potential impacts:

> The following mitigation process will be used to mitigate potential hydrothermal impacts on the Owens tui chub and may be modified as appropriate to mitigate impacts to Hot Creek Hatchery and Hot Creek Gorge springs:
>
> a) The operator shall be responsible for reporting to the authorized officer the monitoring measurements required to be collected by the Plan for Baseline Data Collection (PBDC) approved for the project, or any other monitoring data which may be required by the authorized officer. The approved PBDC will incorporate the monitoring program recommended for the project by the Long Valley Hydrologic Advisory Committee (LVHAC) dated October 1987, as corrected, and shall require monitoring information be collected and reported for the C-D Hot Creek headsprings comparable to that recommended by the LVHAC for the A-B Hot Creek headsprings which is Critical Habitat for the endangered Owens tui chub.

b) The authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, will evaluate the monitoring data and consult with the U.S. Geological Survey, the California Division of Oil and Gas, the County of Mono, and the U.S. Fish and Wildlife Service, if appropriate (the "consulting agencies"), regarding the analysis of the data and the development of mitigating measures as indicated appropriate by the conclusions of the analysis of the data.

c) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, determines a need to supplement monitoring information developed from existing Monitoring Well 65-32, a second monitoring well may be required to be drilled, maintained, and monitored in conformance with the requirements of Stipulation 23(a) (above). The well shall generally be located in the area of Colton Springs, with the specific location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction. The authorized officer may also require mitigation actions in addition to the second monitoring well including, but not limited to, one or more of the following actions:

(1) Temporarily modify the production or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one or more of the following:

(i) Change fluid volumes or pressures in one (1) or more wells;

(ii) Discontinue use of one (1) or more production or injection wells; or

(iii) Relocate one (1) or more production or injection wells.

d) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, determines that monitoring information from the second monitoring well (located near Colton Springs) and all other monitoring information indicate a need for further information with respect to a threat posed by plant operations to beneficial uses of thermal water, or to the continued existence of the Owens tui chub, the authorized officer may require that a third monitoring well be drilled, maintained, and monitored in conformance with the requirements of Stipulation (a) (above). The well shall generally be located in the area between Colton Springs and the Hot Creek headsprings, with the specific location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction.

e) If the authorized officer, in cooperation with the U.S. Fish and Wildlife service regarding the Owens tui chub, determines that monitoring information from the second monitoring well (located near Colton Springs) and all other monitoring information indicate that plant operations may threaten an unacceptable impact to other current beneficial uses of thermal water, or threaten a reduction in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including but not limited to, those listed in paragraphs c(1) and c(2) above, shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

f) After monitoring the third monitoring well, (located in the area between Colton Springs and the Hot Creek headsprings), should the authorized officer determine that plant operations threaten an unacceptable impact or are resulting in an unacceptable impact to beneficial uses of thermal water, or threaten a reduction or are resulting in a reduction in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including, but not limited to, those listed in subparagraphs (a) through (d) below shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

(1) Temporarily modify the production or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one or more of the following:

(i) Change fluid volumes or pressures in one (1) or more wells;

(ii) Discontinue use of one (1) or more production or injection wells; or

(iii) Relocate one (1) or more production or injection wells.

(2) Permanently modify the production/injection program.

(3) Provide an alternate source of thermal water to the affected Hot Creek headspring(s). Such thermal water shall be conveyed to the Hot Creek headspring(s) in a manner that does not facilitate the introduction of other fishes into the headsprings.

(4) Reduce or discontinue power production.

g) If monitoring activities of the three monitoring wells described above indicate a progressive temperature decline is occurring that threatens a change of temperature at the Hot Creek headsprings, A-B or C-D, or threatens the continued existence of the Owens tui chub, the operator shall, at a minimum, implement the mitigation action described in Stipulation f(3) above.

h) The Operator shall be responsible for maintaining the thermal water conveyance facilities described in Stipulation f(3) above for as long as an alternate source of thermal water is needed to maintain water temperatures in the affected Hot Creek headsprings at levels existing prior to the onset of impacts from plant operations.

i) The Operator shall establish a funding mechanism to ensure that the mitigation actions described in Stipulations (a) through (h), above, will be implemented in a timely manner. Such funding mechanism shall be provided either directly through the provision of materials and services needed to satisfy the monitoring and alternate thermal water supply requirements described above, or indirectly, through insurance, performance bond, dedicating project revenues to a special escrow account or other mechanism acceptable to the authorized officer. The funding mechanism shall be developed by the Operator in consultation with the authorized officer and the U.S. Fish and Wildlife Service, and agreed to by the authorized officer in cooperation with the U.S. Fish and Wildlife Service, prior to the commencement of geothermal production by the Operator.

This mitigation process was designed to reduce to insignificance the possibility of impacts to any of the sensitive hydrothermal features by implementing a program of monitoring the hydrothermal system at numerous points to detect any potentially adverse changes so that mitigation measures could be implemented before those changes reach the sensitive hydrothermal features. This hydrothermal system monitoring program would establish additional baseline data, detect changes caused by project operations before they could affect hydrothermal features of concern, provide information to select and implement appropriate mitigations to prevent hydrothermal changes from migrating away from the production field toward the sensitive hydrothermal features, and monitor the effectiveness of the implemented mitigation. The data to be collected by the operator are listed in the Plan for Baseline Data Collection discussed in Chapter 2.

The proposed monitoring program is progressive; that is, the results of initial monitoring may result in the establishment of additional monitoring, and possibly the drilling of additional monitoring wells. It was designed to provide documentation of any progressive movement of hydrothermal system changes away from the Casa Diablo project area toward the Hot Creek Hatchery and other areas of concern. Finally, it was intended to provide the information necessary to select, implement, and monitor those mitigation measures appropriate to prevent any detected adverse hydrothermal system changes from reaching the thermal features of concern.

The proposed hydrothermal mitigation program consists of several techniques which are commonly used in geothermal and oil and gas wellfield operations to manage pressure changes within the reservoir. Geothermal wellfield operations basically consist of the production and injection of large quantities of water so that the heat in the reservoir can be extracted. To produce water from a geothermal well, the pressure in the well is reduced so that water flows from the geothermal reservoir into the wells, and then to the surface. Injection wells reverse this process; increasing the pressure in the injection well forces the water into the injection reservoir, slightly increasing the reservoir pressure in the injection zone.

Impact: Without a mechanism for establishing trigger points, implementation of mitigations may be delayed or prematurely implemented thereby reducing the mitigations effectiveness.

Mitigation:

(6) Replace item 23 in Section 2.1.1 with the following:

The following monitoring and remedial action program is designed to prevent, or mitigate, potential hydrothermal impacts to the Owens tui chub critical habitat, Hot Creek Hatchery, and Hot Creek Gorge springs:

a) The operator shall be responsible for reporting to the authorized officer the monitoring measurements required to be collected by the Plan for Baseline Data Collection ("PBDC") approved for the project, or any other monitoring data which may be required by the authorized officer. The approved PBDC will incorporate the monitoring program recommended for the project by the Long Valley Hydrologic Advisory Committee ("LVHAC") dated October 1987, as corrected, and shall require monitoring information be collected and reported for the C-D Hot Creek headsprings comparable to that recommended by the LVHAC for the A-B Hot Creek headsprings which is critical habitat for the endangered Owens tui chub.

b) The operator will fund an independent expert, acceptable to the authorized officer, to conduct annual technical analyses and evaluations of hydrological monitoring data and will provide all results of these analyses and evaluations to the authorized officer in a timely manner.

c) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub, and in cooperation with the California Department of Fish and Game regarding the Hot Creek Hatchery and Mammoth Creek/Hot Creek, determines a need to supplement monitoring information developed from existing monitoring well SF 65-32, the operator shall drill a second monitoring well to be maintained and monitored in conformance with the requirements of Stipulation (a) above. The well shall be sited at a location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction, in consultation with U.S. Geological Survey.

d) The authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub and in cooperation with the California Department of Fish and Game regarding the State Fish Hatchery and Mammoth Creek/Hot Creek, will at a minimum, annually evaluate the monitoring data and consult with the U.S. Geological Survey, the California Division of Oil and Gas, the County of Mono, the U.S. Fish and Wildlife Service, and California Department of Fish and Game (the "consulting agencies"), if appropriate, regarding the analysis of the data and the implementation of mitigating measures as indicated appropriate by the conclusions of the analysis of the data.

e) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub and in cooperation with the California Department of Fish and Game regarding the Hot Creek Hatchery and Mammoth Creek/Hot Creek, determines that monitoring information from the existing monitoring well SF 65-32 and all other monitoring information indicate that:

(1) Pressure, temperature, and/or chemical/changes or trends are occurring within the production or injection fields in excess of the anticipated variations, based on production experience;

(2) Pressure, temperature, and/or chemical changes or trends are occurring within the monitoring well(s) in excess of the anticipated range of variation; or

(3) Plant operations may threaten an unacceptable impact to other current beneficial uses of thermal water, or threaten a change in the temperature of the A-B or C-D Hot Creek headsprings, then the operator shall, as required by the authorized officer, immediately implement one or more of the following mitigation actions:

(i) Temporarily modify the production and/or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one or more of the following:

- change fluid volumes or pressures in one (1) or more production or injection well(s);
- discontinue use of one (1) or more production or injection well(s);
- change the depth of injection;
- relocate one (1) or more production or injection well(s); or
- any other measures as directed by the authorized officer, or

(ii) Permanently modify the production and/or injection program.

In reaching a decision regarding the implementation of mitigation measures, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

f) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub and in cooperation with the California Department of Fish and Game regarding the State Fish Hatchery and Mammoth/Hot Creek, determines the monitoring information from the second monitoring well and all other monitoring information indicate a need for further information with respect to a threat posed by plant operations to beneficial uses of thermal water, or to the continued existence of the Owens tui chub, the operator shall drill a third monitoring well to be maintained, and monitored in conformance with the requirements of this stipulation. The well shall generally be located in the area between Colton Springs and the Hot Creek headsprings, with the specific location to be determined by the authorized officer and the appropriate governmental agencies with land use jurisdiction, in consultation with the U.S. Geologic Survey.

g) If the authorized officer, in cooperation with the U.S. Fish and Wildlife Service regarding the Owens tui chub and in cooperation with the California Department of Fish and Game regarding the Hot Creek Hatchery and Mammoth Creek/Hot Creek, determines that monitoring information from the second monitoring well and all other monitoring information indicate that plant operations may threaten an unacceptable impact to other current beneficial uses of thermal water, or threaten a change in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including but not limited to, those listed in paragraph e) above, shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

h) After monitoring the third monitoring well (located in the area between Colton Springs and the Hot Creek headsprings), should the authorized officer determine that plant operations threaten an unacceptable impact or are resulting in an unacceptable impact to beneficial uses of thermal water, or threaten a change or are resulting in a change in the temperature of the A-B or C-D Hot Creek headsprings, one or more mitigation actions, including, but not limited to, those listed in subparagraphs (1) through (4) below shall be required. In reaching a decision, the authorized officer shall consider, among other factors, the recommendations of the consulting agencies.

(1) Temporarily modify the production or injection of geothermal fluids within the field and monitor the reservoir response. Modification could include one or more of the following:

(i) Change fluid volumes or pressures in one (1) or more injection or production well(s);

(ii) Discontinue use of one (1) or more production or injection well(s);

(iii) Change the depth of injection; or

(iv) Relocate one (1) or more production or injection well(s).

(2) Permanently modify the production and/or injection program.

(3) Provide an alternate source of thermal energy or water to the affected Hot Creek headspring(s). Such thermal energy or water shall be conveyed to the Hot Creek headspring(s) in a manner that does not facilitate the introduction of other fishes into the headsprings.

(4) Reduce or discontinue power production.

i) If monitoring activities of the three monitoring wells described above indicate a progressive temperature or pressure change is occurring that threatens a change of temperature at the A-B or C-D Hot Creek headsprings, or threatens the continued existence of the Owens tui chub, the operator shall, at a minimum, implement the mitigation action described in Stipulation h (3) above.

j) The operator shall be responsible for maintaining the thermal energy or water conveyance facilities described in Stipulation h (3) above for as long as an alternate source of thermal energy or water is needed to maintain water temperatures in the affected Hot Creek headsprings at levels existing prior to the onset of impacts from plant operations.

k) The operator shall establish a funding mechanism to ensure that the mitigation actions described in this stipulation will be implemented in a timely manner. Such funding shall be provided either directly through the provision of materials and services needed to satisfy the monitoring and remedial action requirements described in this stipulation, or indirectly, through insurance, performance bond, dedication of project revenues to a special escrow account or other mechanism acceptable to the authorized officer. The funding mechanism shall be developed by the operator in consultation with the authorized officer in cooperation with the U.S. Fish and Wildlife Service and the California Department of Fish and Game, prior to the commencement of geothermal production by the operator.

Effectiveness: The sequence of actions defined by the revised stipulation listed above will ensure the beneficial uses of the geothermal resource by its flexibility and responsiveness. The following steps, carried out the BLM in cooperation with the consulting agencies listed in the stipulation, either have been taken already or would be taken as necessary.

STEP 1: The first monitoring well (65-32, see Figure 2-1) has already been drilled by Pacific Energy east of the proposed PLES I well fields. This well, on the basis of pressure responses to changes in pumping at the MP I production wells, is clearly monitoring conditions in the production reservoir and indicating the extent to which reservoir changes may propogate in a direction toward Hot Creek. Data on pressure and temperature in production and injection reservoirs are being collected from the newly instrumented and continuously monitored wells at MP I. Water from the production wells is sampled and analyzed periodically. The same kind of information would be collected in the wells at PLES I wells.

Other baseline data are being collected at AB and CD springs at the hatchery and at other locations (see the Hydrologic Monitoring Plan Section 2.1.7). On the basis of these data, the BLM and consulting agencies will evaluate normal variability in the observed features (see Section 4.1.4.3.1). These normal variation levels become the "trigger points" which will be used to trigger the implementation of the described wellfield mitigation measures.

STEP 2: A second monitoring well may be drilled between well 65-32 and Colton Springs if the authorized officer determines, based upon review of any new monitoring or wellfield operation data collected and after discussion with the consulting agencies, that additional monitoring data is necessary or advisable. At present, none of the monitoring or wellfield operation data indicate the need to drill and monitor such a well. Its location would be determined by the BLM and those governmental agencies with land use jurisdiction. It would be monitored in the same way 65-32 is being monitored. There are no surface manifestations of the geothermal resource between Casa Diablo and Colton Spring, so a guarantee of hydrologic communication with the production reservoir may be more difficult to provide the further the well is from Colton Spring.

At this point, it is worth reviewing the two conceptual models of the production reservoir, which were discussed in Chapter 3, Section 3.1.4. For purposes of considering a worst-case situation, this analysis has assumed the Lateral Flow model which calls for fluid to originate on the west side of Long Valley Caldera and flow through the reservoir rocks toward the east/southeast while cooling. In this model, fluid moves vertically along faults to stay within the permeable reservoir rocks. The reservoir, although offset along faults, is considered widespread and continuous in the southwestern part of the caldera. Colton Spring's thermal component would come from the same reservoir as the springs, fumaroles, and wells at Casa Diablo. If the second observation well penetrated a reservoir of the proper temperature and depth, it would almost certainly be in hydrologic communication with the production reservoir if the Lateral Flow model is generally correct. If the Upwelling/Fracture Flow model more accurately reflects existing conditions, then there is no risk that the effects of production or injection at Casa Diablo would propagate toward the resources underlying the hatchery or Hot Creek Gorge because each area would be fed by a separate reservoir. This is not the assumption which has been made for this analysis, since such an assumption would render the phased monitoring program and associated mitigation measures unnecessary.

STEP 3: Monitoring results from MP I and PLES I production, injection and monitoring wells would be analyzed to detect changes or trends in pressure, temperature, and/or chemistry outside of the established "trigger points," the range of anticipated variations based on previous operational experience. This would provide the most immediately available data on impacts to the geothermal reservoir. As discussed in Section 4.1.4.3, geothermal reservoir changes would originate in the geothermal reservoir at Casa Diablo before moving toward the hatchery. It would also be in the self-interest of Mammoth Pacific and Pacific Energy to manage the reservoir to maintain its viability for power generation.

The resource at Casa Diablo is at a relatively low temperature for efficient power generation, especially using air-cooled condensers. If production or generation operations at MP I and PLES I caused changes in the reservoir which threatened their operation, reservoir management techniques would be used to reduce or reverse those changes.

The selection of the proper reservoir management technique or techniques to implement (from those listed, or others, as appropriate) would depend upon the change in the geothermal reservoir detected by the monitoring program, and the other information provided by the entire hydrologic monitoring program. These reservoir management techniques have been proven effective in other geothermal, oil and gas, and groundwater fields, and there is every reason to believe that they will be effective in these situations. The authorized officer has the authority to require the lessee to implement any necessary wellfield operation changes as mitigation measures under the Geothermal Steam Act of 1970, the Act's implementing regulations, and the geothermal lease. To date, reservoir parameter changes have not required the use of any reservoir management technique at MP I.

STEP 4: If information from the monitoring wells or any other phases of the monitoring program indicated the need for further information, another monitoring well would be drilled. It would be located between Colton Spring and the Hot Creek headsprings at the hatchery. The same arguments about its hydrologic communication with the geothermal reservoir as were given for the second monitoring well would apply: that is, the well is likely to be in hydrologic communication with the geothermal reservoir if it encounters a reservoir of the appropriate depth and temperature under the assumptions of the Lateral Flow Model.

STEP 5: If the authorized officer determines, based upon the available monitoring and any other information, that operations may threaten an unacceptable impact to other current beneficial uses of thermal water, or threaten a reduction in the temperature of the A-B or C-D Hot Creek headsprings, the authorized officer will require that one or more of the wellfield mitigation measures identified in the stipulation above be implemented. As stated above, the selection of proper reservoir management technique or techniques to implement (from those listed, or others, as appropriate) would again depend upon the change in the geothermal reservoir detected by the monitoring program, and the other information provided by the entire hydrologic monitoring program.

STEP 6: A significant impact to the geothermal reservoir is not predicted by the various models and is considered highly unlikely. Nevertheless, the progressive monitoring/mitigation program provides the specific means by which any changes, large or small, in the geothermal reservoir can be detected and then, as necessary, mitigated so that the water temperature is maintained at Hot Creek headsprings, which ensures that the Owens tui chub habitat is unimpaired and hatchery operations are not affected by PLES I.

If monitoring of the wells, or any other data, indicated changes induced by PLES I operations were actually threatening or impacting the beneficial uses of thermal water, temporary and then permanent reservoir management techniques would be employed, with reduction or discontinuation of geothermal fluid production the ultimate reservoir management technique. Again, the selection of the proper reservoir management technique or techniques to implement (from those listed, or others, as appropriate) would depend upon the nature of the threat or impact to the beneficial uses of the thermal water.

If the authorized officer determines from the monitoring of the three monitoring wells that a progressive temperature or pressure change is occurring that threatens a change of temperature at the Hot Creek hatchery, or threatens the continued existence of the Owens tui chub, or that there is a threat to the Hot Creek Headsprings from project operations, then Pacific Energy would be required to supply an alternate source of thermal energy or water to the Hot Creek headsprings, and maintain the supply for as long as this alternative source was necessary. The following methods are some of the technically feasible means of supplying more heat or thermal water to the hatchery springs:

- heat the headsprings water with an external source of heat, such as a combined solar/fossil fuel (propane, etc.) or geothermal (through a heat exchanger) heater;
- supply PLES I Project geothermal production or injection fluid directly to the headsprings via a pipeline;
- drill a new, dedicated geothermal well in the vicinity of the hatchery headpsrings and deliver the fluid into the headsprings; or
- obtain geothermal fluid from the Mammoth Chance Project and pipe it to the headsprings.

If the thermal component of the hatchery headsprings increased so that the water was too hot, the following methods are some of the technically feasible means of cooling down or supplying cold water to the hatchery springs:

- cool the headspring water with an evaporative or dry (air) chiller or other cooling system;
- cycle water from Mammoth Creek immediately upstream of the confluence with Hot Creek to the headsprings;
- recycle water from Hot Creek as it leaves the hatchery back to the headsprings.

As noted in Section 4.1.4.3.1, it is considered exceedingly remote that pressure in the hydrothermal reservoir would rise, which could result in increased temperatures of the Hot Creek headsprings. The very small pressure increase predicted by the model occurs because the model assumes complete hydrologic communication between the production and injection reservoirs. In reality, it is unlikely that there is such complete communication. Therefore, although no detectable impact is expected, of the two possibilities, a decrease in the thermal component is the more likely.

Effectiveness/Impact:

STEP 1: No impact would result from this measure. Well SF 65-32 has already been drilled, and continued monitoring will have no discernable impacts.

STEP 2: The potential impacts of drilling another monitoring well would be similar in nature, but smaller in magnitude, than those from the drilling of a single geothermal well. The actual location of the well would be selected using the same criteria used to select the locations of the geothermal wells to ensure that potential impacts to case during the drilling of existing monitoring well SF 65-32. Existing disturbed areas would be used if possible. Temporary impacts to less than one acre of land around the surface resources would be minimized to insignificance, as was the wellhead would be created. Mitigation measures proposed or stipulated for the drilling of the project geothermal wells would be implemented to ensure that the impacts during the short drilling time are insignificant. Because the well would not be flow-tested into a pit, nor would the well be connected to any power plant via a pipeline, the potential for any impacts related to the geothermal fluid are negligible. Much of the small amount of disturbed surface area could be reclaimed after drilling, although access would have to be maintained throughout the life of the well for continued monitoring and maintenance.

STEP 3: Monitoring of the hydrologic data would create no new impacts. Implementation of the reservoir management techniques would have beneficial impacts on the geothermal reservoir. Changing fluid volumes, discontinuing use of a well, or changing the depth of injection would not have an adverse effect on surface resources, and could have a positive effect on surface resources if a well or pipeline were abandoned and the surface properly reclaimed, as described in this chapter. If it were necessary to drill one or more new injection or production wells, the impact of each of these operations would be as described and analyzed in this chapter, and the measures required to mitigate these potential impacts to insignificance would be that same as also described in this chapter. The site(s) for any new well(s) would be selected to ensure that impacts are insignificant.

STEP 4: The impacts of drilling a third monitoring well, and the measures to mitigate potential impacts to insignificance, are identical to those described above in the discussion of STEP 2.

STEP 5: The impacts of this step, and the mitigation measures available to ensure mitigation of the potential impacts to insignificance, are the same as those described above under STEP 3.

STEP 6: Each of the suggested methods for applying thermal energy or water to the Hot Creek headsprings is technically feasible, but each would have some potential for creating associated environmental impacts. Mitigation measures can be applied which would ensure that the magnitude of the impacts is small.

One of the simplest means of supplying additional thermal energy to the Hot Creek headsprings is to apply an external heating source to the water flow of the headsprings. The previously prepared Environmental Assessment/Environmental Impact Report for the PLES I Project estimated the cost of fuel for replacing all the heat in the headsprings which could be lost at approximately $500,000 annually, a worst-case estimate. However, through the combination of a solar heating/storage system and a fossil fuel supplemental heater, the fuel cost of replacing the lost heat would be substantially reduced. The fossil-fuel burning heater would produce air quality impacts (nitrogen oxides, carbon dioxide, carbon monoxide, particulates, etc.) which would depend upon the fuel consumed and the specific burner chosen, and would require the approval of the Great Basin Unified Air Pollution Control District. However, the potential air emissions can be controlled, as necessary, to non-significant levels and ensure conformance with the District's regulations. In contrast, a solar heating system would produce no similar air quality impacts, but could be visually intrusive, especially if the system used highly reflective solar collectors. Proper selection, placement, and screening of the solar heating system components should ensure that visual impacts are not significant.

Diverting geothermal production or injection fluid from the PLES I or Mammoth Chance wellfields to supply additional thermal fluid or water to the Hot Creek headsprings could further deplete the geothermal resource in these areas, although it is likely that through the application of selected reservoir management techniques, the transfer of this geothermal fluid could be managed so that it does not adversely impact the temperatures or pressures of the geothermal reservoir under the Hot Creek headsprings. The amount of PLES I geothermal injection fluid necessary to compensate for the maximum (worst-case) thermal component of the headsprings flow which could be lost would be about 930 gpm, slightly less than 20% of the 5,000 gpm which would be produced (and injected) for the PLES I Project. Supplying the same amount of heat from a dedicated PLES I Project or Mammoth Chance Project geothermal production well would require about 480 gpm of geothermal fluid because it would be hotter. In either case, the amount of heat extracted from the commercially developed geothermal reservoir(s) and introduced into the Hot Creek headsprings would be substantially less than that considered, and judged insignificant, in Section 4.1.4.3.6 (Cumulative Analysis) of this EIS/SEIR for the operation of any of the other geothermal projects. Some additional field exploration work may need to be conducted in the vicinity of the hatchery prior to the drilling of a new, dedicated well since the existence of the source geothermal reservoir in this immediate area has not yet been completely confirmed. However, the existence of the thermal component in the headsprings strongly suggests that a geothermal reservoir is located there.

Drilling additional wells (whether PLES I production or injection wells, Mammoth Chance geothermal wells, or shallow coldwater wells) could have temporary impacts on a variety of resources, much as described in this EIS/SEIR for wells drilled for the proposed project. However, these impacts would be very similar to those identified and analyzed by this document for the drilling of the project wells. Mitigation of these potential impacts would entail the implementation of the same measures as proposed in the project description and this document for pipelines and wells. Most impacts would be temporary (such as noise, visual intrustion, etc.), and could be substantially reduced by proper siting (to take advantage of natural screening by vegetation and topography) and scheduling to avoid those periods known to be potentially sensitive to certain resources (deer, songbirds, etc.).

Although pipelines for carrying geothermal water to the headsprings could be visible and would present the danger of spills, the measures presented in this chapter for the PLES I Project can reduce the potential impacts of these pipelines to insignificance. Geothermal fluid pipelines from the PLES I Project area to the Hot Creek headsprings could be routed along either the existing road system (Hot Springs Road and U.S. 395) to the headsprings or a more direct path. Potential visual impacts of the pipeline could be greatly reduced by siting so that natural vegetation and terrain provide visual screening, revegetating disturbed areas as soon as practical, and painting natural or neutral colors, and other measures. In addition, it could be possible to place significant portions of the pipeline(s) below grade, as the terrain may be more suitable for trenching and the temperature of the transported geothermal fluid may be substantially lower than that conveyed in the PLES I geothermal production pipelines.

The potential for geothermal fluid spills, which could reach Mammoth Creek and potentially cause environmental impacts, can be greatly reduced through the installation of automatic check valves at regular intervals along the line, high/low-pressure cutoff sensors, and low-pressure transfer pumps. The operator would also be required to regularly test, maintain, and inspect emergency shutdown systems, and may be required to develop and maintain a spill contingency plan. Any spill which, despite all the precautions, did occur would likely produce substantially less severe impacts to Mammoth or Hot Creek than from a spill from the PLES I Project operations if there were no spill containment features. This is because the amount of geothermal fluid which could spill from the pipeline is substantially less than (only 10 to 20%) of that which could spill from the PLES I Project; because the temperature of the fluid which could spill would likely be substantially less than that of the PLES I geothermal production wells; and because the pipeline could be located at a greater distance from the creek, which would result in more fluid infiltrating and not reaching the creek.

Should the temperature of the Hot Creek headsprings increase instead of decrease (which, as stated above, is unlikely), cooling could be accomplished by an evaporative cooling system for some of the outflow of the headsprings, or by the use of dry, or non-evaporative cooling, much like the system proposed for the PLES I Project cooling system. Besides consuming some of the water, the evaporative cooling system could be visually intrusive because of its height and blocky silhouette, and would occasionally produce water-vapor plumes which would be highly visible. In contrast, although somewhat less energy efficient, dry (air) cooling towers have a lower profile and do not produce visible plumes. Visual impacts from the implementation of this method could be reduced to insignificance through the careful painting and placement of the coolers to take advantage of the hatchery facilities already constructed in the near vicinity.

Pumping cold water from the shallow, cold groundwater aquifer in the vicinity of the hatchery into the headsprings could cool heated spring flows sufficiently, but could also affect natural flow of spring water at the headsprings. In contast to the very limited shallow groundwater aquifer system found in the immediate vicinity of the Casa Diablo project area, the groundwater system in the vicinity of Hot Creek Hatchery contributes significantly to the surface water flows of Mammoth and Hot Creeks downgradient of the hatchery. One or more shallow groundwater wells placed downgradient of the fish hatchery would be able to intercept a small portion of this cold groundwater flow and add it to the headsprings, which ultimately discharge into Hot Creek, the same surface water that would normally receive the groundwater flow.

Cycling water from Mammoth Creek, upstream of its confluence with Hot Creek, could also be used to cool the flow of the headsprings without any consumptive use of the water. However, this technique could introduce other organisms into the refugia which might compete or otherwise adversely affect the Owens tui chub currently occupying the water. One means of avoiding this potential problem is to cycle the water to a closed system through the refugia upstream of the hatchery intake weirs, then discharge the water into the hatchery. Recycling of the outfall water of the hatchery itself would also be a technically feasible means to cool the headsprings water. However, the hatchery outfall water typically contains significant levels of biological oxygen demand (BOD) and nitrogen, among other substances which degrade water quality, which are normally discharged into Hot Creek. These products of the intensive aquaculture that is conducted at the hatchery could adversely affect both the Owens tui chub and the trout raised by the hatchery if allowed to accumulate/concentrate, and care would need to be taken to avoid adverse effects.

In summary, the revised hydrologic monitoring/mitigation plan as recommended above would monitor the geothermal reservoir and provide for implementation of reservoir management techniques and other mitigation measures in a progressive fashion in order to protect the beneficial uses of the geothermal resource. It is extremely unlikely that implementation of Step 6 would ever be necessary (see also mitigation, (7), below).

Impact: There could be delays in actually implementing the hydrologic monitoring or remedial action requirements, including supplying thermal energy or water to the hatchery area, if it were necessary to obtain necessary permits, engineer hardware, or design the system before proceeding.

Pumping cold water from the shallow aquifer could affect natural flow of spring water at the headsprings. Recycling water from Hot Creek could introduce other organisms into the refugia currently occupied by the Owens tui chub. Mitigations of these potential impacts would depend upon the measure(s) selected for cooling.

In summary, the monitoring/mitigation plan as recommended in mitigation (6) above would serve to monitor the production reservoir and allow for implementation of management techniques in a progressive fashion in order to protect the geothermal resource. It is overwhelmingly likely that implementation of Step 6 would never be necessary (see also mitigation (7), below).

Impact: The monitoring wells are designed to penetrate only the production reservoir, where fluid is being withdrawn. The behavior of the injection reservoir would be monitored only in the injection wells themselves.

Mitigation:

- See mitigation 6(c).

Effectiveness/Impact: The injection reservoir would be monitored. Temporary impacts from well drilling would occur.

Impact: There could be delays in actually supplying water to the hatchery area if it were necessary to obtain permits, install hardware, or undergo environmental review before proceeding.

Mitigation:

(7) Prior to commencing commercial geothermal operations, the operator shall prepare, and have approved by the authorized officer, a detailed program for timely implementing hydrologic monitoring or remedial action measures which may be

required through approval of these Plans of Operation. At a minimum, the program must include basic engineering designs, preliminary equipment fabrication and construction schedules, and permit or rights-of-way acquisition plans and schedules. The operator shall review and update the program annually, or as required by the authorized officer.

Effectiveness/Impact: This requirement would provide technical specifications for the potential future monitoring or contingency mitigation measures. The requirement would provide the BLM, and cooperating and consulting agencies, with additional information to ensure that potential monitoring or contingency mitigation measures could be required and implemented in a timely manner, as necessary.

Impact: Diminished value as a geologic interpretation site, due to reduction of spring flows at Hot Creek Gorge below measured background levels caused by PLES I operations.

Mitigation:

(8) Inject geothermal water into the geothermal reservoir upgradient of Hot Creek Gorge to offset reservoir pressure declines reducing spring flows.

Effectiveness/Impact: Pressure increases should restore spring flows and temperatures with time. The impacts of implementation of this measure would be the same as drilling any other well. See also Effectiveness/Impact discussion for Mitigation (6), above.

4.1.4.3.2 Alternative Location Impacts

The impacts due to production and injection for the Alternate PLES I site project are similar to that for the proposed project. The effect of increasing pumping from 5,000 to 6,000 gpm would have little effect on the pressure drawdowns, bulk model or heat balance calculations for effects on the reservoir. The result including PLES I and MP I are summarized below:

a) Pressure Response Calculation

	Predicted Pressure Response (psi) in Reservoir		
Area	After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo	+2.43	+2.43	+2.43
Hot Creek Hatchery	+0.61	+0.61	+0.61
Hot Creek Gorge	+0.43	+0.43	+0.43

The results, as expected, are similar to those for the proposed project showing predicted increases in average reservoir pressure in the three areas. The additional pumping for the alternative site causes pressure increases of approximately 9% greater than those calculated for the proposed project.

b) Bulk Model

Distance of Thermal Front from Casa Diablo		
After 10 yrs.	20 yrs.	30 yrs.
770 ft.	1080 ft.	1330 ft.

These results show only a very slight increase in distance traveled compared to that for the proposed project. See discussion in Section 4.1.4.3.1.

c) Heat Balance

	Predicted Temperature Change in Reservoir		
Area	After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo	-3.2°C (-5.8°F)	-6.3°C (-11.3°F)	-9.5°C (-17.1°F)
Hot Creek Hatchery	-0.6°C (-1.1°F)	-1.3°C (-2.3°F)	-2.0°C (-3.6°F)
Hot Creek Gorge	0	0	0

The results are not significantly changed from those calculated for the proposed project. Effects on the hatchery spring flow and temperature are likely to be insignificant given the estimated at 2-3% thermal component of the springs (Sorey, 1976).

Mitigation: See mitigation (6) for the proposed project.

4.1.4.3.3 Smaller Power Plant Impacts

Impacts to the geothermal reservoir are likely to be similar to that for proposed PLES I including existing MP I. The reduction from estimated flow rate of 5000 to 3800 gpm is only 15% of the total flow required for operation of both PLES I and MP I, and the potential impact on the reservoir is not significantly lowered.

A summary of the analysis methods is given below:

a) Pressure Response Calculation

	Predicted Pressure Response (psi) in Reservoir		
Area	After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo (65-32)	+2.0	+2.0	+2.0
Hot Creek Hatchery	+0.49	+0.49	+0.49
Hot Creek Gorge	+0.34	+0.34	+0.34

b) Bulk Model Calculation

Distance of Thermal Front from Casa Diablo		
After 10 yrs.	20 yrs.	30 yrs.
675 ft.	955 ft.	1170 ft.

c) Heat Balance Calculation

Area	Predicted Temperature Change in Reservoir		
	After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo	-1.9°C (-3.4°F)	-3.8°C (-6.8°F)	-5.7°C (-10.3°F)
Hot Creek Hatchery	0	0	0
Hot Creek Gorge	0	0	0

These results are lower by approximately 7% compared to the proposed project.

Overall, the impacts on the geothermal reservoir are not significantly different from the proposed project.

See Appendix C and Section 4.1.4.3.1 for a discussion of calculation methods.

4.1.4.3.4 No-Action Alternative Impacts

Calculations were again performed to estimate impacts on the reservoir in the Hot Creek Hatchery and Hot Creek Gorge areas. Temperature and pressure effects are likely to be less for springs at the hatchery than in the subsurface. See Section 4.1.1.4 for a discussion of calculation methods and limitations.

a) Pressure Response Calculation (MP I only)

Area	Predicted Pressure Response (psi) in Reservoir		
	After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo	+1.31	+1.31	+1.31
Hot Creek Hatchery	+0.30	+0.30	+0.30
Hot Creek Gorge	+0.21	+0.21	+0.21

b) Bulk Model (MP I only)

Distance of Thermal Front from Casa Diablo		
After 10 yrs.	20 yrs.	30 yrs.
480 ft.	680 ft.	830 ft.

c) Heat Balance (MP I only)

Area	Predicted Temperature Change in Reservoir After 10 yrs.	20 yrs.	30 yrs.
Casa Diablo	-1.2°C (-2.2°F)	-2.5°C (-4.5°F)	-3.7°C (-6.7°F)
Hot Creek Hatchery	0	0	0
Hot Creek Gorge	0	0	0

In summary, the threat of changes in the subsurface at the hatchery and Hot Creek Gorge is reduced by approximately 50% by the no-action alternative.

4.1.4.3.5 Abandonment and Reclamation

Use of the hydrothermal resource would cease with abandonment.

4.1.4.3.6 Cumulative Impacts

As indicated in the introduction, there are a number of geothermal and groundwater use projects in the vicinity that are proposed or may be proposed. Of these, five are considered planned to a point at which impacts may be estimated in addition to those for the PLES I project. These five projects are:

1)	MP I	7 MW
2)	MP II	10 MW
3)	MP III	10 MW
4)	Mammoth Chance I	10 MW
5)	Sandia/Santa Fe Deep Well	0 MW

The calculations were performed using the pressure response computer program referred to in Section 4.1.4.3.1. It assumes reservoir lateral communication and absence of recharge. Flowrates and startup dates were also assumed, details are given in Appendix C. The results provide a conservative (or reasonable worst-case) estimate of anticipated reservoir pressure response. Calculated responses due to operation of five power plants simultaneously are given below.

No production other than a short-term test is proposed for the Sandia/Santa Fe Deep Well project so it was not included in this analysis.

a) Calculated Pressure Response (psi)

Area	Predicted Pressure Response (psi) in a Reservoir After 10 yrs	20 yrs	30 yrs
Casa Diablo	+5.53	+5.53	+5.53
Hot Creek Hatchery	-1.88	-1.88	-1.88
Hot Creek Gorge	+0.30	+0.30	+0.30

These results are far more sensitive to placement of wells for the Mammoth/Chance project than for Casa Diablo area projects. Mammoth/Chance I well placements used here are those specified in the Mammoth/Chance I Final EA/EIR. Again, the results show that with all power plants operating at full capacity, a steady-state equilibrium would be reached after two years of operation. This result is due to the high porosity and 100% injection.

b) Bulk Model

The bulk model calculation is not easily adapted to a cumulative analysis involving injection in two widely separated areas. This is because a single uniform cylindrical front cannot be used to describe effects occurring 2-3 miles apart. The calculation was therefore performed for each area individually. Results for the Casa Diablo area include MP I, PLES I, MP II, and MP III acting simultaneously. Results for the Mammoth/Chance lease area include only Mammoth/Chance I.

Distance of Thermal Front from Injection Wells

Casa Diablo			Mammoth/Chance		
After 10 years	20 years	30 years	10 years	20 years	30 years
980	1390	1700 ft.	850	1200	1475 ft.

Neither front is predicted to affect the hatchery or gorge springs.

c) Heat Balance

The same assumptions used for this calculation in Section 4.1.4.3.1 for MP I and PLES I also apply here with the additional production and injection for MP II, MP III and Mammoth/Chance I.

Area	Predicted Temperature Change in Reservoir After 10 yrs	20 yrs	30 yrs
Casa Diablo	-11.4°C (-20.5°F)	-21.1°C (-38.0°F)	-29.4° (-52.9°F)
Hot Creek Hatchery	-7.3°C (-13.1°F)	-14.2°C (-25.6°F)	-19.8° (-35.6°F)
Hot Creek Gorge	0	0	0

The temperature drawdown is much greater for the hatchery and Casa Diablo areas with all plants operating. However, based on the assumption that a 30°C (54°F) reservoir temperature decline may cause a 1°C (1.8°F) decline in the temperature at the hatchery spring flow, no significant impact is predicted.

A regional program for monitoring effects from existing and proposed geothermal power plants and other relevant projects has been developed by LVHAC and put into effect and, based on information obtained through monitoring programs required by the BLM, will provide guidelines for detection limits and trigger point limits which would initiate revised pumping plans, hatchery mitigation, and power plant shutdown. While monitoring will not, in and of itself, mitigate adverse cumulative impacts, it would provide an opportunity to identify hydrologic changes as they occur and would allow sufficient time for appropriate remedial mitigation measures to be implemented, if necessary.

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 VEGETATION

4.2.1.1 Proposed Project Impacts

Impact: A loss of approximately 13 acres of sagebrush scrub and Jeffrey pine plant communities would occur from construction of the PLES I power plant, well fields, and pipelines. These estimates are based on site maps prepared by the project proponent and vegetation maps prepared by Taylor and Buckberg (1987). No botanically sensitive areas and no riparian areas would be directly impacted by the proposed project. The proposed project includes an extensive revegetation scheme, as described in Chapter 2 and Appendix B. It is possible that botanically sensitive rhyolite buckwheat areas could be damaged during construction activities near injection wells if equipment is driven outside designated areas.

The following measures are included in the proposed project to reduce impacts:

- During construction and operation of the facilities, care would be taken to avoid damaging existing vegetation whenever possible.
- Areas which are already disturbed would be utilized for laydown, storage, and construction activities. Only minimal damage to vegetation and soil would occur.
- Revegetation would be done as soon as practical.

Mitigation:

(9) Clearly mark limits of construction activity to avoid equipment vehicle travel outside construction area. Fencing may be required near sensitive areas.

Effectiveness/Impact: Inadvertant use of vehicles and equipment would not damage rhyolite buckwheat.

4.2.1.2 Alternative Location Impacts

Impact: A loss of approximately 15 acres of sagebrush scrub and Jeffrey pine plant communities would occur. The production pipelines would cross the sedge meadow northwest of Casa Diablo Geyser, disturbing about 2,400 square feet. No botanically sensitive area would be directly affected by the production pipelines. The injection pipelines would cross botanically sensitive areas, disturbing about 9,000 square feet of rhyolite buckwheat scrub.

Mitigation:

- Reroute the main injection pipeline to the west of the dirt road which it would follow.

Effectiveness/Impact: Sensitive species and cultural resources could both be avoided by careful siting of the injection pipeline. The terrain may be slightly steeper west of the road, requiring more erosion control measures.

4.2.1.3 Smaller Power Plant Alternative Impacts

Impact: Approximately 12 acres of sagebrush scrub and Jeffrey pine plant communities would be cleared. No botanically sensitive areas would be directly affected. Otherwise impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

4.2.1.4 No-Action Alternative Impacts

Impact: No additional land would be cleared and the landscaping of the distrubed area across Hot Springs Road from MPI would not be done.

Mitigation: No mitigation is recommended.

4.2.1.5 Abandonment and Reclamation Impacts

Impact: Areas disturbed by project facilities would be recontoured and revegetated, as required by BLM regulations. Vegetation would in time return to its natural condition if revegetation efforts were successful.

Mitigation: No mitigation is recommended.

4.2.1.6 Cumulative Impacts

Impact: The Mammoth/Chance, Mammoth Pacific, and PLES I geothermal plants would remove about 60 acres of sagebrush scrub, Jeffrey pine, Jeffrey pine/pinyon pine and mountain meadow plant communities. Exact acreages would be dependent on final site configuration. The Snow Creek, Sherwin Bowl and Juniper Ridge developments, which are at higher elevations than the geothermal plants, would impact coniferous forest and riparian plant communities in addition to sagebrush scrub and mountain meadows. Approximately 400 acres of these plant communities could be directly impacted by these developments. The Doe Ridge airport expansion may directly impact another 200 acres of sagebrush scrub.

If all of these projects are developed, approximately 700 acres (slightly more than one square mile) of natural vegetation would be cleared, much of it on Forest Service land. Of the 700 acres of vegetation cleared, a total of about 13 acres would be due to PLES I. If revegetation measures are successful, some of this acreage could be reclaimed. Adverse impacts to major widespread plant communities, such as sagebrush scrub, are not expected to be significant. Impacts from other projects to unique or uncommon plant communities, such as riparian corridors and thermal marshes, could be significant unless proper safeguards/mitigations are implemented.

Mitigation:

- Responsible agencies should require revegetation plans for all projects.

Effectiveness/Impact: Some vegetation would be restored. No further impacts would be expected from implementation of this measure.

4.2.2 TERRESTRIAL WILDLIFE

4.2.2.1 Proposed Project Impacts

Impact: A loss of up to 13 acres of sagebrush scrub and Jeffrey pine wildlife habitats is expected from construction of the power plant. These are widespread habitats in the area. Populations of pygmy nuthatches and hairy woodpeckers are not expected to be impacted, as fewer than 10 acres of Jeffrey pine habitat would be lost. No impacts to sage grouse populations are expected, as the area receives little sage grouse use and there are no nearby leks. No endangered, threatened, or other special status animal species are known to use the site. Thus, no significant impacts to populations of residential species are anticipated.

Mitigation: No mitigation is recommended.

Impact: Noise and human activity during construction and plant operation may reduce songbird density and may cause migratory deer to avoid the area but would not adversely affect songbird or deer populations. The impact on pygmy nuthatch and hairy woodpecker populations is not likely to be significant (Pacific Gas & Electric, 1986). The correlation between songbird density and noise levels has not been unequivocally demonstrated, so a definite effect cannot be predicted. Similarly, it is unclear to what extent deer are affected and no specific result can be anticipated with respect to deer populations and noise levels (Pacific Gas & Electric, 1986). The project proponent has adopted BLM measures limiting noise-intensive activities during deer migration periods.

Mitigation: No mitigation is recommended.

Impact: Approximately 70 deer were found to use the immediate Casa Diablo area during the spring 1987 migration (Kucera, T.E., 1987b and 1988). About 6,000 deer from the Casa Diablo, Sherwin Grade, and Buttermilk herds are potential users of the Casa Diablo area. The plant and pipelines may directly impede deer movement through the area, or pipeline configuration may funnel deer into impassable areas; however, deer move across a broad area in this flat terrain in contrast to the narrow, constrained corridors of the Sierra escarpment, and it is relatively easy for them to avoid obstruction in the project area (Kucera, T., 1987). Reports of deer jumping fences up to eight feet tall are common especially when the fence encloses well-watered vegetation (Sunset New Western Garden Book, 1979). It is therefore likely that some, or perhaps many, of the adult deer could jump single pipelines along most of their length. However, there is no information available on how effective a deterrent the pipeline would be to normal migration or what the effect would be on pregnant deer in the spring migration or young deer in the fall migration. It is possible that some deer would be adversely impacted. Does carrying fawn may be more vulnerable to stress from disruptions.

The proposed project includes limiting noise intensive activities during deer migration periods and trenching or burying sections of the pipeline as described in the revegetation plan. Ramps would be built across the trenches at the direction of the authorized officer to facilitate deer movements. All fencing must be approved by the authorized officer to ensure that it will not funnel deer into dead-end routes or direct them into inappropriate areas.

Mitigation: No mitigation is recommended.

Impact: There is no important habitat on-site for bald eagle, peregrine falcon, northern goshawk, Williamson's sapsucker, or yellow warbler in the project area. Thus no impacts to these species are expected from project development.

Mitigation: No mitigation is recommended.

4.2.2.2 Alternative Location Impacts

Impact: A loss of up to 15 acres of sagebrush scrub and Jeffrey pine wildlife habitats is expected from construction of this alternative. These are widespread habitats in the area. Populations of pygmy nuthatches and hairy woodpeckers are not expected to be impacted, as fewer than 10 acres of Jeffrey pine habitat would be lost. No impacts to sage grouse populations are expected, as the area receives little sage grouse use and there are no nearby leks. No endangered, threatened, or other special status animal species are known to use the site. Thus, no significant impacts to populations of residential species are anticipated.

Mitigation: No mitigation is recommended.

Impact: Noise and human activity during construction and plant operation may reduce songbird density and may cause migratory deer to avoid the area but would not adversely affect songbird or deer populations. The impact on pygmy nuthatch and hairy woodpecker populations is not likely to be significant (Pacific Gas & Electric, 1986). The correlation between songbird density and noise levels has not been unequivocally demonstrated, so a definite effect cannot be predicted. Similarly, it is unclear to what extent deer are affected and no specific result can be anticipated with respect to deer populations and noise levels (Pacific Gas & Electric, 1986). The project proponent has adopted BLM measures limiting noise-intensive activities during deer migration periods.

Mitigation: No mitigation is recommended.

Impact: Approximately 70 deer were found to use the immediate Casa Diablo area during the spring 1987 migration (Kucera, T.E., 1987b and 1988). About 6,000 deer from the Casa Diablo, Sherwin Grade, and Buttermilk herds are potential users of the Casa Diablo area. The plant and pipelines may directly impede deer movement through the area, or pipeline configuration may funnel deer into impassable areas; however, deer move across a broad area in this flat terrain in contrast to the narrow, constrained corridors of the Sierra escarpment, and it is relatively easy for them to avoid obstruction in the project area (Kucera T., 1987). Reports of deer jumping fences up to eight feet tall are common especially when the fence encloses well-watered vegetation (Sunset New Western Garden Book, 1979). It is therefore likely that some, or perhaps many, of the adult deer could jump single pipelines along most of their length. However, there is no information available on how effective a deterrent the pipeline would be to normal migration or what the effect would be on pregnant deer in the spring migration or young deer in the fall migration. It is possible that some deer would be adversely impacted. Does carrying fawn may be more vulnerable to stress from disruptions.

The alternate power plant location in combination with the existing MP I power plant would have a greater impact on deer using the Çasa Diablo area than if the power plant sites adjoined (Kucera, 1987). This is because a larger area would be affected by the alternative location.

Mitigation:

- Require burial, trenching, and use of ramps at pipelines to facilitate deer movement.

Effectiveness/Impact: Impacts to deer would be less than if no lines were buried or trenched..

Impact: There is no important habitat on-site for bald eagle, peregrine falcon, northern goshawk, Williamson's sapsucker, or yellow warbler. Thus no impacts to these species are expected from project development.

Mitigation: No mitigation is recommended.

4.2.2.3 Smaller Power Plant Impacts

Impacts to wildlife from the smaller power plant alternative would be effectively indistinguishable from the proposed project. See Section 4.2.2.1.

4.2.2.4 No-Action Alternative Impacts

No impacts to wildlife would occur from the no-action alternative.

4.2.2.5 Abandonment and Reclamation Impacts

Impact: Grading and recontouring would increase human activities, but when reclamation were complete, the habitat value of the project site would be regained.

Mitigation:

- The abandonment plans shall have provisions for monitoring revegetation. The revegetation shall have as its goals establishing habitat value equivalent to the scrub and forest vegetation in the area and controlling erosion.

4.2.2.6 Cumulative Impacts

Impact: Habitat removal of up to 400 acres of forest could impact goshawks, pygmy nuthatch, and hairy woodpeckers, due to loss of foraging and nesting areas when timber, including snags, is harvested.

Mitigation:

- Minimize timber harvesting for all projects.

Effectiveness/Impact: Impacts to habitat would be slightly diminished. No further impacts to other resources would be anticipated.

Impact: Cumulative impacts to local deer herds are potentially significant. While summer and winter ranges would be largely unaffected, deer migration routes, which are a vital link in deer ecology, could be disrupted by the proposed projects. The proposed projects and alternatives are within the potential migration routes of the Buttermilk, Sherwin Grade, and/or Casa Diablo deer herds. Disruption of migration would lead to a decline in deer populations which, while currently stable in the region, are more generally on a downward trend..

Mitigation:

- New projects should contribute to off-site mitigation measures proportional to their relative impacts on deer:

- Cumulative impacts to the deer herds could be mitigated by regulating and limiting development in areas of known migration routes and/or acquisition of critical habitat in migration and winter range areas, such as Swall Meadow. Swall Meadow, located approximately 18 miles southeast of Casa Diablo, has been identified as an extremely critical deer resource area in that both the Buttermilk and Sherwin Grade deer herds spend the winter there. Protection of this area through acquisition by the BLM, Forest Service, state, county, or a conservation organization would provide significant protection of winter range for those herds.

- Water availability on summer and winter ranges was specifically identified as a factor limiting the size of the Casa Diablo herd (T. Taylor, 1988). Construction of permanent artificial watering sources was suggested as a specific means for improving water-scarce portions of deer range and could also serve as a valuable off-site mitigation measure.

Effectiveness/Impact: The precise effectiveness of either mitigation is difficult to predict, but each measure would address an identified source of pressure on the deer population.

4.2.3 AQUATIC RESOURCES

4.2.3.1 Proposed Project Impacts

Impact: Should the spill containment plan and all erosion control measures completely fail, increased sedimentation in Mammoth and Hot Creeks may result. Elevated turbidity levels would clog and irritate gill structures and impair respiration, feeding, and swimming capabilities of resident fish and aquatic invertebrates. Erosion control measures proposed as part of the project in combination with the spill containment basins would likely eliminate the risk of this happening (see Section 4.1.2.2.1).

Mitigation: No mitigation is recommended.

Impact: Organic compounds which would be used during drilling, construction, or operation could spill and contaminate local waters.. Paint, diesel fuel, lubricating oils, and small quantities of solvents would be stored and used on-site. These compounds are toxic in low concentrations and would cause adverse effects to aquatic resources if any leakages or spills occur into Mammoth Creek. To reach Mammoth Creek spills would have to escape from the bermed project area, flow over the surface for a distance of 100 to 1,500 feet to the intermittent stream bed, then travel approximately 0.6 mile.

Permit requirements of the Lahontan Regional Water Quality Control Board should suffice to mitigate this potential impact by the requirement that all paints, fuels, lubricants, solvents, or other compounds potentially harmful to aquatic organisms be stored in secure containers within bermed areas so that leaks would be contained.

The project includes the installation and operation of emergency spill containment basins as well as sedimentation basins during construction to help decrease to insignificant levels the potential of any spill adversely affecting surface aquatic resources.

Mitigation: No mitigation is recommended.

Impact: If the geothermal production pipelines supplying the power plant should rupture, pressure would suddenly drop, alarms would sound in the plant, isolation valves in the pipelines would close, and the wells would be shutdown automatically within less than one minute. Assuming a worst-case scenario that the largest pipeline had ruptured, 5,000 gpm of superheated geothermal fluid would be released for five minutes. Approximately 25,000 gallons of 200°F fluid would be released during that period. (Approximately 15% of the fluid would flash to steam as the elevated fluid pressure drops to atmospheric pressure). If all automatic shutdown controls failed, the pumps and isolation valves could be shutdown from the plant control room within two to three minutes. Should all electricity fail, pumps would stop and valves would shut automatically. In addition, all pumps and valves could be closed manually by plant personnel within five munites. If none of the released fluid infiltrated into the soil, it would flow via the intermittent streambed and then to the spill containment structures. The containment structures have a total capacity of approximately 1.7 million gallons or 68 times the volume of the worst-case pipeline rupture. It is therefore unlikely that this fluid would ever reach Mammoth Creek. The temperature of water reaching Mammoth Creek if the spill containment basins were to rupture has been estimated (see Section 4.1.4.1.1) for two cases. For the first case, assuming high stream flow of 50°F water, the mixed geothermal fluid / stream water would be at a temperature of 60°F. This would not pose a threat to any aquatic organisms. The second case assumes very low stream flow, in which case the mixed water would have a temperature perhaps as high as 118°F. This would cause mortality in trout as long as the water temperature remained above about 80°F. A bioassay of the geothermal fluid conducted by the CDFG in April 1988 apparently indicates that geothermal fluids spilled into Mammoth Creek would not be acutely toxic to aquatic organism (Mono County Energy Management Department 1988 [in MP II EIR Addendum]). A bioassay would be required under the revised Plan for Baseline Data Collection.

If project operations caused mortality to fish in Mammoth Creek, Pacific Energy has agreed to fund restocking of the affected stream reach.

Mitigation:

(10) Implement and maintain the emergency spill containment plan.

Impact: If production of geothermal fluid at the proposed project does, contrary to predicted results, cause a change in the temperature or amount of thermal water reaching Hot Creek Hatchery, its operations could be adversely affected. However, implementation of the mitigation measures required by the BLM and Forest Service of the PLES I project are considered sufficient to reduce the potential for significant impacts to insignificance. See Section 4.1.4.3.1 for a discussion of impacts of the proposed project on hydrothermal resources and the measures included in the project to reduce impacts.

Mitigation: See mitigations (6), (7), and (8) in Section 4.1.4.3.1, Hydrothermal Resources.

4.2.3.2 Alternative Location Impacts

The power plant at the alternative site would employ the same emergency shutdown procedures as described for the proposed project in Section 4.2.3.1. Assuming an worst-case scenario, approximately 60,000 gallons of 200°F fluid would be released. It is possible that this fluid could reach the ephemeral lakes northwest of the plant, but it is highly unlikely any of this spilled fluid would reach Mammoth Creek because of the emergency spill containment structure.

A significant amount of cooling and percolation would be likely to occur as the fluid traveled approximately one mile to the basin. Cooling and percolation may reduce temperature and flow to effectively compensate for the additional 1,000 gpm which would be required to run the power plant at the alternative site. Impacts of emergency spill containment failure would be the same as for the proposed project.

4.2.3.3 Smaller Power Plant Alternative Impacts

Impacts to aquatic resources would be substantially the same as for the proposed project.

4.2.3.4 No-Action Impacts

Impact: A major spill from MP I could reach Mammoth Creek in the absence of spill containment basins, which would be built as a result of the PLES I project. See discussion in Section 4.1.4.1.

Mitigation:

- Appropriate agencies should require spill containment facilities to protect Mammoth Creek from spills.

Effectiveness/Impact: Aquatic resources in Mammoth/Hot Creeks would be protected.

4.2.3.5 Abandonment and Reclamation Impacts

Impact: No serious impacts to aquatic resources would occur. See Sections 4.1.2.2.5 under Soils and Erosion, and 4.1.4.1.5 under Surface Water Quality.

Mitigation: No mitigation is recommended.

4.2.3.6 Cumulative Impacts

Impact: The proposed spill containment facilities would protect the entire Casa Diablo geothermal development area, so it is not believed that the cumulative potential for spills from the proposed geothermal projects in the Casa Diablo area represents a potentially significant impact, regardless of potential impacts of other development.

Mitigation: See mitigations recommended in Section 4.1.2.2.6 under Soils and Erosion.

Impact: Known refugia of Owens tui chub would not be affected by the geothermal plants near Casa Diablo. However, it is possible that shallow groundwater flows and the water quality of surface runoff near the refugia could be affected by the Mammoth/Chance geothermal projects, the Doe Ridge project, or by increased water use by the Town of Mammoth Lakes. In addition, any upgradient development in the Mammoth Creek basin which would significantly decrease groundwater recharge of the area could indirectly impact the chub by changing the characteristics of the springs supplying the critical chub habitat to a level beyond their adaptability. The Owens tui chub will be protected pursuant to stipulations rendered by a biological opinion to be prepared by U.S. Fish and Wildlife Service as specified by Section 7 of the Endangered Species Act.

Mitigation: No mitigation is recommended.

4.3 SOCIAL ENVIRONMENT

4.3.1 CULTURAL RESOURCES

4.3.1.1 Proposed Project Impacts

Impact: Potential adverse impacts to cultural resources sites in the project area may be of two kinds: direct and indirect. Direct adverse impacts would be expected if construction of the proposed facilities altered the location of, or destroyed, cultural resources or areas traditionally used by Native American groups. Indirect adverse impacts are less clear-cut and can be expected to occur beyond the actual spatial confines of direct impact during construction and operation. Indirect adverse impacts may affect any cultural resources in the general vicinity of proposed geothermal development. An example of indirect impact to cultural resources would be collection of artifacts by construction and operation personnel.

Mitigation:

(11) A focused program of educating project personnel to develop an awareness of the surrounding cultural environment and the need to leave any cultural remains as they are found in the environment should be implemented to mitigate indirect impacts on cultural resources.

Effectiveness/Impact: If the program were successful, artifacts would be protected; otherwise, it might serve to make personnel more aware of the presence of artifacts and promote their collection. No other impacts would result from implementation of this measure.

Direct Impact: Cultural Resource Site-1 (see Section 3.3.1) is locate immediately east of the proposed power plant site. All injection wells except SFI 44-32 are likely to be within Cultural Resource Site-1. This site has been tested for significance through a formal program of systematic data recovery (Hall, M.C., 1986). Results from this investigation have provided useful scientific data indicating a non-intensive, but recurrent, prehistoric occupation and use of the site over several thousand years.

Consultation with the State Historic Preservation Officer (SHPO) has taken place and a no-effect determination has been made.

Mitigation: None is necessary.

Direct Impact: The injection pipeline would pass immediately adjacent to Cultural Resource Sites-7, -8, and -9. Careless use of equipment during laying of the pipeline could damage those sites.

Mitigation:

(12) Designate the pipeline route with stakes and flagging before installation of the pipeline begins.

Effectiveness/Impact: The sites would be protected from inadvertant damage. No further environmental impact would result from implementation of this measure.

Direct Impact: It is possible that subsurface cultural resources may be encountered during construction. If subsurface cultural resources were encountered during construction activities, standard geothermal lease stipulations regarding cultural resources would be followed.

Special Stipulation No. 3, of Geothermal Lease #11667 Antiquities and Cultural Values, reads as follows:

"Prior to beginning any operations other than casual use as defined in 43 CFR 3209.0-5(d), the lessee shall furnish to the Forest Service and the DCM for Geothermal, an archaeological report prepared by a qualified archaeologist acceptable to the Forest Supervisor, which clears the proposed sites if no cultural values exist; or if cultural values are found on any of the proposed site, makes recommendations for the collection of the values, avoidance (relocation of the sites), or other mitigation measures. The Forest Supervisor will review these plans, and in consultation with the lessee, determine an appropriate course of action. All mitigation shall be completed prior to beginning operations which would disturb the cultural values. The responsibility and cost for survey and mitigation shall be borne by the lessee. All such work shall be conducted under authority of a Forest Service Antiquities Permit and be subject to the provisions and stipulations contained therein, as well as all pertinent Federal Historic Preservation mandates and guidelines.

Should previously unknown objects of cultural, historic, or scientific artifacts and paleontological specimens be discovered during the course of operations, all activity in the affected area shall cease. The lessee shall leave all such material in place and contact the Forest Supervisor and the DCM for Geothermal immediately. Operations in the area shall not recommence until approved by the Forest Supervisor and the DCM for Geothermal."

Mitigation: No mitigation is recommended.

Indirect Impact: The Native American Bishop Elders voiced concerns about proposed geothermal development in areas where they have traditional Native American interests (Reynolds, L., 1987). Such interest include use of hot springs in the region for ritualistic purposes, the collection of special plants which grow near the hot springs, and the collection of a special type of soil which occurs near the project area. Although no specific sites near the proposed project have been identified as sacred by Native Americans, Pacific Energy has indicated that continued access to traditional Native American camping and collecting areas would be provided. As such, Native Americans would have continued access to their traditional use areas. This access will be required by the BLM.

Mitigation: No mitigation is recommended.

4.3.1.2 Alternative Location Impacts

Impact: Potential adverse impacts to cultural resources sites in the general vicinity of the project may be of two kinds: direct and indirect. Direct adverse impacts would be expected if construction of the proposed facilities altered the location of, or destroyed, cultural resources or areas traditionally used by Native American groups. Indirect adverse impacts are less clear-cut and can be expected to occur beyond the actual spatial confines of direct impact during construction and operation. Indirect adverse impacts may affect any cultural resources in the general vicinity of proposed geothermal development. An example of indirect impact to cultural resources would be collection of artifacts by construction and operation personnel.

Mitigation: See mitigation (11) for the proposed project.

Direct Impact: All injection wells except SFI 44-32 are on Cultural Resource Site-1. This site has been tested for significance through a formal program of systematic data recovery (Hall, M.C., 1986). Results from this investigation have provided useful scientific data indicating a non-intensive, but recurrent prehistoric occupation and use of the site over several thousand years.

Hall (1986) does not consider the site to be eligible for nomination to the National Register of Historic Places because no additional information is likely to be obtained from further data recovery. Eligibility would be determined upon consultation with the State Historic Preservation Officer (SHPO).

Mitigation: None is necessary if SHPO determines the site is not eligible for the National Register of Historic Places.

Effect/Effectiveness: If SHPO concurs with the assessment of no eligibility, there would be no adverse impacts to cultural resources at Cultural Resource Site-1. If the SHPO does not concur with the assessment that site Cultural Resource Site-1 is not eligible for the National Register of Historic Places, then a mitigation program acceptable to the SHPO should be developed by the project proponent, in coordination with the Inyo National Forest Archaeologist, as required by special stipulation to the geothermal lease.

Direct Impact: The injection pipeline would pass immediately adjacent to Cultural Resource Sites-7, -8, and -9. Careless use of equipment during laying of the pipeline could damage these sites.

Mitigation:

- Designate the pipeline route with stakes and flagging before installation of the pipeline begins.

Effectiveness/Impact: The sites would be protected from inadvertant damage. No further environmental impact would result from implementation of this measure.

Direct Impact: It is possible that subsurface cultural resources may be encountered during construction. If subsurface cultural resources were encountered during construction activities, standard geothermal lease stipulations regarding cultural resources would be followed.

Special Stipulation No. 3, of Geothermal Lease #11667 Antiquities and Cultural Values, reads as follows:

> "Prior to beginning any operations other than casual use as defined in 43 CFR 3209.0-5(d), the lessee shall furnish to the Forest Service and the DCM for Geothermal, an archaeological report prepared by a qualified archaeologist acceptable to the Forest Supervisor, which clears the proposed sites if no cultural values exist; or if cultural values are found on any of the proposed site, makes recommendations for the collection of the values, avoidance (relocation of the sites), or other mitigation measures. The Forest Supervisor will review these plans, and in consultation with the lessee, determine an appropriate course of action. All mitigation shall be completed prior to beginning operations which would disturb the cultural values. The responsibility and cost for survey and mitigation shall be borne by the lessee. All such work shall be conducted under authority of a Forest Service Antiquities Permit and be subject to the provisions and stipulations contained therein, as well as all pertinent Federal Historic Preservation mandates and guidelines. Should previously unknown objects of cultural, historic, or scientific artifacts and paleontological specimens be discovered during the course of operations, all activity in the affected area shall cease. The lessee shall leave all such material in place and contact the Forest Supervisor and the DCM for Geothermal immediately. Operations in the area shall not recommence until approved by the Forest Supervisor and the DCM for Geothermal."

Mitigation: No mitigation is recommended.

Indirect Impact: The Native American Bishop Elders voiced concerns about proposed geothermal development in areas where they have traditional Native American interests (Reynolds, L., 1987). Such interest include use of hot springs in the region for ritualistic purposes, the collection of special plants which grow near the hot springs, and the collection of a special type of soil which occurs near the project area. Pacific Energy has indicated that continued access to traditional Native American camping and collecting areas would be provided. As such, Native Americans would have continued access to their traditional use areas. This access will be required by the BLM.

Mitigation: No mitigation is recommended.

4.3.1.3 Smaller Power Plant Impacts

Impacts of this alternative would be the same as those of the proposed project.

4.3.1.4 No-Action Alternative Impacts

Cultural resources would be unaffected by project activities.

4.3.1.5 Abandonment and Reclamation Impacts

There would be no additional direct impacts to cultural resources due to abandonment and reclamation beyond those caused by the original construction of the project.

Impact: Indirect impacts could result from having workers on the site who might collect artifacts.

Mitigation: See mitigation (11) in Section 4.3.1.1.

4.3.1.6 Cumulative Impacts

Impact: Five geothermal power generation plants of similar size either exist or are proposed for the area impacting a total area of about 75 acres. Their cumulative adverse impacts would be greater than for any one project. These impacts include, but are not limited to, cultural resource site disturbance and/or total destruction. As development of the region increases, it will become more difficult to relocate construction sites and access roads to avoid potential adverse impacts to identified cultural resources. In turn, the only alternative that would remain is a comprehensive, systematic data recovery plan of these cultural resources sites and this, in and of itself, results in the ultimate destruction of the site. Additional proposed projects would disturb approximately 1,000 acres. Without a program of identification of the cultural resources existing within the entire project vicinity, it can be assumed that some type of disturbance and/or destruction of cultural resources will occur. Cultural remains are non-renewable resources and the incompatibility of these sites and proposed geothermal development will remain a significant factor within the area.

<u>Mitigation</u>:

- Upon the preliminary siting of future facilities, an on-site inspection, evaluation, and mitigation of any identified areas of cultural resource significance should be made mandatory prior to the commencement of construction activities.

<u>Effectiveness/Impact</u>: Some measure of protection would be provided cultural resources. No further impact would be expected.

<u>Indirect Impact</u>: Native American access to areas where they have traditional interests could be limited by more intensive geothermal development.

<u>Mitigation</u>:

- Require operations of geothermal projects to allow Native Americans continued access to visit hot springs and to collect special soil and plants from the areas.

<u>Effectiveness/Impact</u>: Native American values with respect to hot springs and their associated soils and vegetation would be protected. No further impact would be expected.

4.3.2 RANGE RESOURCES

4.3.2.1 Proposed Project Impacts

Impact: Occupation at the proposed site by permanent facilities would remove approximately 7.5 acres of range land from the grazing allotment. The power plant facilities would be fenced, preventing access to the land. An additional 5.5 acres would be cleared of all vegetation but would be available for revegetation once site occupation was completed. The 13 acres of range initially cleared and occupied represents a loss of approximately two AUMs to the permittee.

If the entire well field and power plant area were unavailable to the grazing permittee (due to pipeline configuration and adjacent fencing on private land), approximately 33 acres of range land would be unusable. This acreage is equal to approximately 5.5 AUMs of grazing output and would not significantly affect the
current lessees operations.

The project includes revegetation of all nonoccupied cleared areas with vegetation suitable for grazing. Approximately 50% of the anticipated range loss could be recovered over time if revegetation efforts are successful.

Mitigation: No mitigation is recommended.

4.3.2.2 Alternative Location Impacts

Impact: The alternative location would remove about 15 acres from the grazing allotment, instead of 13 acres removed by the proposed project. Otherwise, impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

4.3.2.3 Smaller Power Plant Alternative Impacts

Impact: The smaller power plant would remove about 12 acres from the grazing allotment. Otherwise impacts would be the same as for the proposed project.

Mitigation: No mitigation is recommended.

4.3.2.4 No-Action Alternative Impacts

Grazing would continue unchanged from present conditions:

4.3.2.5 Abandonment and Reclamation Impacts

Impact: If revegetation efforts were successful, the full range would be recovered after project abandonment.

Mitigation: No mitigation is recommended.

4.3.2.6 Cumulative Impacts

Up to 60 acres of land would be removed from use as rangeland by construction of PLES I, and MP II & III and Mammoth / Chance I. This represents approximately ten AUMs. Vegetation on up to 200 acres of grazeland could be disturbed at Doe Ridge. If the whole area were lost to grazing, it would represent an additional 30 AUMs.

4.3.3 RECREATIONAL RESOURCES

4.3.3.1 Proposed Project Impacts

Impact: If hydrologic analysis is correct there would be no impact to the thermal springs at Hot Creek Gorge. If thermal springs at Hot Creek Gorge were reduced or depleted as a result of operating the PLES I plant, it would be less valuable as a geologic interpretative site. There could be a loss of one of the many natural features which attract recreationists to the Mammoth area, including a loss of approximately 95,000 recreational visitor days per year at that site.

The trout stocking program in California would be adversely affected if year-round operation could not continue at Hot Creek Hatchery due to lowered temperatures. See the discussion on Aquatic Resources, Section 4.2.3.1, and Hydrothermal Resources, Section 4.1.4.3.

Mitigation: See mitigation (8) in Section 4.1.4.3.1.

Impact: If a spill of geothermal fluid resulted in significant fish mortality, fishing in Mammoth Creek would be temporarily adversely affected. The remote possibility of a spill reaching Mammoth Creek is described in Surface Water Quality, Section 4.1.4.1.1. Should operation of PLES I cause significant fish kills, as determined by the authorized officer, the operator will restock the affected fishery(s). A bioassay of the geothermal fluid conducted by the CDFG in April 1988 apparently indicates that geothermal fluids spilled into Mammoth Creek would not be acutely toxic to aquatic organisms (Mono County Energy Management Department, 1988, MP II EIR Addendum). A bioassay would be required under the revised Plan for Baseline Data Collection.

Mitigation: See mitigation (10) in Section 4.2.3.1.

Impact: There are no recreational facilities within the project area and other than cycling and jogging, no known recreational activities occur there. A relatively small number of recreationists travel east on Antelope Springs Road past the project area to utilize the unimproved dispersed recreation opportunities of Little Antelope Valley. Recreationists driving, cycling, and jogging near the project area may be affected by the noise of the facility, but recreational opportunities would not be affected.

Mitigation: No mitigation is recommended.

4.3.3.2 Alternative Location Impacts

Impact: There are no known recreational facilities within the area which would be used by the power plant at the alternative site and other than jogging and target shooting, no known recreational activities occur nearby. Those recreationists using the informal target shooting area or traveling further east into Little Antelope Valley would pass immediately north of the power plant and could hear and see the plant. Recreational opportunities would not be affected.

Mitigation: No mitigation is recommended.

4.3.3.3 Smaller Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.3.4 No-Action Alternative Impacts

Impact: No spill containment structure would be developed, so if a major geothermal fluid spill which occurred outside the bermed area or which escaped the berms and containment facilities on the power plant site, it is possible it could reach Mammoth Creek and damage the fishery. For a full discussion, see Surface Water Quality, Section 4.1.4.1.4 and Aquatic Resources, Section 4.2.3.4.

Mitigation: No mitigation is recommended.

4.3.3.5 Abandonment and Reclamation Impacts

Impact: Well-plugging and grading activities would cause temporary noise and dust which affect recreationists.

Mitigation:

- Apply the same dust and noise control measures as would be required during construction.

4.3.3.6 Cumulative Impacts

Impact: If the hydrologic analysis is correct, there would be no significant impact to thermal springs at Hot Creek Hatchery or Hot Creek Gorge from the combined production of MP I and the four proposed geothermal projects. For the full discussion, see Hydrothermal Resources Section 4.1.4.3.6. If the thermal springs at Hot Creek Gorge were reduced or depleted as a result of the operation of the geothermal power plants, it would be less valuable as a geologic interpretive site and could result in the loss of approximately 95,000 recreation visitor days per year of use at the site.

The trout stocking program in California would be adversely affected if year-round operation at Hot Creek Hatchery could not continue due to lowered temperatures.

Mitigation: See mitigations (7) and (8) in Section 4.1.4.3.1.

Impact: If a spill of geothermal fluid resulted in significant fish mortality, fishing in Mammoth Creek would be temporarily, adversely affected. The remote possibility of a spill reaching the creek is described in Surface Water Quality, Section 4.1.4.1.6.

Mitigation: No mitigation is recommended.

Impact: As the areas of geothermal are not visible from nearby tourist destinations (e.g., Shady Rest or Sherwin Creek Campgrounds, Little Antelope Valley, or Hot Creek Gorge) and the view near the site also encompasses other man-made features (e.g., power plant, multiple roads and electrical transmission lines, and gasoline and propane storage tanks), tourists are not likely to be deterred from visiting the area or to experience a less rewarding recreational experience because of the presence of the proposed geothermal power plants. The BLM/Forest Service approval of the project as earlier proposed found that the facility would be in keeping with the existing visual character and would not significantly alter the view in the local area.

Mitigation: No mitigation is recommended.

4.3.4 TIMBER RESOURCES

4.3.4.1 Proposed Project Impacts

Impact: Merchantable-size Jeffrey pine would be harvested during the clearing of injection well pads, and the eastern portion of the injection pipeline path (where necessary). A few merchantable trees are located on the power plant site. No merchantable-size trees would be harvested during the clearing of production well pads, production pipeline path, or western portion of the injection pipeline path. Where merchantable-size Jeffrey pine are present, timber volumes are estimated at 24,000 board-feet per acre. At this stocking level fewer than 40,000 board-feet would be harvested during the clearing for pipelines and well pads. These lands are not managed for timber production and are not included in the Inyo National Forest timber base.

An unknown number of smaller, nonmerchantable trees would be transplanted during the construction of all proposed facilities. These trees would be transplanted to the viewshed foreground and used to screen facilities.

<u>Mitigation</u>: No mitigation is recommended.

4.3.4.2 <u>Alternative Location Impacts</u>

<u>Impact</u>: The alternative power plant site has timber volumes estimated at 30,000 board-feet per acre. The longer injection pipelines pass through areas similarly forested. At those stocking rates, construction of this alternative would result in the harvesting of no more than 220,000 board-feet would be harvested.

<u>Mitigation</u>: No mitigation is recommended.

4.3.4.3 <u>Smaller Power Plant Impacts</u>

Impact would be the same as for the proposed project.

4.3.4.4 <u>No-Action Alternative Impacts</u>

No timber would be harvested.

4.3.4.5 <u>Abandonment and Reclamation Impacts</u>

<u>Impact</u>: Revegetation efforts would, in time, restore timber levels.

<u>Mitigation</u>: No mitigation is recommended.

4.3.4.6 Cumulative Impacts

Because the Mammoth/Chance development would require no timber harvest, the cumulative effects of geothermal development would be the additive effects of the PLES I and the MP II & III projects. A maximum of 303,000 board-feet could be harvested during clearing for the three mentioned power plant units. Timber volumes harvested from these lands could be used to either offset timber harvested in other sale areas or add to the forest timber target for any one year.

At Sherwin Bowl, up to 150 acres of timber would be cleared. Some timber would be harvested for the Juniper Ridge project as well. Depending on stocking levels and exact averages, these projects could result in the harvesting of perhaps as much as 6 million board-feet.

4.3.5 TRANSPORTATION AND SITE ACCESS

4.3.5.1 Proposed Project Impacts

Impact: Transportation and access to the project site would not be problem most of the year. Seasonally heavy traffic utilizing the north-bound offramp from Highway 395 to Route 203 and the Mammoth Mountain ski areas could become congested if peak project construction traffic coincides. However, it is unlikely that peak construction activity would occur during either winter months or during weekend peak traffic periods. During seasonal weekend peak traffic periods, construction traffic would be routed to Hot Springs Road (Old Highway 395) and the project site from the Sherwin Creek Road turnoff of Highway 395, if necessary; thereby, avoiding the busier Route 203 offramp.

Mitigation: No mitigation is recommended.

4.3.5.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.3.5.3 Smaller Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.5.4 No-Action Alternative

Traffic conditions would be unchanged from existing.

4.3.5.5. Abandonment and Reclamation Impacts

Impact: Traffic to and from the project during abandonment and reclamation is not likely to adversely affect traffic on the area.

Mitigation: No mitigation is recommended.

4.3.5.6 Cumulative Impacts

Impact: If more than one geothermal power plant is under construction at one time, Route 203 east of Highway 395 and Hot Springs Road would experience a significant, short-term increase in traffic. No more than two of the power plant units are expected to be under construction at any given time.

Traffic associated with the operation of the existing MP I plant and the proposed power plant units in the Casa Diablo area is not expected to affect service in the area.

Mitigation:

- On busy winter ski weekends, route construction traffic from all geothermal plants onto Hot Springs Road at Sherwin Creek Road to avoid the busy Route 203 / Highway 395 off-ramp.

Effectiveness/Impact: This measure would releive congestion at the busy off-ramp. Traffic and wear on Hot Springs Road would increase, but levels of service would not be affected.

4.3.6 VISUAL RESOURCES

4.3.6.1 Proposed Project Impacts

Impact: Drilling rigs and accessory equipment would be visually strong but temporary elements of the landscape because of their form, size, strong vertical lines, and contrasting colors. Once the wells were completed, the wells would be capped and the drilling equipment would be removed, eliminating any substantial structures from the well sites. The landscape plan includes planting of shrubs and trees to screen well sites.

Mitigation: No mitigation is recommended.

Impacts: The viewpoint from which the most viewers would see the project area is Highway 395 near the meadow containing Mammoth Creek. The generator and condensers, at heights of about 30 feet above grade, would be partially visible through the existing and proposed transplanted trees.

Well pads, wellhead equipment, pipelines, and access roads would become long-term features of the landscape. Grading for well pads and access roads would alter the natural form of the landscape slightly. The smooth, horizontal lines of the roads, and pad surfaces would contrast with the existing slopes and ridges, which are undulating and irregular, without sharp lines or divisions. These project elements would differ in texture, also, from existing natural surface features. The road and well pad surfaces could contrast in color with existing vegetation and surface soils.

Once the drilling rigs and associated equipment were removed from the well pads, the wellhead equipment, fluid transmission lines, and access roads could be visible to northbound traffic from Highway 395 from about one mile southeast of the Casa Diablo area and Route 203 east of Highway 395. Visibility from these viewpoints and the degree of contrast would be moderate, the degree depending upon the exact placement of well pads, alignment of access roads and pipelines, and extent of revegetation and screening. With appropriate mitigation for visual effects, the overall visual impact would be slight to moderate.

The power plant would be the most visible element of the project, visible from Route 203 east of Highway 395 and from northbound Highway 395 from about one mile southeast of

Casa Diablo to one-half mile south of Casa Diablo. At night, work lights and structural lighting of the power plant would be visible. The views of the power plant and accessory structures would create the impression of light industrial activity. Figure 4-1 is a line-of-sight section of the proposed power plant in the existing setting, as seen from the viewpoint on Highway 395 near Mammoth Creek shown on Figure 3-7. The cone of visibility shows topography and vegetation in relation to the power plant. Most of the power plant would be screened from view, but there would be narrow corridors through which almost the entire height of the condensers could be seen.

The proposed project includes the following measures to reduce impacts:

- The power plant site, well pads, pipelines, and new access roads would avoid mature trees whenever possible.
- Disturbed soil areas would be partially or completely revegetated as soon as practical once construction and site development are completed.
- Exteriors of structures, including pipelines, and their supports, would be neutral colors approved by the authorized officer.
- To the extent compatible with engineering considerations, all exterior surfaces would be rough texture, with no reflective metal or glass surfaces oriented toward the south or west.
- Exterior structural lighting would be minimized; where exterior lighting is necessary, diffuse lighting systems would be used. Work lights would be switched or equipped with timers, rather than being designed for continuous use, and workers should be encouraged to minimize the use of night lighting to the extent safely practical.
- Electrical transmission lines would be on pipeline stanchions.
- Native trees would be transplanted and planted on the project site to screen equipment yards and accessory structures, and the lower portions of the major structures on the site.
- Pipelines would be sited so that natural vegetation and terrain provide visual screening to the extent possible.

Screening by trees and shrubs as proposed would be increasingly effective as the vegetation grew taller. Transplanting of trees up to 30+ feet in height would accelerate the screening process. Over a period of about five years the VQO of Retention would be met. See Section 2.1.6 for a discussion of revegetation plans.

Mitigation: No mitigation is recommended.

4.3.6.2 Alternative Location Impacts

Impact: The power plant would be completely screened from view from Highway 395 and Route 203 by topography and vegetation. It would be visible from Antelope Springs Road, the dirt road serving Little Antelope Valley. The pipelines and wellheads would be visible.

Mitigation:

- Require landscaping and other visual screening to lessen visual impacts of the pipeline and well heads.

4.3.6.3 Smaller Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.6.4 No-Action Alternative Impacts

Impact: Landscaping and revegetation associated with the proposed project would not be done.

Mitigation: No mitigation is recommended.

4.3.6.5 Abandonment and Reclamation Impacts

Impact: Recountouring and grading the soil would lead to temporary visual impacts.

Mitigation: No mitigation is recommended.

4.3.6.6 Cumulative Impacts

Impacts: The addition of PLES I and MP II & III to the existing MP I plant would add additional man-made elements to the landscape at the expense of the natural features. The scattered and transplanted trees would provide substantial screening in the background views across the meadow. The MP II & III project, proposed for a site behind the proposed PLES I power plant site would, in effect, be screened from view behind PLES I, which in turn would be screened from the major view corridor along Highway 395 by terrain and by existing and relocated mature trees while new vegetation required by

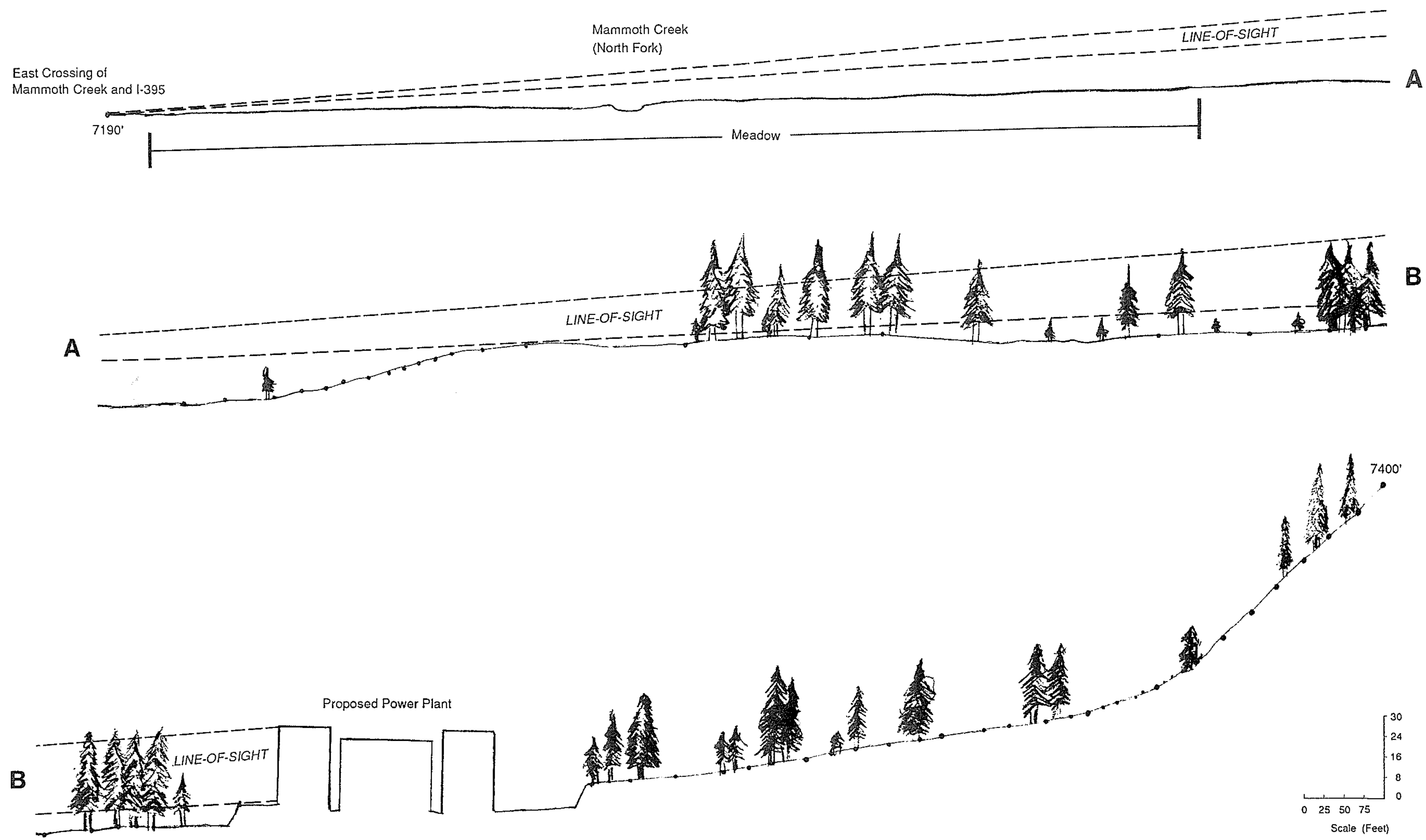


FIGURE 4-1
Cross-Section Along Line-of-Sight from Highway 395 Near Mammoth Creek to Proposed Power Plant Site

SOURCE: ESA, Inc., 1988

the site reclamation program matured. In views from Highway 395 and Route 203, these power plants and their ancillary facilities would not likely be noticeable to the casual observer. Instead, due to the natural topography, the observer's view would most likely be drawn to the eastern crest of the Sierras, Mammoth Mountain, and the Minarets to the west or to the meadow in the immediate foreground.

In addition, given the existing visual intrusions from the view corridor toward Casa Diablo site (see Visual Resources, Section 3.3.6.4), the cumulative geothermal development at Casa Diablo would not constitute significant visual impacts. The landscape and revegetation measures included in the PLES I project would further reduce the visual impact.

4.3.7 LAND USE AND PLANNING

4.3.7.1 Proposed Project Impacts

Impact: The proposed construction of PLES I would change the partially undeveloped character of the site to one of light industrial activity. The project is compatible with Forest Service plans and would not conflict with existing or planned land uses in the area. No land uses are planned nearby other than the MP II & III geothermal project proposed for the area immediately north of the PLES I site. In addition, no recreational uses are planned for the area.

4.3.7.2 Alternative Location Impacts

The impacts would be the same as for the proposed project.

4.3.7.3 Smaller Power Plant Impacts

The impacts would be the same as for the proposed project.

4.3.7.4 No-Action Alternative Impacts

Land use on the project site would continue in its present state.

4.3.7.5 Abandonment and Reclamation Impacts

Impact: After the changes associated with the PLES I project were removed, the land use would likely return to the present open space / grazing use.

Mitigation: No mitigation is recommended.

4.3.7.6 Cumulative Impacts

Impact: Continuing geothermal resource development on both federal and private lands in the Long Valley would affect land uses directly by transforming several undeveloped areas to light-industrial uses. Geothermal development at Casa Diablo is consistent with Mono County and Inyo National Forest Plans. A total of 60 acres of open space and grazeland would be lost in the development of the proposed Casa Diablo and Mammoth / Chance geothermal projects.

Mitigation: No mitigation is recommended.

4.3.8. EMPLOYMENT, POPULATION AND HOUSING

4.3.8.1 Proposed Project Impacts

Impact: The type and amount of employment generated by the PLES I power plant would differ between the construction phase and operation phase. Based on the work force used during the construction of the existing MP I facility, the construction phase employment is expected to fluctuate with the stage of power plant construction and well drilling, averaging 48 workers over a nine-month period, peaking with 82 workers in the fifth month during the summer when weather conditions are most favorable for construction work. During the operational phase, 16 persons are expected to operate the facility when commercial production begins. The impact upon the local labor force will vary depending on whether the employees are hired locally or brought in from outside the area. A worker who would commute to work from his present address is considered part of the local labor force. Thus, the local area includes the northern part of Inyo County and encompasses the Native American communities in southern Mono County and northern Inyo County.

Three employment scenarios are considered and presented in Table 4-3:

- Minimum local employment (0%) -- entire labor force non-local;
- Mid-range local employment increase (44%) -- only entry level jobs filled by local labor force (Asper, W.E., 1987b); and
- Maximum local employment increase (69%) -- labor force employment pattern similar to patter found at the MP I geothermal plant (Asper, W.E., 1987b).

TABLE 4-3: LOCAL EMPLOYMENT

Level of Local Employment	Average Construction	Peak Construction	Production Operations
Minimum	0	0	0
Mid-range	21	36	7
Maximum	33	56	11

SOURCE: Environmental Science Associates, Inc., 1987.

Since some employment would go to people presently living outside of the area, an increase in the local population would result. The size of the increase would depend on the portion of employment that would go to people living outside of the local area, the labor pattern of households and household size.

For this analysis it is assumed that the average household of each non-local employee would consist of 2.33 persons (California Department of Finance, 1987) and that non-local employees would relocate their households to the local area during their employment. Some non-local construction workers may not relocate their households, thus lessening the actual average number of persons per household. Using the three employment scenarios, the expected population increase is shown in Table 4-4.

Since a portion of employment would go to people presently living outside of the area, a demand for housing would result as these people move into the area. The increased demand would tighten the housing market at the lower end of the price scale and potentially increase the price of housing. Most construction employees would be expected

TABLE 4-4: POPULATION INCREASES

Local Employment	Average Construction	Peak Construction	Production Operations
Minimum	112	191	37
Mid-range	63	107	21
Maximum	35	59	12

SOURCE: Environmental Science Associates, Inc., 1987.

to seek temporary housing while the operating employees could seek permanent housing. Experience during the construction of the MP I geothermal plant indicates there would be no problem housing the construction workforce. In a large measure, this was due to the fact that the greatest population increase coincided with the off-peak season, which increased the ability of the local housing market to meet the increased demand for housing.

The immediate housing market is about 11,000 housing units. About 4,500 are used as permanent housing and 6,500 mainly condominium units, as temporary housing. The vacancy rate for permanent housing is around 2 to 3%. The vacancy rate for temporary housing varies greatly with the seasons and day of the week. The lowest vacancy rates occur during the weekends of the winter skiing season and the highest during the weekdays in the spring and fall.

Under the maximum population increase scenario, the demand for permanent residential housing is expected to increase by less than 0.4%. Given the duration of the development phase, construction of some additional housing for the less expensive end of the housing market can be expected. Although there is currently a relatively high vacancy rate of condominiums in Mammoth Lakes, this condition would not necessarily remain unchanged over the next one or two years, and the condominiums currently being built are generally designed for the most expensive end of the housing market.

If Pacific Energy hires locally, housing needs would be reduced.

Mitigation:

(13) Time construction activity to avoid having the peak construction housing needs coincide with the peak winter tourist housing demand.

Effectiveness/Impact: Minimal additional housing would be required during construction activities. There would be little additional impact caused by implementation of this measure.

4.3.8.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.3.8.3 Smaller Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.8.4 No-Action Alternative Impacts

There would be no increased housing demand due to PLES I.

4.3.8.5 Abandonment and Reclamation Impacts

Impact: Termination of operations would cause the loss of 11 jobs. If these people could not find other local employment, they would likely leave the area and housing demand would decrease slightly. The temporary work of abandonment and reclamation would be of such short duration it is not likely to create perceptible housing demand.

4.3.8.6 Cumulative Impacts

Impact: The cumulative demand for housing from operation of all four proposed geothermal plants would be about 24 units, less than 0.6% of the permanent housing market and less than 0.3% of the overall housing market. The overall impact on housing would not be significant. Simultaneous construction of two geothermal plants could temporarily tighten the market for nonpermanent housing, an average of 68 workers would seek temporary housing, with 132 workers the largest number seeking temporary housing.

While this demand could prevent rents from falling to their usual off-season lows, its temporary nature would not provide an incentive for developing additional housing. The increased demand would not result in a significant environmental impact.

Similarly, the impacts associated with the employment generated and the maximum population increases, as a result of PLES I is likely to be small in comparison to large-scale proposed projects.

4.3.9 ECONOMICS

4.3.9.1 Proposed Project Impacts

Impact: The local economy would temporarily benefit from the increased retail demand and demand for housing during the peak construction phase, as would employment in the construction sector. The local economy would experience a longer lasting but lower level benefit during the operational phase from retail purchases made by the plant and by plant employees, and from the availability of local entry-level jobs. The local economy would be financed from those property taxes and federal funds. The local economy would benefit from the payroll paid to local construction labor estimated at $500,000 and from approximately $500,000 spent for room and board by temporary construction labor and project supervisory personnel during construction of the project. The direct payroll is expected to be similar to the payroll at the MP I project which totaled $451,000 in 1986. Local trade with Inyo and Mono County merchants from MP I totaled $159,000 in 1986 (Asper, W.E., 1987b). The year-round operation of the plant would help stabilize the highly seasonal nature of employment and retail sales.

Mitigation: No mitigation is recommended.

Impact: The possibility of negative local economic impact is largely associated with the unlikely loss of geothermal water at Hot Creek Gorge and the Hot Creek Hatchery. Such a loss could reduce employment, retail sales, and rentals based on servicing trout fishing and hot spring bathing, increasing the severity of the unbalanced winter/summer tourist economy (Hawley, B., 1987). The hydrology analysis estimates that it is unlikely for temperature or pressure changes in the hydrothermal reservoir to cause changes at the hatchery or the gorge and there would be no economic impact.

The most severe potential impact would occur if year-round operation of Hot Creek Hatchery were not viable due to the total loss of thermal water in the hatchery springs.

To raise an equal number of trout in the colder waters, the cost would be higher due to the larger number of ponds and amount of water required to hold the fish for a longer period until they reached planting size. The loss of the fall spawning trout, which account for 40% of the 2 million eggs and 20% of the fish raised at Hot Creek Hatchery, would eliminate year-round planting of the trout stock and be felt throughout the area west of the Rocky Mountains (Porter, R., 1987). Year-round, the price of eggs ranges from less than $10 per 1,000 to almost $20 per 1,000 eggs, depending on the number of eggs purchased at one time. If the hatchery sold all its Coleman strain eggs for $20 per thousand, the loss of 800,000 eggs would represent lost income of $16,000 annually. In addition, a major part of the facilities for the backcounty aerial planting for the northern Sierra Nevada would have to be relocated other hatcheries (Porter, R., 1987). The project includes provision to, supply thermal water to the hatchery either via pipeline from PLES I or by drilling a well at the hatchery to tap the geothermal reservoir.

Mitigation: See mitigation (7) in Section 4.1.4.3.1.

Effectiveness/Impact: This requirement would provide technical specifications for the potential future monitoring or contingency mitigation measures. The requirement would provide the BLM, and cooperating and consulting agencies, with additional information to ensure that potential monitoring or contingency mitigation measures could be required and implemented in a timely manner, as necessary.

Impact: County revenues are expected to increase by about $250,000 per year based on the 1987 tax levy in Mono County. Increased revenues would come from property taxes, sales taxes, and a portion of the geothermal lease revenues. The property value is expected to increase from approximately $112,000 to over $23,000,000, similar to the property value of the existing MP I plant (McCulloch, L., 1987). The increase in sales to the plant and plant personnel would mainly occur in the Town of Mammoth Lakes and in communities in Inyo County rather than in unincorporated Mono County. Therefore, Mono County can expect only a slight increase in sales tax revenue.

County expenditures are expected to increase. Costs incurred by various county departments would, for most part, be financed out of the general fund and not by applicant fees (e.g., Board of Supervisors, Sheriff, County Counsel). The greatest demand for increased general county services and fiscal expenditures would be associated with the increase in the residential population rather than with the plant itself.

It is estimated by Pacific Energy that PLES I would generate about $95,000 annually in Federal County of Origin Funds. In addition, property taxes are estimated at $300,000 annually based on current valuation methods. Services provided by the county would be financed from property taxes and federal funds.

Mitigation: No mitigation is recommended.

4.3.9.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.3.9.3 Smaller Power Plant Impacts

Impacts would be slightly less than the proposed project because of the smaller size. The labor force would be the same. Economic benefits to the federal government from royalty revenues; and to the local economy from property taxes, county of origin revenues, local employment, local spending and sales taxes would be proportionally less for the smaller power plant than for the proposed project.

4.3.9.4 No-Action Alternative Impacts

The region would forego economic benefits from PLES I.

4.3.9.5 Abandonment and Reclamation Impacts

Impact: The economic benefits to the region would cease after abandonment and reclamation were complete. There would be short-term benefits from employment during reclamation activities.

Mitigation: No mitigation is recommended.

4.3.9.6 Cumulative Impacts

Impact: County revenues from taxes and Federal County of Origin Funds would be about $725,000 per year (based on the 1987 tax levy in Mono County) for the four proposed and one existing geothermal projects. The Draft EIS for Sherwin Bowl indicates that it would be expected to generate up to $720,000 annually in fees to the county during its first five years of operation, depending on the alternative. Other projects with extensive construction components such as Doe Ridge and Snow Creek are likely to be comparable to Sherwin Bowl. As an order of magnitude estimate, the county could expect to receive over three million dollars in revenues from the proposed projects. PLES I would account about 10% of that amount.

Mitigation: No mitigation is recommended.

4.3.10 COMMUNITY SERVICES

4.3.10.1 Proposed Project Impacts

(a) Schools

Impact: The impact on school facilities is tied directly to increased school enrollment. School enrollment in turn will be dependent upon the demographic characteristics of the families of non-local labor force. To estimate enrollment impacts, the Mammoth School District uses a student generation factor of one student per 7.67 persons of permanent population (Martin M., 1987). With an average household size of 2.33 persons and assuming only one geothermal worker per household, the generation factor is approximately 0.304 students per permanent employee. This is very close to the actual 0.313 students per permanent employee experienced with the MP I geothermal plant (Asper, W.E., 1987).

Using a slightly more liberal factor of 0.33 students per permanent employee, Table 4-5 presents possible enrollment increase for the average construction workforce and permanent employees. It is assumed that non-local workers hired for short term peak period employment would not relocate their families. Because the elementary school is already overcrowded, any increase in the elementary school age population would increase the current overcrowding at the elementary levels (Martin, M., 1987). The increased enrollment associated with construction and permanent employment will not occur simultaneously.

The addition of project-related students could increase overall enrollment to the point where the formation of an additional class would be desired. This would be most likely to occur during the construction phase under the maximum non-local employment scenario. Impacts may also be reduced through increased use of the local labor force as discussed in Section 4.3.8.1 (Employment, Population and Housing).

Mitigation: No mitigation is recommended.

TABLE 4-5: INCREASED SCHOOL ENROLLMENT

Non-Local Employment	Construction	Permanent
Maximum	16	5
Mid-range	9	3
Minimum	5	2

SOURCE: Environmental Science Associates, Inc., 1987.

(b) Police

Impacts: The Mono County Sheriff's Department expects that the attendant increase in the residential population during construction or operation of the geothermal plants would have only a minor impact on the current work load and not require additional law enforcement officers. Vandalism at the site is a potential problem that can be expected both during the construction phase and when the plants are in operation (Padilla, T., 1987). Such criminal activities do not require major investigative efforts by the Sheriff's Department. There may be some increased costs due to housing and transporting of prisoners. There have been no incidents of vandalism reported at the MP I power plant.

Mitigation: No mitigation is recommended.

(c) Medical Facilities

Impact: During the construction phase, construction accidents can be expected. Medical facilities are expected to be operating below capacity if the construction phase does not coincide with the winter ski season. Local hospital staff and facilities regularly handle accident victims with severe injuries and should not be significantly impacted by handling construction accident victims. The health care services of Mono County are not expected to be significantly impacted either during the construction period or by the increase in permanent population under the maximum population increase scenario. Health officials are concerned with the possibility of severe burns and scalding in the event of a geothermal accident. Local facilities are not equipped to handle such cases which would have to evacuated (Jacobsen, T., 1987).

Mitigation:

(14) Revise the county and Inyo National Forest emergency response plans to incorporate emergencies which might arise from geothermal exploration and development activities.

(15) Train on-site personnel in first-aid and Cardio-Pulmonary Resuscitation (CPR).

(16) Develop and maintain communication and evacuation procedures for potential severe burn accidents.

Effectiveness/Impact: Responsible parties would be better prepared to deal with an emergency at the power plant.

(d) Fire Protection

Impact: The construction and operational phases present different concerns. The major concern during the construction phase is the potential for forest or brush fires, especially during the end of the dry summer season. During the operational phase, flammable working fluid would be stored on-site and the possibility of an accident or an equipment failure and the release of the working fluid to the atmosphere is the major concern. In such an event the working fluid could form a cloud at ground level which might be ignited. In both cases the spreading of a fire during the seven- to fifteen-minute response/access time is a serious problem.

Were the fire to spread beyond the immediate area, safety concerns would focus on three areas: (1) traffic on the adjacent U.S. Highway 395; (2) the three 10,000 gallon gasoline storage tanks owned by Chevron, located one-quarter mile east of State Route 203 and one-eight mile north of U.S. Highway 395; and (3) the 100,000 to 150,000 gallons of propane stored in six tanks owned by Cal-Gas, Petro-Lane and Turner, located about one mile from the site (Malby, B., 1987).

A fire prevention and protection plan has been approved by the Long Valley Fire Protection District. The review procedure will allow local fire prevention units to become familiar with the resources and dangers on the site, and would provide the opportunity for the fire units to request additional details which would help them to deal with possible emergencies at the facility, and to suggest any additional mitigations they may feel are appropriate in light of more detailed knowledge.

Mitigation: No mitigation is recommended.

(e) Street and Road Maintenance

Impact: Heavy loads would be transported over county and Forest Service roads during the nine-month construction period. This may result in the need for additional repair and increased maintenance. Impacted most heavily will be the Hot Springs Road (Mono County Road No. 346A) which provides immediate access to the PLES I site. The volume of traffic generated by the operational work force is not expected to significantly increase the local traffic level of the roadway.

Mitigation:

(17) Transfer the cost of repairing damage to county and Forest Service roads, caused by project activities, to the project proponent. This could be done by posting of performance bonds. Alternatively, a user fee based on weight of vehicle and frequency of use could be imposed.

Effectiveness/Impact: The costs of road repair attributable to the project would not be borne by the county or Forest Service.

Impact: Because air-cooled condensers would be employed instead of wet cooling towers, the potential problems of road icing, induced fog clouds, and the resultant cooling tower blowdown fluids would not present a problem during normal power plant operations. A slight potential for road icing and induced fog clouds exists during well flow testing. Should a vapor cloud be generated during flow testing which could cause icing of roads or reduced visibility on roads, flow testing would be limited by an authorized officer until weather conditions improve. If this procedure is followed, no road icing or induced fog clouds would occur.

Mitigation: No mitigation is recommended.

(f) Wastewater

Impact: Temporary water and sanitary facilities would be provided during construction operations. The expected water requirement for the facility, based on an estimated operational manpower requirement of sixteen people, would be 300 gallons per day. The users would also generate sanitary wastes. There would be no consumptive water use for power plant cooling as air cooling would be used during the operational phase.

Mitigation: No mitigation is recommended.

(g) Solid Waste

Impact: Solid wastes would be generated during drilling of the geothermal walls and construction operations. Waste from both activities are expected to be nonhazardous. Construction wastes composes of inert solids (Group 3 wastes) and organic solids (Group 2 wastes) may be collected and transported to the Class I landfill at Benton Crossing with no adverse effects. The increase in residential wastes associated with the increase in residential population is not expected to significantly affect the lifespan of the Benton Crossing landfill.

Mitigation: No mitigation is recommended.

(h) Utilities

Utilities will be contracted for on a private basis with short extension from the MP I plant. During normal power plant operations, parasitic electric power requirements would be satisfied by electric power generated on-site. During start-up, electric power would be purchased from SCE. No community services would be required.

4.3.10.2 Alternative Site Impacts

Impacts to community services would be the same as for the proposed project.

4.3.10.3 Small Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.10.4 No Action-Alternative Impacts

No demands due to PLES I would result.

4.3.10.5 Abandonment and Reclamation Impacts

Use of community services would cease after abandonment and reclamation were complete.

4.3.10.6 Cumulative Impacts

(a) Schools

Impact: In the worst-case, a total of 14 permanent new students would be added due to employment at the four proposed geothermal plants. The Draft EIS for Sherwin Bowl indicates it would add no more than seven new students. Environmental documents for Snow Creek and Juniper Ridge, both with condominium units, and Doe Ridge are not available. Even if Snow Creek, Juniper Ridge, and Doe Ridge each result in no more students than Sherwin Bowl, they would account for an additional 21 students. Of the estimated total 42 students, PLES I would account for about 10%.

Mitigation: No mitigation is recommended.

(b) Police

Impact: Impacts cumulatively would be mainly a function of the total population increase. The cumulative effects of all four proposed geothermal power plants is unlikely to place a burden on law enforcement services. The large number of visitors attracted by additional ski facilities would be more likely to require the addition of police officers, so that the contribution of PLES I to the cumulative burden placed on the police department would be minor.

Mitigation: No mitigation is recommended.

(c) Medical Facilities

Impact: Impacts to health care facilities would be a function of the total population increase and probably would not be severe. A total of five geothermal plants, each storing approximately 20,000 gallons of flammable hydrocarbon working fluid and using pressurized geothermal fluids would increase the chance of a severe buring or scalding event.

Mitigation: See mitigations (14), (15), and (16) in Section 4.3.10.1

(d) Fire Protection

Impact: The major fire danger during construction is the potential for brush or forest forest. This would apply equally to all the cumulative projects, roughly in proportion to the area being cleared and its proximity to fuel sources. The PLES I project represents less than 2% of the area being cleared.

Construction is over the assorted projects present very different concerns. About 100,000 gallons of flammable isobutane or other hydrocarbon working fluid would be stored at the five power plants, with 80,000 gallons near Casa Diablo. A fire prevention and protection plan for the project has been approved by the Long Valley Fire Department.

Mitigation: No mitigation is recommended.

(e) Street and Road Maintenance

Impact: Heavy loads would be transported over county and Forest Service roads. This could result in the need for additional repair and road maintenance. The roads used during PLES I construction would also be used while MP III are under construction, so PLES I would account for about one-third of the excess wear on the affected roads, mainly Hot Springs Road.

Mitigation: See mitigation (17) in Section 4.3.10.1.

(f) Wastewater

Impact: The Town of Mammoth Lakes General Plan has identified the need for additional wastewater treatment capacity.

Almost all of that demand would come from additional residents and visitors to the area. The PLES I project would make a minor contribution to the general demand due to the population growth and no direct contribution since wastewater produced at the facility would be disposed of in an on-site septic system.

Mitigation: Suggestions for mitigation of these cumulative impacts are beyond the scope of this EIS/EIR Addendum.

(g) Solid Waste

Impact: Solid waste generation from the cumulative projects would be very large in comparison to the waste generated because of PLES I. The Draft EIS on Sherwin Bowl states that it is expected to generate from 4% to 14% of the amount of solid waste currently produced in the Town of Mammoth Lakes.

Mitigation: No mitigation is recommended.

(h) Utilities

Impact: Cumulative demand for utilities is not likely to cause any impacts to electrical or telephone service.

Mitigation: No mitigation is recommended.

4.3.11 HAZARDOUS MATERIALS

4.3.11.1 Proposed Project Impacts

Impact: During drilling operations, potentially hazardous materials would be stored at the well site. These may include diesel fuel for diesel powered drilling equipment, some drilling mud additives, and miscellaneous paints or solvents. Spills from containers or from drilling fluids during drilling activities could result in surface contamination.

Mitigation:

(18) Employ the following measures:

- Keep hazardous liquid materials used during drilling operations in sealed containers designed for containment of the hazardous material.
- Keep hazardous dry materials protected from precipitation and unopened within their original manufacturer's packaging until used.
- Store all hazardous materials in an area of the well site surrounded by a berm to contain small spills and designed to drain spilled substances into the lined drilling mud pit.
- Remove unused hazardous materials from the well site immediately after drilling operations have been completed.
- Keep drilling fluids in either a tank(s) or a lined reserve pit during drilling operations.
- Sample and characterize waste drilling mud prior to on-site burial, or off-site disposal, to confirm the water is being disposed of consistent with the requirements of the California Regional Water Quality Control Board, Lahontan Basin Region.

Effectiveness/Impacts: These measures minimize the risk of having hazardous materials which would be used during drilling operations leave the well site and contaminate surface or subsurface water resources.

Impact: During power plant operations, approximately 20,000 gallons of hydrocarbon working fluid would be stored on-site. The working fluid is extremely flammable and a potential fire hazard would result from spills or system upsets. Hydrocarbon detection sensors and alarms are proposed which would warn of detectable concentrations of the hydrocarbon working fluid in excess of approximately one-third its minimum flammability limits. Miscellaneous paints or solvents would also be a source of potential surface contamination from spills.

The proposed project includes a fire and safety program which require:

- keeping potential ignition sources away from the hydrocarbon accumulator and storage tanks areas. Similarly, ignition sources should be kept away from the power plant site drainage courses and proposed catch basin.

- posting "No smoking" and "flammable liquid" signs in all areas except areas specifically designated as smoking areas.

- constructing all hydrocarbon storage and utilization facilities in conformance with applicable industry standards and in compliance with applicable fire and safety codes.

- preparing and reviewing emergency fire and spill continency plans with local fire fighting authorities (see Section 4.3.10.1(d), Fire Protection).

Mitigation:

(19) Sample and characterize soils which are contaminated from spills or leaks of hazardous materials. Remove any waste or contaminated soils characterized as hazardous to a disposal site acceptable to the BLM and approved by the Lahontan Regional Water Quality Control Board.

Effectiveness/Impact: The measures should substantially reduce the risk of fire or spill hazards associated with the storage of hydrocarbon working fluid and other hazardous materials on the power plant site. No further impact would be expected as a result of implementation of their measures.

4.3.11.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.3.11.3 Smaller Power Plant Impacts

Impacts would be the same as for the proposed project.

4.3.11.4 No-Action Alternative Impacts

No additional hazardous materials would be introduced at the project site.

4.3.11.5 Abandonment and Reclamation Impacts

Impact: Hazardous materials uses on the site would be removed as part of the abandonment procedures.

Mitigation:

- Require compliance with all applicable county, state, and federal regulations dealing with removal and disposal of the hazardous materials and wastes.

Effectiveness/Impact: Hazardous materials and wastes would be handled using approved procedures and would be transported and disposed of properly. No further environmental impacts would be expected from implementation of this measure.

4.3.11.6 Cumulative Impacts

Impact: Hydrocarbon working fluid stored at the existing MP I plant and the three currently proposed power plant units in the Casa Diablo area would result in the storage of approximately 80,000 gallons (20,000 gallons at each unit) of highly flammable hydrocarbon working fluid within the immediate vicinity.

Because of their close proximity, a major fire at any one of the power plant units could threaten each of the other power plant units.

Mitigation:

- Emergency spill and fire contingency plans should be prepared for each power plant unit which include emergency communications among the power plant unit operators.

Effectiveness/Impact: Early warning of a fire, or potential fire hazard, would provide power plant operators an opportunity to implement emergency action procedures to protect their respective power plant units. No further impact would be expected from implementation of this measure.

4.3.12 GEOTHERMAL RESOURCE LEASE

4.3.12.1 Proposed Project Impacts

Impact: The proposed project would result in the development and beneficial use of the geothermal resources within the federal geothermal lease as proposed by Pacific Energy.

Mitigation: No mitigation is recommended.

4.3.12.2 Alternative Location Impacts

Impacts would be the same as for the proposed project.

4.3.12.3 Smaller Power Plant Impacts

Impact: Reduction in net output from 10 MWe to 7 MWe would constitute a breach of the existing power purchase agreement between the applicant and SCE and could result in termination of the development proposal. In addition, the reduction in revenue from the electric output of the smaller power plant would reduce the availability of operating revenue to support operating expenses, including the mitigation measures incorporated into the project, and would reduce the economic viability of the project.

Mitigation:

- Approve the proposed project.

Effectiveness/Impact: The geothermal lease would be used beneficially. This document describes environmental impacts of such use.

4.3.12.4 No-Action Alternative Impacts

Impact: The no-action alternative would prohibit the project proponent from developing the federal geothermal lease under the currently proposed Plans of Operation and may limit any future development of the geothermal resource on the lease. The federal geothermal lease requires the lessees to develop the geothermal lease within 10 years of lease acquisition or forfeit the lease. Forfeiture of the lease as a result of no-action alternative decision could significantly constrain future geothermal leasing of federal lands in the Mono-Long Valley area and would forego possible increases in future revenue to the federal, state, or local governments from geothermal lease and royalty payments. In addition, prohibiting the lessees from developing the lease could result in a breach of contract between the lessee and the federal government.

Mitigation:

- Approve the proposed project.

Effectiveness/Impact: The geothermal lease would be used beneficially. This document describes environmental impacts of such use.

4.3.12.5 Abandonment and Reclamation

The lease would terminate upon completion of reclamation.

4.3.12.6 Cumulative Impacts

Impact: The combined geothermal production from the existing MP I power plant, the proposed MP II and III project, and the proposed PLES I project would substantially increase the beneficial use of the available geothermal resources in the Casa Diablo Hot Springs Area.

Mitigation: No mitigation is recommended.

4.4 GROWTH INDUCING IMPACTS

The proposed project would broaden the economic base of Mono County by providing an additional source of ad valorem tax revenue. Growth could also be stimulated from revenues which would come from property taxes, sales taxes and a portion of the federal geothermal lease revenue. In addition, income from local expenditures would be expected, particularly in the Town of Mammoth Lakes (see Section 4.3.9.1).

The project would also provide limited additional opportunities for stable, year-round, employment (see Section 4.3.8.1). Some growth inducing opportunity exists for direct use of the geothermal resource for non-power generating purposes, such as space heating, which could conceivably be developed in conjunction with the proposed project.

However, to date, there have not been any proposals to develop a geothermal cogeneration project in the area. County services could be increased as a result of increased revenue from geothermal development and, from that perspective, could make the area more attractive to potential residents; however, no additional residential development is likely to result from the project.

5.0 AGENCIES, ORGANIZATIONS, AND INDIVIDUALS CONSULTED

The following individuals, organizations, and agency representatives were contacted during this assessment. Where appropriate, specific communications are identified as a reference (see Section 7.0, References).

5.1 PUBLIC AGENCIES

5.1.1 FEDERAL AGENCIES

Bureau of Land Management, Bishop Resource Area Office:

Robert Beehler, Environmental Coordinator
Michael Ferguson, Acting Area Manager
Jim Morrison, Area Manager
Terry Russi, Wildlife Biologist
Mark Ziegenbein, Geologist

Bureau of Land Management, Bakersfield District Office:

Robert Rheiner, District Manager
H. Edward Lynch, Jr., Planning and Environmental Coordinator

Bureau of Land Management, California State Office

Richard Johnson, Deputy State Director - Division of Lands and Renewable Resources
Carl Rountree, Chief, Planning and Environmental Coordination
Sean Hagerty, Geologist, Branch of Fluid Minerals
Douglas Koza, Chief, Branch of Fluid Minerals

Inyo National Forest

Mark Clark, Hydrologist
Tina Hargis, Biologist
Heather Harvey, Planner
J. Lloyd, Developed Sites Foreman
Clinton McCarthy, Forest Wildlife Biologist
Vernon McLean, Geologist
Dennis Martin, Forest Supervisor
M. Morse, Recreation Officer
Linda Reynolds, Forest Archaeologist
E.B. Rickford, Forest Landscape Architect
Dan Totheroh, Forest Engineer
Bob Wood, Winter Sports Specialist

U.S. Fish and Wildlife Service:

Ed Lorentzen
R.H. Porter, Resource Office
Jack Williams

5.1.2 STATE OF CALIFORNIA AND REGIONAL AGENCIES

Air Resources Board

Norma Montey

Department of Fish and Game

Thomas Blankenship, Wildlife Biologist
James L. Eichmann, Manager Hot Creek Hatchery
Robert Holland, Natural Communities Biologist
Dennis McEwan
Philip Pister, Fisheries Biologist
Ronald Thomas, Wildlife Biologist

Department of Transportation

Jack Edell, Environmental Planner
James Racine, Environmental Planner

Division of Oil and Gas

R. Habel, Geologist

Regional Water Quality Control Board, Lahontan Basin Region

Jahill Cass, Water Resources Control Engineer
Curt Shifrer, Water Resources Control Engineer
Keith Turner, Water Resources Control Engineer

Great Basin Unified Air Pollution Control District

Larry Cameron
William Cox, Deputy Air Pollution Control Officer
Ellen Hardebeck, Air Pollution Control Officer

University of California at Davis

Dr. Burgess Kay, Botanist

University of California, Lawrence Berkeley Laboratory:

H. Wolenberg, Geochemist

5.1.3 COUNTY OF MONO (AND SPECIAL LOCAL DISTRICTS)

Scott Burns, Planning Director
Daniel Lyster Director, Office of Energy Management
Lee McColloch, Mono County Assessor's Office
Terry Padilla, Sergeant, Mono County Sheriff's Office

5.1.4 OTHER LOCAL AGENCIES

B. Tillman, Biologist, Los Angeles Department of Water and Power
Thomas Jacobsen, Administrator, Mammoth Lakes School District
Bruce Malby, President and Board of Directors, Long Valley Fire Protection District
Marilyn Martin, Secretary to the Superintendent, Mammoth School District
Brian Hawley, Planning Director, Town of Mammoth Lakes

5.2 PRIVATE ORGANIZATIONS

Ecological Research Services

C. Robert Feldmeth, Ph.D.

Environmental Management Associates, Inc.

Dwight L. Carey, D. Env.
Terry R. Thomas, D. Env.

Mammoth Pacific I Geothermal Plant

Wilbert J. Asper, Manager

Mesquite Group, Inc.

Donald A. Campbell, President
J.S. "Skip" Matlick, Geologist

Pacific Energy

Michael H. Clinton, Director and General Manager - Geothermal
Claude Harvey, Vice President
Donald L. Vinson, Director of Projects
Michael J. Walker, Manager of Geothermal Projects

Razon Associates

G. Milliken, Attorney at Law

Pacific Enterprises

Donald C. Liddell, Special Counsel

Pacific Gas and Electric Company

Ken Divittorio, Department of Engineering Research

Santa Fe Minerals, Inc.

R.W. Potter, Geochemist

5.3 OTHER INDIVIDUALS

Timothy Alpers
Thomas M. Jenkins, Ph.D. - June Lake
Thomas E. Kucera, Doctoral Candidate, U.C. Berkeley - Bishop

5.4 CHRONOLOGY OF PUBLIC INVOLVEMENT

September 3, 1986	Plan of Operation for PLES I project was submitted to Bishop Resource Area (RA).
October 21, 1986	Bishop RA conducted a public site inspection.
November 15, 1986	Comment period on PLES I plan closed.
November 25, 1986	Proposal was issued to contract for preparation of joint EA/EIR.
August 19, 1987	Joint Draft EA/EIR was distributed for public review and comment.
September 15, 1987	Public hearing on Draft EIR was held in Mammoth Lakes.
October 9, 1987	Comment period on PLES I Draft EA/EIR closed.
October 14, 1987	Sierra Club submitted a protest to BLM California State Office (CSO).
February 10, 1988	U.S. Fish and Wildlife Service, after a Section 7 Consultation regarding the Owens tui chub, issued a "No Jeopardy Opinion."
February 11, 1988	Bishop RA and Inyo N.F. approved the PLES I project.
February 26, 1988	CSO dismissed Sierra Club protest.
March 9, 1988	California Department of Fish and Game (Fish and Game) appealed the decision of the Bishop RA.
March 9, 1988	Bishop RA approved the PLES I Plan for Baseline Data Collection.
March 11, 1988	Sierra Club et al. also appealed BLM decision.
March 31, 1988	BLM (CSO) requested an expedited Interior Board of Land Appeals review.

April 8, 1988	Fish and Game appealed the BLM approval of the PLES I Plan for Baseline Data Collection.
May 2, 1988	BLM and Fish and Game met in Sacramento to discuss Fish and Game concerns.
May 12, 1988	Sierra Club et al. and Fish and Game filed their Statement of Reasons with BLM.
May 23, 1988	BLM and Fish and Game met in Bishop to discussed the specific concerns identified by Fish and Game.
May 24, 1988	Final EIR was certified.
May 31, 1988	BLM staff from CSO and solicitor met to evaluate Fish and Game and Sierra Club Statement of Reasons. The decision to require an EIS was made.
June 23, 1988	BLM sends out public notice of the July 8, 1988 public scoping meeting and site visit to identify specific issues and concerns for analysis in the PLES I EIS.
July 8, 1988	BLM conducts public scoping meeting and site visit of the PLES I project area.
August 30, 1988	Memorandum of Understanding between BLM and Great Basin Unified Air Pollution Control District to prepare a joint EIS/SEIR
Sept. 9, 1988	Public notice in Federal Register of the availability of the PLES I Draft EIS No. 880294.
Oct. 21, 1988	The Great Basin Unified Air Pollution Control District conducts a Public Hearing on the Supplemental EIR for the PLES I project.

6.0 REPORT CONTRIBUTORS

This Environmental Impact Statement was undertaken by several organizations and prepared and coordinated through Environmental Science Associates, Inc. (ESA) of San Francisco, California. The organizations and persons principally responsible for the analysis of the respective resource sections of the Joint Environmental Assessment, prepared and coordinated in 1987 for the project by the Environmental Management Associates, Inc. (EMA) of Brea, California, and Draft Environmental Impact Report are listed below.

The original document has been substantially revised by ESA to contain newly gathered information and to respond to concerns raised during review.

Organization	Individual	Section
U.S. Bureau of Land Management, Bishop Area Office (BLM)	Mark Ziegenbein	Purpose and Need for Action
U.S. Forest Service, Inyo National Forest (USFS)	Vernon McLean	Timber and Range
Berkeley Group, Inc. (BGI)	Peter Pyle	Hydrology, Appendix C
Environmental Science Associates, Inc. (ESA)	Sandra Guldman	Introduction, Summary, and Soils
	Kristian Macoskey	Noise
	Gregg Miller	Terrestrial Biology
	Noriko Kawamoto	Aquatic Biology
	Glen Elder	Socioeconomics and Public Service
	Vanessa Hawkins	Recreation, Land Use and Planning
	Bruce Campbell	Visual
Environmental Management Associates, Inc. (EMA)	Terry Thomas	Air Quality, Geology, Hazardous Materials

7.0 REFERENCES CITED

Asper, Wilbert, General Manager - Mammoth-Pacific I Geothermal Plant. 1987. Internal Memorandum to Ben Holt (April 10, 1987).

Asper, Wilbert, General Manager - Mammoth-Pacific I Geothermal Plant. 1987a. Telephone Conversation - January 30, 1987.

Asper, Wilbert, General Manager - Mammoth-Pacific I Geothermal Plant. 1987b. Telephone Conversation - January 29, 1987.

Asper, Wilbert, General Manager - Mammoth-Pacific I Geothermal Plant. 1988. Memo to Ben Holt - February 8, 1988.

Bean, L. and S. Vane. 1987. Cultural Resources Surveying, California Low-Level Radioactive Waste Disposal Project. Prepared for U.S. Ecology.

Bolt, Beranek, and Newman. 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. U.S. Environmental Protection Agency.

Boone, Chris - Hot Creek Hatchery. 1988. Telephone Conversation - August 5, 1988.

Bureau of Land Management. 1986a. Pacific Lighting Energy Systems Casa Diablo/Santa Fe Project. Environmental Assessment Serial Number Ca-017-P006-37 (EA Roster No. CA-017-86-53). Bishop, California.

Bureau of Land Management. 1986b. Mammoth-Pacific, Magma Project Environmental Assessment. Environmental Assessment Serial Number Ca-017-P006-41 (EA Roster No. CA-017-86-63). Bishop, California.

California Department of Water Resources. 1967. Investigation of Geothermal Waters in the Long Valley Area Mono County. Sacramento, California.

California Department of Water Resources. 1973. Mammoth Basin Water Resources Environmental Study (final report). Sacramento, California.

California Division of Mines and Geology. 1982. Alquist-Priolo Special Studies Zone Map, Old Mammoth Quadrangle.

California State Air Resources Board. Aerometric Data Division. 1986. California Air Quality Data: Summaries of Air Quality Data (1981-1985). Volumes XIII - XVII.

California State Board of Equalization. 1982-1986. Taxable Sales in California. First Quarter 1982-Second Quarter 1986. Sacramento, California.

California State Department of Finance Population Research Unit. 1987. State and County Population Estimates to July 1, 1986 (Provisional). Report 86E-2. January 1987. Sacramento, California.

California State Employment Development Department. 1983-1986. California Labor Market Bulletin. January 1983-October 1986. Sacramento, California.

Clark, M. - Hydrologist, U.S. Geological Survey. Meeting with V. McLean - August 16, 1988.

Cox, William G. - Deputy Air Pollution Control Officer, Great Basin Unified Air Pollution Control District. 1987a. Telephone Conversation - July 30, 1987.

Cuniff, Patrick, F. 1977. Environmental Noise Pollution. John Wiley and Sons. New York.

Earth Metrics, Inc. 1984. Mammoth Lakes Housing Study Needs. Burlingame, California.

Eichmann, James, Manager - Hot Creek Hatchery. 1987a. Telephone Conversation - January 27, 1987.

Eichmann, James, Manager - Hot Creek Hatchery. 1987b. Telephone Conversation - April 1, 1987.

Eichmann, James, Manager - Hot Creek Hatchery. 1987c. Telephone Conversation - April 27, 1987.

Farrar, C. D., M. L. Sorey, S. A. Rojstaczer, C. J. Janik, R. H. Mariner, T. L. Winnett, and M. D. Clark. 1985. Hydrologic and Geochemical Monitoring in Long Valley Caldera, Mono County, California. 1982-1984. U.S. Geological Survey Water Resources Investigations Report 85-4183.

Farrar, C. D., M. L. Sorey, S. A. Rojstaczer, C. J. Janik, R. H. Mariner, T. L. Winnett, and M. D. Clark. 1986. Hydrologic and Geochemical Monitoring in Long Valley Caldera, Mono County, California. U.S. Geological Survey Open File Report 86-xxxx. Not yet approved for publication.

Fish and Game. 1988. IBLA #88-303, Statement of Reasons Pursuant to Notice of Appeal Dated March 9, 1988, Before the Department of the Interior Office of Hearing and Appeals, Board of Land Appeals.

Forest Service. 1988. Environmental Impact Statement. Forest Land and Resource Management Plan. Inyo National Forest. Bishop, California.

Forest Service. 1986. Environmental Assessment. Leasing of National Forest Lands for Geothermal Explorations in the Long Valley Caldera. Bishop, California.

Forest Service. 1974. National Forest Landscape Management. Two Volumes.

GeothermEx, Inc. 1986. Evaluation of the Geothermal Energy Potential in the Casa Diablo Area of Long Valley, California. Richmond, California.

Great Basin Unified Air Pollution Control District. 1988. Mono-Long Valley Air Quality Baseline Data Grant, January 1988.

Habel, Robert, Geologist - Division of Oil and Gas. 1988. Telephone Conversation - August 18, 1988.

Hall, M. C. 1986. Draft Report on Archaeological Investigations at Site PLES-1 (FS-04-52-870) and a Cultural Resources Survey of Adjacent Properties near Casa Diablo Hot Springs, Mono County, California. Prepared for Carey and Thomas of Brea, California, by Far Western Anthropological Research Group, Inc. Davis, California.

Hardebeck, Ellen - Air Pollution Control Officer, Great Basin Unified Air Pollution Control District. 1987. Telephone Conversation - April 10, 1987.

Hart, E. W. 1980. Fault-Rupture Hazard Zones in California. Special Publ. 42. California Division of Mines and Geology. Sacramento, California.

Hawley, Brian, Planning Director - Town of Mammoth Lakes. 1987. Telephone Conversation - January 30, 1987.

Hershler, Robert. 1987. Draft Report, Status Survey of Hydrobiidae in Owens River Drainage..

Hill, D. P., Roy A. Bailey, and Alan S. Ryall. 1985a. Active Tectonic and Magmatic Processes Beneath Long Valley Caldera, Eastern California: An Overview. Journal of Geophysical Research, 90 (B13): 11, 111-11, 120. November 10, 1985.

Hill, D. P., R. E. Wallace, and R. S. Cockerham, 1985b. Review of Evidence on the Potential for Major Earthquakes and Volcanism in the Long Valley- Mono Craters - White Mountains Region of Eastern California. Earthquake Prediction Research 3: 571-594.

Holland, R. R. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Game. Sacramento, California.

Holland, Robert - Natural Communities Biologist, California Department of Fish and Game. 1988. Telephone Conversation - August 9, 1988.

Honour, Water W. 1979. Honour's Energy and Environmental Handbook. Technomic Publishing Company, Inc. Westport, Connecticut.

International Conference of Building Officials. 1985. Uniform Building Code. Whittier, California.

Jacobsen, Thomas, Administrator - Mammoth Lakes Hospital District. 1987. Telephone Conversation - January 26, 1987.

Kucera, Thomas, E. - Wildlife Biologist. 1987a. Meeting - January 12, 1987.

Kucera, T. E. 1987b. Casa Diablo Geothermal Development Project: Deer Migration Study, Spring 1987. Prepared for Environmental Management Associates, Inc., Brea, California.

Kucera, T. E. 1987 Casa Diablo Geothermal Development Project: Deer Study Final Report, 1987. Prepared for Pacific Energy.

Lawrence Berkeley Laboratory. 1984. Proceedings of the Workshop on Hydrologic and Geochemical Monitoring in the Long Valley Caldera, (LBL-20020).

Lloyd, J., Developed Sites Foreman - Forest Service. 1987. Telephone Conversation - January 27, 1987.

Lucas, G. - Chief, Long Valley Fire Protection District. 1988. Letter - May 27, 1988.

Lyster, Daniel, Director - Energy Management Department, County of Mono. 1987a. Telephone Conversation - January 20, 1987.

Malby, Bruce, President - Board of Directors, Long Valley Fire Protection District. 1987. Telephone Conversation - February 3, 1987.

Mammoth Lakes, Town of. 1987. General Plan, October 1987.

Mariner, R. H., and L. M. Willey. 1976. Geochemistry of Thermal Waters In Long Valley, Mono County, California. Journal of Geophysical Research, v. 81, pp. 792-800.

Martin, Marilyn, Secretary to the Superintendent - Mammoth School District. 1987. Telephone Conversation - January 26, 1987.

McAlister, D. 1988. Personal Communication with V. McLean - August 18, 1988.

McCarthy, C. and C. Hargis. 1984. Analyzing Wildlife Habitats at the Project Level: An Evaluation Method. The Wildlife Society, Cal-Neva Wildlife Transactions.

McColloch, Lee, Assessor - Mono County. 1986. Telephone Conversation - January 27, 1987.

Mesquite Group, Inc. 1986. Final Report on Well SF 35-32, Casa Diablo Geothermal Field Exploration. Prepared for Pacific Lighting Energy Systems. Commerce, California.

Mesquite Group, Inc. 1988. Review and Evaluation of Subsidence in the Casa Diablo Area, Long Valley Caldera, Mono County, California. Prepared for Pacific Energy

Millikan, G., Attorney - Razon Associates. 1987. Telephone Conversation - January 27, 1987.

Mono County. 1986. Final Budget 1986-1987. Bridgeport, California.

Mono County Planning Department. 1981. Noise Element of the General Plan. Bridgeport, California.

Morse, M., Recreation Officer - Forest Service. 1987. Telephone Conversation - January 27, 1987.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California.

Neilson, Terry - Mount Lassen Trout Farm. 1988. Telephone Conversation - August 5, 1988.

Pacific Energy. 1988. Letter to Great Basin Unified Air Pollution Control District - July 28, 1988.

Pacific Gas and Electricity. 1986. The Distribution and Abundance of Wildlife Populations in Relation to Geothermal Development: Final Report. PG&E, San Ramon, California.

Pacific Energy Lighting Systems. 1986. Plans of Operation, Development, Injection, and Utilization, PLES I-10 MW (net) Binary Power Plant Projects. Commerce, California.

Pacific Energy Lighting Systems. 1987. Plan for Baseline Data Collection PLES I - 10MWe (net) Binary Power Plant Project.

Padilla, Terry, Sergeant - Mono County Sheriff's Office. 1987. Telephone Conversation - January 26, 1987.

Papadopulous, S.S. & Associates, Inc. 1988. Evaluation of Impacts of Geothermal Development within Long Valley, May 1988.

Porter, R., Resource Officer - Forest Service. 1987. Telephone Conversation - January 28, 1987.

Reynolds, Linda, Forest Archaeologist - Inyo National Forest. 1987. Telephone Conversation - March 9, 1987.

Rickford, E.B. Forest Landscape Architect - Inyo National Forest. 1987. Telephone Conversation - March 27, 1987.

Savage, Dr. J.S. - U.S. Geological Survey. 1987. Long Valley Caldera Monitoring Report, July-September 1987.

Setmire J.G. 1984. Water-Quality Appraisal of Mammoth Creek and Hot Creek, Mono County, California. U.S. Geological Survey Water Resources Investigation Report, 84-4060.

Shevenel, L., C.O. Grigsby, F. Gogg, N.O. Jannik, and F. Phillips. 1986. Mixing and Boiling of the Thermal Fluids in Long Valley Caldera, California. In press.

Sorey, M.L. 1987. U.S. Geological Survey. Telephone Conversation - February 1987.

Sorey, M.L. 1987a. U.S. Geological Survey. Telephone Conversation - June 4, 1987.

Sorey, M.L. 1976. Potential Effects of Geothermal Development on Springs at the Hot Creek Fish Hatchery in Long Valley, Mono County, California. U.S. Geological Survey Open File Report 75-637.

Sorey, M.L. and M.D. Clark. 1981. Changes in the Discharge Characteristics of Thermal Springs and Fumaroles in the Long Valley Caldera, California Resulting from Earthquakes on May 25-27, 1980. U.S. Geological Survey Open File Report 81-203.

Sunset New Western Garden Handbook. 1979. Lane Publishing Company. Menlo Park, California.

Taylor, D.W. and R. Buckberg. 1986. Biotic Assessment for Proposed Geothermal Energy Facilities, Casa Diablo Hot Springs, Mono County, California. BioSystems Analysis, Inc., Santa Cruz, California.

Taylor, D.W. and G.L. Clifton. 1988. Casa Diablo Geothermal Biological Studies, July 1988. BioSystems Analysis, Inc., Santa Cruz, California.

Taylor, T.J. 1988. Casa Diablo Deer Study: Migration and Seasonal Habitats of the Casa Diablo Deer Herd, March 1988.

Tesche, T.W. 1985. Final Report: Air Pollution Climatology and Dispersion Meteorology in the Mammoth Lakes-Long Valley Caldera Area. SYSAPP-84/129 Prepared by Systems Applications, Inc.

Thomas, R.D. 1986a. Management Plan for the Sherwin Grade Deer Herd. California Department of Fish and Game.

Thomas, R.D. 1986b. Casa Diablo Deer Herd Management Plan. California Department of Fish and Game.

Thomas, T., and R. Feldmeth. 1987. Biological Assessment of Proposed Geothermal Energy Development in Casa Diablo Hot Springs Area on the Owens Tui Chub (Gila bicolor snyderi) and Hot Creek Headsprings Refugia, August 1987.

U.S. Fish and Wildlife Service. 1986. Endangered and Threatened Wildlife and Plants. January 1, 1986. 50 CFR 17.11 and 17.12.

U.S. Geological Survey, Conservation Division. 1976. Geothermal Resources Operational Orders. Issued under the Goethermal Stream Act of 1970.

Warner, S. et al. 1986. Storage, Transport, and Spills of Hazardous Materials in the Russian River Basin. Regional Water Quality Control Board, North Coast Region, Santa Rosa, California.

WESTEC Services, Inc. 1986. Draft Environmental Impact Report - Mammoth/Chance Geothermal Development Project. Two volumes. Project No. 36037001. San Diego, California.

WESTEC Services, Inc. 1987. Revised Mammoth Chance I EA/EIR.

Williamson, S.J. 1973. Fundamentals of Air Pollution. Addison-Wesley, Pub. Rading, Massachusetts.

Wong, D., Fisheries Biologist, California Department of Fish and Game. 1988. Telephone Conversation - January 28, 1988.

8.0 GLOSSARY AND ACRONYMS

AUM - Animal Unit Month - the amount of range land which will support one animal for one month.

Aquifer - a geologic formation, group of formations or part of a formation, capable of yielding a significant amount of ground water to wells or springs (California Code of Regulations, Title 22, Section 66011.1).

BLM - Bureau of Land Management

Bioassay - a test in which aquatic organisms are used to detect or measure the presence or effect of one or more substances, wastes, or environmental factors, alone or in combination, on aquatic organisms.

Binary process cycle - cycle in which a secondary working fluid, such as isobutane (rather than the use of steam directly from the ground), is vaporized and used to power a turbine generator to convert geothermal energy into electricity.

Bishop tuff - consolidated pyroclastic flow and ash fall several thousand feet in thickness within the Long Valley region that resulted from the catastrophic eruption of a massive caldera-forming event approximately 700,000 years ago.

BACT - Best Available Control Technology

Brine - subsurface water with a high content of dissolved salts.

CEQA - California Environmental Quality Act

CFR - Code of Federal Regulations

CPUC - California Public Utilities Commission

Critical habitat - any or all habitat element(s), the loss of which, would appreciably decrease the likelihood of the survival and recovery of an officially listed species. It may represent any portion of the present habitat of an officially listed species and may include additional areas for population expansion. The official determination of critical habitat is the responsibility of the U.S. Fish and Wildlife Service and takes appropriate Federal Register notification and action.

DCM - District Cultural Manager

EIS - Environmental Impact Statement

Endangered species - an animal or plant species which is in danger of extinction throughout all or a significant portion of its range (as defined in The Endangered Species Act Amendments of 1982). This is the definition use by the U.S. Fish and Wildlife Service. The State of California and the California Native Plant Society define the term slightly differently.

Enthalpy - heat content.

Environmental Assessment (EA) - a concise public document for which a Federal Agency is responsible. An EA serves (1) to briefly provide enough evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a finding of no significant impacts; (2) to aid an agency's compliance with the National Environmental Policy Act when no EIS is needed; and (3) to facilitate preparation of an EIS when one is needed.

Environmental Impact Statement (EIS) - an analytical document that portrays potential impacts on the human environment of a particular course of action and its possible alternatives written in compliance with the Natural Environmental Policy Act. An EIS is developed for use by decision makers to weigh the environmental consequences of a potential decision.

EPA - Environmental Protection Agency

Federal leases - leases administered by the BLM for development of geothermal and other energy resources.

Fumarole - a vent, ususally volcanic, from which gases and vapors are emitted; it is characteristic of a late stage of volcanic activity.

Geothermal - pertaining to the heat of the interior of the Earth.

Geothermal fluids - steam or hot water from the Earth's interior.

Geothermal resources operational orders (GRO Orders) - regulations issued under the Geothermal Steam Act of 1970 enforced by the BLM for geothermal exploration, well drilling, operation, plugging and abandonment, and environmental protection for projects on land under federal jurisdiction.

Groundwater - water below the land surface in a zone of saturation (California Code of Regulations, Title 22, Section 66079).

Hazardous material - a substance or combination of substances which, because of its quantity, concentration, or physical, chemical or infectious characteristics may either:

(1) Cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness: or

(2) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported or disposed of or otherwise managed. Unless expressly provided otherwise, the term "hazardous material" shall be understood also to include extremely hazardous material (CAC, Title 22, Section 66084).

Hydrocarbon - any organic compound, gaseous, liquid, or solid, consisiting solely of carbon and hydrogen.

Hydrogen sulfide (H_2S) - flammable, poisonous gas with charactaristic odor of rotten eggs. Ignition temperature 260°C.

Hydrologic models - a physical or mathematical representation of a hydrologic system. Ordinarily, and accurate model describes how the system acts and how it would repsond to changes.

Hydrologic monitoring - the measurement of a variety of parameters of both ground and surface waters (including temperature, pressure, flow rates, chemistry, etc.) as appropriate.

Injection reservoir - aquifer into which geothermal fluids are injected after some heat has been extracted.

Injection well - a recharge well or input well for storage or disposal of the injected fluid.

Isobutane - (2-Methylpropane), a flammable gas.

KGRA - Known Geothermal Resource Area

kV - Kilavolt - one thousand volts

LVHAC - Long Valley Hydrologic Advisory Committee

MP - Mammoth Pacific

MWe - Megawatt (one million Watts)

Mitigation - the lessening of an adverse effect by avoiding or applying appropriate protection measures (e.g., the recovery of cultural resource data, off-site compensation for diminished habitat, environmental reclamation).

Mitigation measures - methods or procedures undertaken for the purpose of avoiding or reducing potential impacts of an action.

National Environmental Policy Act (NEPA) of 1969 - a law enacted on January 1, 1970, that established a national policy to maintain conditions under which man and nature can exist in productive harmony and fulfill the social, economic and other requirements of present and future generations of Americans. It established the Council on Environmental Quality for coordinating environmental matters at the Federal level and to serve as advisor to the President on such matters. The law made all Federal actions and proposals which could have significant impact on the environment subject to review by Federal, State and local environmental authorities.

National Register of Historic Places (NRHP) - a list of districts, sites, buildings, structures and objects significant in American history, architecture, archaeology and culture maintained by the Secretary of the Interior. Expanded as authorized by Section 2(b) of the Historic Sites Act of 1935 and Section 101 of the National Historic Preservation Act.

NEPA - National Environmental Policy Act

Piezometer - a tube inserted in the ground used to measure the elevation of the groundwater level. It is sealed along its length, open to water flow at the bottom, and open to the atmosphere at the top.

PLES -Pacific Lighting Energy Systems, now known as Pacific Energy

Pounds per square inch gauge - pressure units measured on a gauge which reads zero at atmospheric pressure.

Production reservoir - aquifer which serves as a source of geothermal fluid.

PURPA - Public Utilities Regulatory Policy Act

Range (rangelands) - land dominated by vegetation than can be grazed or browsed and whose husbandry is provided routinely through grazing management instead of renovations or cultural treatment (Range Term Glossary Comittee, 1974).

Refugia - pockets or enclaves of suitable habitat remaining from a formerly much larger habitat.

Rhyolite - a fine-grained rock which is compositionally equivalent to granite.

SCE - Southern California Edison

Scenic quality - the degree of harmony, contrast, and variety within a landscape (used in visual resources management).

Seismicity - the likelihood of an area being subject to earthquakes.

Sensitive receptors - people, plants, or animals which would be sensitive to nearby noises or sources of air pollution.

Siltation - the deposition or accumulation of silt that is suspended throughout a body of standing water or in some considerable portion of it.

Sleepers - horizontal supports which lift a structure off the ground surface.

Subsidence - a sinking of the land surface following the removal of solid mineral matter or fluids (e.g., water or oil) from the subsurface.

Threatened species - an animal or plant species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (as defined in the Endangered Species Act Amendments of 1982). This is the definition use by the U.S. Fish and Wildlife Service. The State of California and the California Native Plant Society define the term slightly differently.

Upwelling/fracture flow - the rising of subsurface water toward the surface through fractures in the rocks.

Visual Resource Management (VRM) - the systematic means to identify visual values, establish objectives which provide the standards for managing those values, and evaluate the visual impacts of proposed projects to ensure that the objectives are met.

Visual resource - the visible physical features on a landscape (e.g. land, water, vegetation, structures, and other features).

VMS - Visual Management System

VQO - Visual Quality Objective

VRM - Visual Resource Management

Water quality - the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Watershed - a total area of land above a given point on a waterway that contributes runoff water to the flow at that point.

Well blowout - uncontrolled, release of fluid from a well.

Working fluid - the fluid used to drive the turbine of and electric generator. In a binary power plant, the working fluid is a hydrocarbon with a low boiling point, such as isobutane.

9.0 INDEX

10. PUBLIC REVIEW, COMMENTS AND RESPONSES

10.1 REVIEW PROCESS

This chapter summarizes the public and agency comments received on the Draft Environmental Impact Statement/Supplemental Environmental Impact Report (EIS/SEIR) prepared for the PLES I Geothermal Project and responses to those comments.

The Draft EIS/SEIR was available for review in September and October 1988. The document was distributed to interested parties on Great Basin Unified Air Pollution Control District (GBUAPCD) and Bureau of Land Management (BLM) lists. The State Clearinghouse also distributed copies to state agencies. The GBUAPCD held a public hearing on the Draft EIS/SEIR on October 21, 1988 in the Town of Mammoth Lakes.

Comments on the Draft EIS/SEIR were received in two forms: letters and oral statements made at the public hearing. Comment letters sent to the GBUAPCD were also sent to the BLM and are included in this Final EIS/SEIR. Statements made at the public hearing were transcribed by the GBUAPCD. Each submission was assigned a number code to assist in organization of this document. Each separate topic within a submission was assigned a separate number. Thus, if an agency or citizen made three different comments, they would be designated, for example, 2-1, 2-2, and 2-3. Table 10-1 is the Comment Index which lists the commenter, the comment code, the page where the response can be found, and the general topic covered by the comment.

Comments and responses are grouped in this document by subject matter and are arranged by topics corresponding to the Table of Contents in the Draft EIS/SEIR. All substantive comments are referred to by number only. The reader may review the entire comment in context by referring to Section 10.2.2 of this document. This was done to delete repetitive and nonsubstantive material and to avoid misinterpretation by paraphrasing or condensing comments. Each group of comments is then followed by a response.

As the subject matter of one topic may overlap that of other topics, the reader must occasionally refer to more than one group of Comments and Responses to review all information on a given subject. Where this occurs, cross references are provided.

These comments and responses, together with the Draft EIS/SEIR constitute the Final EIS/SEIR for the PLES I Geothermal Project.

10.2 COMMENTS

10.2.1 LIST OF PERSONS COMMENTING

1. Michael L. Sorey, U.S. Geological Survey. November 8, 1988.
2. Eugene V. Toffoli, Legal Advisor, California Department of Fish and Game, The Resources Agency. Letter to James Morrison, Area Manager, Bureau of Land Management. October 21, 1988.
3. Hamilton Hess, Geothermal Coordinator, Sierra Club. Letter to James Morrison, Area Manager, Bureau of Land Management. October 22, 1988.
4. Emilie Strauss, Private Citizen. Letter to Bureau of Land Management. October 23, 1988.
5. Dan Lyster, Director, Energy Management, County of Mono. Letter to James Morrison, Area Manager, Bureau of Land Management. October 5, 1988.
6. Frank Stewart, Toiyabe Chapter, Sierra Club. Letter to James Morrison, Area Manager, Bureau of Land Management. October 24, 1988.
7. Ellen Hardebeck, GBUAPCD. Draft EIS/SEIR public hearing comments. November 7, 1988.
8. Michael J. Walker, Manager of Operations - Geothermal, Pacific Energy. Letter to James Morrison, Area Manager, Bureau of Land Management. November 4, 1988.
9. David E. Clapp, Environmental Health Scientist, Department of Health and Human Services. Letter to James Morrison, Area Manager, Bureau of Land Management. October 21, 1988.
10. Gary Flynn, Mayor, Town of Mammoth Lakes Planning Department. Letter to James Morrison, Area Manager, Bureau of Land Management. October 6, 1988.
11. Andrew J. Zeilman, Chief, Transportation Planning Branch, California Department of Transportation. Letter to Bishop Resource Area. October 14, 1988.
12. David L. Harlow, Acting Field Supervisor, Endangered Species, U.S. Fish and Wildlife Service. Letter to James Morrison, Area Manager, Bureau of Land Management. October 21, 1988.
13. Christopher Farrar, Water Resources Division, U.S. Geological Survey. Letter to James Morrison, Area Manager, Bureau of Land Management. November 8, 1988.
14. Dan Lyster, Director, Energy Management, Mono County. Letter to James Morrison, Area Manager, Bureau of Land Management. November 23, 1988.

These letters include those received by the Great Basin Unified Air Pollution Control District.

10.2.2 WRITTEN COMMENTS AND HEARING SUMMARY

Table 10-1 is the Comment Index, which lists the commentor, the comment code, the page where the response can be found, and the general topic covered.

TABLE 10-1: COMMENT INDEX

Name/Agency	Comment Code	Page No.	Topic
Michael L. Sorey, U.S. Geological Survey	1-1	10-182	Water Quality and Hydrology
	1-2	10-182	Water Quality and Hydrology
	1-3	10-183	Water Quality and Hydrology
	1-4	10-183	Water Quality and Hydrology
	1-5	10-184	Water Quality and Hydrology
	1-6	10-184	Water Quality and Hydrology
	1-7	10-184	Water Quality and Hydrology
	1-8	10-185	Water Quality and Hydrology
Eugene V. Toffoli, California Department of Fish and Game	2-1	10-212	Aquatic Resources
	2-2	10-185	Water Quality and Hydrology
	2-3	10-170	General
	2-4	10-211	Aquatic Resources
	2-5	10-185	Water Quality and Hydrology
	2-6	10-202	Vegetation
	2-7	10-186	Water Quality and Hydrology
	2-8	10-186	Water Quality and Hydrology
	2-9	10-206	Terrestrial Wildlife
	2-10	10-175	Alternatives
	2-11	10-206	Terrestrial Wildlife
	2-12a	10-170	General
	2-12b	10-173	General
	2-13a	10-171	General
	2-13b	10-171	General
	2-14	10-187	Water Quality and Hydrology
	2-15	10-187	Water Quality and Hydrology
	2-16	10-187	Water Quality and Hydrology
	2-17	10-187	Water Quality and Hydrology
	2-18	10-187	Water Quality and Hydrology
	2-19	10-188	Water Quality and Hydrology
	2-20	10-187	Water Quality and Hydrology
	2-21	10-188	Water Quality and Hydrology
	2-22	10-189	Water Quality and Hydrology
	2-23	10-189	Water Quality and Hydrology
	2-24a	10-189	Water Quality and Hydrology
	2-24b	10-182	Water Quality and Hydrology
	2-24c	10-187	Water Quality and Hydrology

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Eugene V. Toffoli, California Fish and Game (Continued)	2-25	10-202	Vegetation
	2-26	10-211	Aquatic Resources
	2-27	10-218	Economics
	2-28	10-171	General
	2-29	10-171	General
	2-30	10-172	General
	2-31	10-172	General
	2-32	10-172	General
	2-33	10-172	General
	2-34	10-171	General
	2-35	10-209	Terrestrial Wildlife
	2-36a	10-202	Vegetation
	2-36b	10-210	Terrestrial Wildlife
	2-36c	10-173	General
	2-37	10-189	Water Quality and Hydrology
	2-38	10-208	Terrestrial Wildlife
	2-39	10-208	Terrestrial Wildlife
	2-40	10-212	Aquatic Resources
	2-41	10-180	Geology, Soils, and Erosion
	2-42	10-190	Water Quality and Hydrology
	2-43	10-181	Geology, Soils, and Erosion
	2-44	10-174	General
	2-45	10-179	Noise
	2-46	10-189	Water Quality and Hydrology
	2-47	10-212	Aquatic Resources
	2-48	10-191	Water Quality and Hydrology
	2-49	10-201	Vegetation
	2-50	10-191	Water Quality and Hydrology
	2-51	10-189	Water Quality and Hydrology
	2-52	10-187	Water Quality and Hydrology
	2-53	10-191	Water Quality and Hydrology
	2-54	10-191	Water Quality and Hydrology
	2-55	10-190	Water Quality and Hydrology
	2-56	10-192	Water Quality and Hydrology
	2-57	10-202	Vegetation
	2-58	10-172	General
	2-59	10-202	Vegetation
	2-60	10-202	Vegetation
	2-61	10-206	Terrestrial Wildlife
	2-62	10-206	Terrestrial Wildlife
	2-63a	10-179	Noise
	2-63b	10-170	General
	2-64	10-209	Terrestrial Wildlife
	2-65	10-209	Terrestrial Wildlife

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Eugene V. Toffoli, California Fish and Game (Continued)	2-66	10-206	Terrestrial Wildlife
	2-67	10-210	Terrestrial Wildlife
	2-68	10-201	Vegetation
	2-69	10-206	Terrestrial Wildlife
	2-70	10-206	Terrestrial Wildlife
	2-71	10-206	Terrestrial Wildlife
	2-72	10-209	Terrestrial Wildlife
	2-73	10-212	Aquatic Resources
	2-74	10-213	Recreational Resources
	2-75	10-213	Recreational Resources
	2-76a	10-171	General
	2-76b	10-172	General
	2-77	10-210	Terrestrial Wildlife
	2-78	10-202	Vegetation
	2-79	10-202	Vegetation
	2-80	10-202	Vegetation
	2-81	10-173	General
	2-82	10-208	Terrestrial Wildlife
	2-83	10-206	Terrestrial Wildlife
	2-84a	10-206	Terrestrial Wildlife
	2-84b	10-209	Terrestrial Wildlife
	2-85	10-206	Terrestrial Wildlife
	2-86a	10-206	Terrestrial Wildlife
	2-86b	10-208	Terrestrial Wildlife
	2-87	10-173	General
	2-88a	10-174	General
	2-88b	10-170	General
	2-89	10-186	Water Quality and Hydrology
	2-90	10-170	General
Hamilton Hess, Sierra Club	3-1	10-175	Alternatives
	3-2	10-180	Geology, Soils, and Erosion
	3-3	10-218	Land Use and Planning
	3-4	10-192	Water Quality and Hydrology
	3-5	10-172	General
	3-6	10-214	Visual Resources
	3-7	10-215	Visual Resources
	3-8	10-212	Aquatic Resources
	3-9	10-192	Water Quality and Hydrology
	3-10	10-193	Water Quality and Hydrology
	3-11	10-193	Water Quality and Hydrology
	3-12	10-201	Vegetation
	3-13	10-175	Alternatives
	3-14	10-201	Vegetation
	3-15	10-179	Noise
	3-16	10-208	Terrestrial Wildlife

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Hamilton Hess, Sierra Club (Continued)	3-17	10-178	Air Quality
	3-18	10-178	Air Quality
	3-19	10-178	Air Quality
	3-20	10-180	Geology, Soils, and Erosion
	3-21	10-181	Geology, Soils, and Erosion
	3-22	10-181	Geology, Soils, and Erosion
	3-23	10-181	Geology, Soils, and Erosion
	3-24	10-181	Geology, Soils, and Erosion
	3-25	10-193	Water Quality and Hydrology
	3-26	10-201	Vegetation
	3-27	10-194	Water Quality and Hydrology
	3-28	10-179	Noise
	3-29	10-180	Noise
	3-30	10-180	Noise
	3-31	10-180	Noise
	3-32	10-194	Water Quality and Hydrology
	3-33	10-191	Water Quality and Hydrology
	3-34	10-194	Water Quality and Hydrology
	3-35a	10-172	General
	3-35b	10-202	Vegetation
	3-36	10-202	Vegetation
	3-37	10-201	Vegetation
	3-38	10-206	Terrestrial Wildlife
	3-39	10-209	Terrestrial Wildlife
	3-40	10-195	Water Quality and Hydrology
	3-41	10-212	Aquatic Resources
	3-42	10-212	Aquatic Resources
	3-43	10-212	Recreational Resources
	3-44	10-179	Noise
	3-45	10-212	Aquatic Resources
	3-46	10-212	Aquatic Resources
	3-47	10-214	Recreational Resources
	3-48	10-217	Visual Resources
	3-49	10-217	Visual Resources
	3-50	10-215	Visual Resources
	3-51	10-214	Visual Resources
	3-52	10-217	Land Use and Planning
	3-53	10-219	Economics
	3-54	10-173	General
Emilie Strauss, Private Citizen	4-1	10-202	Vegetation
	4-2	10-211	Aquatic Resources

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Dan Lyster, Mono County	5-1	10-216	Visual Resources
	5-2	10-216	Visual Resources
	5-3	10-195	Water Quality and Hydrology
	5-4	10-195	Water Quality and Hydrology
Frank Stewart, Sierra Club	6-1a	10-175	General
	6-1b	10-170	Alternatives
	6-2	10-176	Alternatives
	6-3	10-176	Alternatives
	6-4	10-175	Alternatives
	6-5	10-171	General
	6-6	10-177	Alternatives
	6-7	10-176	Alternatives
	6-8	10-209	Terrestrial Wildlife
	6-9	10-195	Water Quality and Hydrology
	6-10	10-195	Water Quality and Hydrology
	6-11	10-176	Alternatives
	6-12	10-176	Alternatives
	6-13	10-176	Alternatives
	6-14	10-205	Vegetation
	6-15	10-201	Vegetation
	6-16	10-176	Alternatives
	6-17	10-173	General
	6-18	10-178	Air Quality
	6-19	10-172	General
	6-20	10-172	General
	6-21	10-172	General
	6-22	10-180	Geology, Soils, and Erosion
	6-23	10-180	Geology, Soils, and Erosion
	6-24	10-196	Water Quality and Hydrology
	6-25a	10-191	Water Quality and Hydrology
	6-25b	10-191	Water Quality and Hydrology
	6-26	10-212	Aquatic Resources
	6-27	10-212	Aquatic Resources
	6-28	10-193	Water Quality and Hydrology
	6-29	10-212	Aquatic Resources
	6-30	10-191	Water Quality and Hydrology
	6-31	10-196	Water Quality and Hydrology
	6-32	10-196	Water Quality and Hydrology
	6-33	10-196	Water Quality and Hydrology
	6-34a	10-196	Water Quality and Hydrology
	6-34b	10-182	Water Quality and Hydrology
	6-35	10-196	Water Quality and Hydrology
	6-36	10-196	Water Quality and Hydrology
	6-37	10-171	General
	6-38	10-206	Terrestrial Wildlife

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Frank Stewart, Sierra Club (Continued)	6-39a	10-172	General
	6-39b	10-173	General
	6-39c	10-177	Alternatives
	6-40	10-206	Terrestrial Wildlife
	6-41	10-209	Terrestrial Wildlife
	6-42	10-210	Terrestrial Wildlife
	6-43	10-210	Terrestrial Wildlife
	6-44	10-210	Terrestrial Wildlife
	6-45	10-212	Aquatic Resources
	6-46	10-197	Water Quality and Hydrology
	6-47	10-213	Cultural Resources
	6-48	10-213	Recreationl Resources
	6-49	10-212	Aquatic Resources
	6-50	10-213	Recreational Resources
	6-51	10-213	Recreational Resources
	6-52	10-215	Visual Resources
	6-53	10-215	Visual Resources
	6-54	10-173	General
	6-55	10-173	General
	6-56	10-173	General
	6-57	10-173	General
	6-58	10-173	General
	6-59	10-173	General
	6-60	10-217	Land Use and Planning
	6-61	10-217	Land Use and Planning
	6-62	10-197	Water Quality and Hydrology
	6-63	10-196	Water Quality and Hydrology
	6-64	10-218	Economics
	6-65	10-219	Community Services
	6-66	10-219	Geothermal Resource Lease
Ellen Hardebeck, GBUAPCD	7-1	10-171	General
	7-2	10-192	Water Quality and Hydrology
	7-3	10-171	General
	7-4	10-213	Recreational Resources
	7-5	10-213	Recreational Resources
	7-6	10-211	Aquatic Resource
	7-7	10-213	Recreational Resources
	7-8	10-213	Recreational Resources
	7-9	10-215	Visual Resources
	7-10	10-181	Geology, Soils, and Erosion
	7-11	10-186	Water Quality and Hydrology
	7-12	10-214	Recreational Resources
	7-13a	10-176	Alternatives
	7-13b	10-216	Visual Resources
	7-14	10-177	Terrestrial Wildlife

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Ellen Hardebeck, GBUAPCD (Continued)	7-15	10-176	Alternatives
	7-16	10-186	Hydrology and Water Quality
	7-17	10-180	Geology, Soils, and Erosion
	7-18	10-212	Aquatic Resources
	7-19	10-177	Alternatives
Michael J. Walker, Pacific Energy	8-1	10-171	General
	8-2	10-205	Vegetation
	8-3	10-181	Geology, Soils, and Erosion
	8-4	10-197	Water Quality and Hydrology
	8-5	10-186	Water Quality and Hydrology
	8-6	10-208	Terrestrial Wildlife
	8-7	10-186	Aquatic Resources
	8-8	10-213	Cultural Resources
	8-9	10-214	Timber Resources
	8-10	10-179	Air Quality
	8-11	10-180	Geology, Soils, and Erosion
	8-12	10-180	Geology, Soils, and Erosion
	8-13	10-197	Water Quality and Hydrology
	8-14	10-212	Aquatic Resources
	8-15a	10-187	Water Quality and Hydrology
	8-15b	10-197	Water Quality and Hydrology
	8-16	10-190	Water Quality and Hydrology
	8-17	10-197	Water Quality and Hydrology
	8-18	10-194	Water Quality and Hydrology
	8-19	10-197	Water Quality and Hydrology
	8-20	10-196	Water Quality and Hydrology
	8-21	10-197	Water Quality and Hydrology
	8-22	10-197	Water Quality and Hydrology
	8-23	10-197	Water Quality and Hydrology
	8-24	10-209	Terrestrial Wildlife
	8-25	10-209	Terrestrial Wildlife
	8-26	10-205	Vegetation
	8-27	10-219	Economics
	8-28	10-171	General
	8-29	10-174	General
	8-30	10-171	General
	8-31	10-174	General
	8-32	10-174	General
	8-33	10-174	General
David E. Clapp, U.S. Dept. of Health and Human Services	9-1	10-178	Air Quality
	9-2	10-178	Air Quality

TABLE 10-1: COMMENT INDEX (Continued)

Name/Agency	Comment Code	Page No.	Topic
Gary Flynn, Town of Mammoth Lakes	10-1	10-210	Terrestrial Wildlife
	10-2	10-190	Water Quality and Hydrology
	10-3	10-210	Terrestrial Wildlife
	10-4	10-198	Water Quality and Hydrology
	10-5	10-217	Visual Resources
	10-6	10-201	Vegetation
	10-7	10-189	Water Quality and Hydrology
	10-8	10-210	Terrestrial Wildlife
	10-9	10-215	Visual Resources
	10-10	10-219	Community Services
	10-11	10-210	Terrestrial Wildlife
	10-12	10-171	General
Andrew Zeilman, Cal. Dept. of Transp.	11-1	10-214	Transportation
David L. Harlow, U.S. Fish and Wildlife Service	12-1	10-187	Water Quality and Hydrology
	12-2	10-187	Water Quality and Hydrology
	12-3	10-187	Water Quality and Hydrology
	12-4	10-187	Water Quality and Hydrology
	12-5	10-187	Water Quality and Hydrology
	12-6	10-188	Water Quality and Hydrology
	12-7	10-187	Water Quality and Hydrology
	12-8	10-187	Water Quality and Hydrology
	12-9	10-189	Water Quality and Hydrology
	12-10	10-189	Water Quality and Hydrology
	12-11	10-189	Water Quality and Hydrology
	12-12	10-182	Water Quality and Hydrology
Christopher Farrar, U.S.Geologic Survey	13-1	10-174	General
	13-2	10-198	Water Quality and Hydrology
	13-3	10-200	Water Quality and Hydrology
	13-4	10-198	Water Quality and Hydrology
	13-5	10-198	Water Quality and Hydrology
	13-6	10-199	Water Quality and Hydrology
	13-7	10-182	Water Quality and Hydrology
	13-8	10-199	Water Quality and Hydrology
	13-9	10-189	Water Quality and Hydrology
	13-10	10-196	Water Quality and Hydrology
	13-11a	10-199	Water Quality and Hydrology
	13-11b	10-198	Water Quality and Hydrology
	13-11c	10-196	Water Quality and Hydrology
	13-12	10-199	Water Quality and Hydrology
Dan Lyster, Mono County	14-1	10-197	Water Quality and Hydrology

10.2.2 WRITTEN COMMENTS AND HEARING SUMMARY

Written comments to the Draft EIS/SEIR and the minutes of the public hearing are included in this section.

United States Department of the Interior

GEOLOGICAL SURVEY

November 8,1988

Comments on Draft EIS for PLES 1 Geothermal Project at Casa Diablo

Michael L. Sorey
U.S. Geological Survey
Menlo Park, California

NOV 1 5 '88

The following remarks and the enclosed comments dated June 27, 1988 are submitted in the hope that they will improve the subject EIS and clarify some areas of controversy surrounding future geothermal developments in the Long Valley caldera.

Conceptual Models

1-1 Several inferences are made in the EIS to the effect that thermal waters from various springs and wells show differences in chemistry and stable isotope contents that are best explained by the Upwelling/Fracture Flow Model, rather than the Lateral Flow Model (e.g p. 3-29, 3-32 to 3-34). The thrust of this argument is that the Upwelling/Fracture Flow Model does not require manipulation of the chemical data to account for the observed differences. It is also argued in the EIS (p. 3-34) that at Casa Diablo the chemical and isotopic data from wells and springs are in close agreement. I would agree that there are chemical and isotopic differences between thermal waters in different parts of the caldera, but I believe they can be satisfactorily explained by relatively simple combinations of mixing with nonthermal water groundwater and near-surface boiling. The isotope data show just as much variation between wells and thermal springs at Casa Diablo as between these springs and the springs in Hot Creek gorge. So one cannot avoid accounting for the effects of mixing and boiling by calling on the Upwelling/Fracture Flow Model. Furthermore, for this model to account for the observed differences in spring chemistry and isotopy in different parts of the caldera, it is necessary to postulate separate deep reservoirs with distinct chemical and isotopic contents - a rather complex situation in itself.

Reservoir Pressure Support from Injection

1-2 All simulations of reservoir pressure response to geothermal development discussed in Chapter 4 and Appendix C are based on 100 percent pressure support by injection. The results of these simulations indicate that minimal pressure changes will occur in the vicinity of the Fish Hatchery and Hot Creek gorge. It is further argued (p. 36, App. C) that a high rate of natural recharge to the system would have a similar influence on reducing impacts of development. Although I agree that the small amount of reservoir

pressure change occurring at Casa Diablo to data requires that one or both effects must be occurring, it should be noted that we do not as yet know which process is dominant. Consequently, it is difficult to predict the level of reservoir pressure change resulting from additional development. If 100 percent injection support occurs, significant pressure changes within and at distance from the developed
1-2 area are unlikely. Of course in this case breakthrough of cooler injection water may cause premature temperature declines in production wells. If, on the other hand, reservoir pressure at Casa Diablo is being supported mainly by induced recharge, there is no guarantee that additional production will be matched by additional recharge. That process cannot as yet be adequately simulated because the characteristics of the recharge region are not known. I think that for the EIS to be viewed as objective, this limitation of the pressure modeling results needs to be emphasized.

A somewhat related matter is that of the impact of an induced reservoir pressure change beneath the Fish Hatchery or Hot Creek gorge on the flow of thermal springs in these areas. Discussions in the EIS (p. 4-38, 4-40) are not very enlightening on this issue. A better way is to relate such a pressure change (say 1 psi) to the pre-existing reservoir pressure at each local, which is typically about 10 percent above hydrostatic pressure beneath areas of hot spring discharge.
1-3 Then if one assumes a thermal reservoir at a depth of 500 ft beneath the Hatchery (based on the temperature profile in well (MW-1)), the pre-existing reservoir pressure would be 200 psi + 20 psi, or 220 psi. A change of 1 psi would then reduce the excess pressure driving hot water upward (and hence the flow of the thermal springs) by 1/20 or 5 percent. In the EIS, a 1 psi change in reservoir pressure is converted to a 2.5 ft change in water level in a well. This does not convey much useful information as how the springs would be affected.

Reservoir Temperature Changes

In both the draft EIS and in public statements by representatives of the developers at Casa Diablo the claim is made that production at the existing MP 1 plant has resulted in no decline in reservoir temperature at Casa Diablo (e.g. p. 4-36 of EIS and Review-Herald October 27, 1988). This is simply not true if one considers the injection zone as part of the reservoir. Because water at temperatures near 80°C is being injected into a zone initially at
1-4 temperatures near 150°C, cooling of this zone must extend from the injection wells to distances that are increasing with time and could conceivably cause cold water breakthrough in production wells if there are permeable connections between production and injection zones. Such connections are required for there to be 100 percent pressure support by injection. So geothermal development at Casa Diablo has caused reservoir temperature declines and additional developments will

1-4 cause more declines in temperature in the injection zone and
ultimately in the production zone.

Calculations of reservoir temperature declines due to geothermal
development made by Papadopulos and Associates (1988) using a heat
budget approach are criticized on p. 4-37 of the EIS for being based
on unreasonably low values of reservoir size and heat in place. The
"more realistic " value for heat in place attributed to Sorey (1988)
is actually an estimate of heat that could be recovered from portions
of the geothermal system situated to the west of Casa Diablo if
production induced hot water recharge to move into the reservoir at
1-5 Casa Diablo. Thus, considering induced hot water recharge or a larger
reservoir of heat available to the wells at Casa Diablo amounts to the
same thing. Of course, if reinjection provides 100 percent pressure
support, as assumed in the BGI reservoir performance simulations,
there will be little or no induced recharge of hot water so that the
reservoir temperature declines calculated by Papadopulos and
Associates for the Casa Diablo area might be valid. As indicated in
the previous paragraph, however, such declines would occur mainly in
the injection zone.

Other scenarios for reservoir temperature changes accompanying
1-6 development are discussed in my comments of June 27, 1988. I suggest
including them in the EIS since they are cited in that document.

Results of Bulk-Model calculations discussed on p. 4-40 to 4-42 are
referred to as <u>worst case conditions</u> because a relatively low value of
reservoir porosity was used. I would think that worst case conditions
should also involve a reservoir thickness less than 500 ft. Using for
1-7 example a thickness of 100 ft would yield estimates of the distance to
the edge of the cold-temperature front approximately five times
greater than those listed on p. 4-40. It would also be instructive to
include an analysis of what happens to the cold-temperature front
after 30 years, for cases of cases with and without continued
injection.

Finally, in the discussion of results of the BGI heat budget
calculations (p. 4-42), the sentence that begins with "The analysis
here, taken from Appendix C, instead of ..." has had some essential
wording left out. The missing information is that a reservoir heat
storage of 10×10^{17} cal and a porosity of 15 percent were used. While
1-8 it can be argued that the larger reservoir volume used by BGI is
appropriate for the reservoir block at Casa Diablo, there is little
justification for BGI's use of similar sized blocks to evaluate
temperature changes east of Casa Diablo. Because of the way reservoir
temperature changes are simulated to the east of Casa Diablo in this
approach, such large reservoir blocks force the calculated temperature
declines at the Hatchery and Hot Creek gorge to be very small.

United States Department of the Interior

GEOLOGICAL SURVEY

TAKE PRIDE IN AMERICA

June 27, 1988

Comments on "Evaluation of Geothermal Development within Long Valley" - a Report by S.S. Papadopulos & Associates, Inc.

Michael L. Sorey
U.S. Geological Survey
Menlo Park, California

At the request of the Bureau of Land Management's Sacramento office, I have reviewed the report cited above. My comments on this report and on the related issues of 1) the effectiveness of hydrologic monitoring in detecting changes in the hydrothermal system due to geothermal production and 2) the effectiveness of proposed mitigation measures to prevent or reduce impacts of geothermal development to acceptable levels are given below.

Papadopulos Report

This report presents an analysis of the changes in stored heat and temperature in part of the Long Valley hydrothermal system between Casa Diablo and the Hot Creek Fish Hatchery resulting from geothermal production at 47 MW over a 20-year period. An energy balance approach is used in which changes in stored heat are computed from the difference between convective heat input and output and net heat outflow from geothermal power production. A continuous reservoir 300 m thick is assumed to extend between Casa Diablo and the Fish Hatchery and this region is subdivided into four blocks, each 300 m thick, for calculating changes in reservoir temperature with time. Hot water inflow to Block #1 at Casa Diablo is set equal to 32.5 L/s at 200^{o}; inflow to each of the other blocks equals 32.5 L/s at 200^{o}C plus the cumulative inflow to the adjacent blocks to the west at temperatures that decline with time with the average temperature of each block. The total hot water inflow to and outflow from the four-block model is thus 130 L/s. The principal conclusions of the report are 1) that heat extraction for geothermal power production at Casa Diablo and Chance Springs (Meadow) will cause large reservoir temperature changes in the production areas (up to 150°C after 20 years) and significant reservoir temperature changes beneath the Fish Hatchery (7° to 67°C after 75 years) and 2) that hydrologic monitoring could not detect adverse impacts before irreversible changes have been created.

To begin with, there is nothing inherently wrong with the energy balance approach utilized in this report. Indeed, the general conclusion that geothermal power production at rates proposed for Long Valley would cause large reservoir temperature declines, in the absence of significant induced inflow of hot water from adjacent regions, is in fact valid. Reference to this matter was made in the EIR for the Mammoth/Chance project (p. 3-32) in terms of a personal communication from me to the effect that only 3 percent of the required heat for the project is stored in the production reservoir beneath the project area. Furthermore, significant changes in reservoir pressure may not occur during development if pressure support is provided by reinjection of produced fluids, but there remains an energy deficit that will cause significant temperature declines unless alleviated by induced inflow of hot water.

The effect of such induced inflow would be to supply heat to the project area from other parts of the geothermal system. Calculations presented on p.2 of the Papadopulos report suggest that even if this were to occur, the potential yield of the geothermal system (1.5×10^8 cal/s from natural convective heat discharge and recoverable heat in storage) is approximately equal to the net heat production rate for the total proposed electric power production of 47 MW, and thus significant impacts to the natural geothermal system are inevitable. Unfortunately, no justification is given for the assumed 1×10^{17} cal of "stored heat that could be mined [by development]". Although published estimates of about 50×10^{17} cal for recoverable heat in the Long Valley geothermal system (Muffler and Williams, 1976; Muffler, 1979) are probably unreasonably large, a more realistic estimate based on recent drilling data from the west moat of the caldera would be about 10 times larger than the value noted in the Papadopulos report.

The controversy that has developed over the impacts of geothermal development on thermal springs at the Fish Hatchery and Hot Creek gorge is due in large part to uncertainty regarding both the degree to which thermal areas between Casa Diablo and Hot Creek gorge are hydrologically connected and the response to development of the geothermal system in the vicinity of each project area. At this stage, no one knows for sure if there is in effect a continuous thermal reservoir between Casa Diablo and Hot Creek gorge or if proposed geothermal developments will induce inflow of hot water from reservoirs at greater depths and/or capture the natural throughflow of thermal water at relatively shallow depths. Answers to these questions are needed before we can predict the magnitude of changes in temperature, pressure, and spring flow rates that could be induced by development. For example, if hot water inflow should occur at Casa Diablo at rates equal to or greater than the natural throughflow rate of 250 L/s (see Sorey and Lewis, 1976; or Papadopulos report, p. 9), temperature drops calculated for Block 1 by the method used in the Papadopulos report would be considerably less than the 150°C value calculated for an inflow of 32.5 L/s.

Potential impacts of geothermal development on thermal springs are best discussed under three possible scenarios that could accompany development. Under scenario (1), there is a natural throughflow of hot water at about 250 L/s moving through the volcanic section between Casa Diablo and Hot Creek gorge. Development at Casa Diablo (and Mammoth/Chance) would lower reservoir pressures sufficiently to capture all the natural throughflow (i.e. redirect it from the thermal springs to the production wells). The resultant reservoir temperature decline in each project area would be considerably less than calculated by Papadopulos & Associates, as discussed above. However, capture of the natural throughflow could result in pressure declines in the vicinity of the thermal springs with resultant declines in spring flow, unless injection wells were located and completed so as to maintain pre-development reservoir pressures near the margins of the project area. Migration of relatively cool injected water toward the thermal springs could eventually cause declines in reservoir temperature beneath the springs. An analysis of this process, included in Appendix I of the joint

EIR/EA for the MP II and MP III projects, suggested that "breakthrough of cool injected fluid is not likely to be a potential threat to existing springs", but the analysis was admittedly very approximate and limited by lack of knowledge of reservoir flow paths. Application of the method used by Papadolpulos & Associates, in which reservoir cooling near the Hatchery results from a decline in the temperature of fluid flow toward the Hatchery from the west, would suggest that cooling of the Hatchery springs could eventually occur under this scenario.

Under scenario (2), the natural throughflow is unaffected by development (or does not exist within a simple lateral flow system at shallow depths), but significant quantities of fluid and heat are induced to flow upward from a deep reservoir beneath the volcanic section into the project area. This is more or less the scenario postulated by the developer at Casa Diablo. This results in the minimum possible impacts at Casa Diablo and at the thermal springs. Using, for example, a value for the recoverable thermal energy in the geothermal system within the southwestern part of the caldera that is ten times the heat stored in Block 1 of the Papadopulos model, the calculated temperature drop in Block 1 assuming this heat could be captured would be only 15^{o}C after 20 years (all other conditions being the same as in the Papadopulos model).

Scenario (3) would be the case assumed in the Papadopulos report - no capture of natural throughflow or heat stored in surrounding regions. Development under these conditions results in the maximum possible declines in reservoir temperature, both in the project areas and beneath the thermal springs. One qualifying point that should be noted is that because the thermal fluid component in the Hatchery springs is small (only a few percent), a given change in the temperature of the thermal reservoir supplying the Hatchery would not cause an identical change in the temperature of the springs. For example, a 30^{o}C change in reservoir temperature should cause about a 1^{o}C change in spring temperature.

Clearly the nature of the response of the geothermal system to development will play an important role in determining the impacts of development on thermal springs. Because this response cannot be adequately predicted at the present time, a prudent course of action has been recommended. This is to set up a monitoring program to accompany development that is capable of detecting changes in the system before they become large and irreversible, and to require mitigation measures in the event that changes are detected by the monitoring program. Measurements of pressure and temperature in production and injection wells are considered part of the monitoring program. Changes in these parameters should provide the first indications that changes in the geothermal system are being induced. Indeed, it is inconceivable that with such monitoring, temperature declines in project areas as large as those postulated in the Papadopulos report could go unnoticed or that significant alteration or cessation in the development scheme would not have been put into effect long before temperature changes became that large. In addition, the most immediate effect of a net energy withdrawl in the project areas should be breakthrough of cooler injected water in production wells. This would occur long before temperature declines occur in the vicinity of the thermal springs. Should an EIS be prepared for the proposed development at Casa Diablo, the issue of reservoir temperature changes within the project area deserves more discussion and analysis than that given so far in Appendix I of the Joint EIR/EA for the MP II and MP III projects.

Effectiveness of the Hydrologic Monitoring Program

A hydrologic monitoring program has been developed by the U.S. Geological Survey, in collaboration with the Long Valley Hydrologic Advisory Committee, to detect impacts of both geothermal and nonthermal groundwater development projects on springs at the Fish Hatchery and Hot Creek gorge. The program became operational on June 1, 1988, with funding provided initially by Mono County. With regard to the existing and proposed geothermal projects at Casa Diablo, this monitoring program covers all aspects of the Plan for Baseline Monitoring approved by the BLM that apply to hydrologic issues, except for compilations of existing data, monitoring of CD supply springs at the Fish Hatchery, and collection of sediment data in streams.

The key elements of the monitoring program are frequent measurements of the discharge characteristics of thermal springs (flow rate, temperature, chemistry) and pressure and temperature in observation wells. The most difficult part of setting up the program is the completion of suitable observation wells. The criteria for such wells is that they be in hydrologic communication with production and injection reservoirs and located between the development field and the thermal springs. Logically, observation wells should first be drilled near the downstream margins of the development field. If no changes attributable to development were found in these wells, additional observation wells would not be needed. If changes were detected and mitigation measures such a relocating production or injection wells failed to reverse these changes, additional observation wells would have to be drilled closer to the thermal springs.

The existing monitoring program includes one observation well (65-32) drilled to a depth of 250 ft at the southeastern edge of the Casa Diablo project area. Although temperature, pressure, and fluid chemical data indicate that this well is in hydrologic communication with the production zone at Casa Diablo (400 to 700 ft), an additional well is needed at this location that taps the deeper injection interval (1000 to 2000 ft), along with well tests to determine the degree of hydrologic connection between both wells and the production and injection wells. Similar requirements for observation well completion and reservoir testing for the Mammoth/Chance project were described in my comments to Dan Lyster, Mono County Energy Management Department, dated January 4, 1988 (copy enclosed).

Successful operation of the monitoring program requires cooperative efforts by the developers, the regulatory agencies, and the agency responsible for conducting and reported on the monitoring. Proper interpretation of monitoring data to discern natural variations from those induced by development may require considerable hydrologic expertise and involve debate between experts. Little experience is available from other areas that could be used to access the likelihood of success of this effort.

We do have the record of over three years of operation of the MP I plant at Casa Diablo during which time no impacts to thermal springs at the Fish Hatchery or Hot Creek gorge have been detected by measurements made by the U.S. Geological Survey. The system response to that development appears to involve no significant decline in reservoir pressure, either due to pressure maintainance by reinjection or the presence of a constant pressure boundary such as a fault that connects the production zone with a deeper, more permeable reservoir. Temperature declines in the vicinity of the injection wells are large (30^0 - 70^0C), but the position of the cold temperature front at distance from these wells is unknown. Considering all the above factors and observations, my opinion at this point is that the existing monitoring program, if augmented by a deeper observation well that taps the injection zone at Casa Diablo and if expanded with additional observation wells drilled closer to the thermal springs as needed, will be adequate to detect changes in the hydrothermal system due to geothermal developments at Casa Diablo.

Effectiveness of Proposed Mitigation Measures

Mitigation measures proposed to prevent or reduce impacts of geothermal developments on thermal springs to acceptable levels are contained in the February 11, 1988, Record of Decision for the PLES I Plan of Operation. The thrust of these measures is to require that additional monitor wells be drilled closer to the thermal springs if changes in the hydrothermal system are detected at closer-in monitor wells and that temporary and permanent modifications in the production/injection scheme be carried out to reverse any changes detected at monitor well locations. If such measures are not effective in stopping the migration of induced pressure or temperature changes through the hydrothermal system toward the thermal springs, the final action would be to discontinue power production.

Overall, I think these mitigation measures in combination with the monitoring program provide an adequate level of protection for the thermal springs. Some qualifying remarks are in order, however. First, I recommend that monitor wells at each location be constructed so as to communicate with both production and injection zones, as discussed in the previous section. Ideally, step-out monitor wells (as noted in measures 1 and 4) should be in place before changes are detected in close-in monitor wells in order to determine the natural level of variation in pressure and temperature away from the project area and to assure that induced changes have not already spread away from the project area. Data gathered from drilling step-out wells would also allow a better conceptual model of the hydrothermal system to be delineated for predictive purposes. To lessen the economic burden this would place on the developer, I suggest waiting until power is on line to require that at least one step out well be drilled in the vicinity of Colton Spring. Finally, there appears to be little latitude for changes in production/injection well locations or depths given present lease boundaries and concerns over premature breakthrough of cooler water. This places even more importance on the early detection of induced changes in monitor wells and serious consideration of curtailment of power production if such changes are observed.

Conclusions

The analysis presented in the Papadolpulos report describes one possible way in which the hydrothermal systems could respond to geothermal development. Other types of response are possible. A properly conceived and implemented hydrologic monitoring program should be capable of determining what the actual response is. More importantly, such monitoring provides for early detection of changes in reservoir conditions within project areas and between these areas and the thermal springs. The Papadolpulos report suggests that temperature changes in thermal springs could take place long after the development period is over and hence monitoring cannot provide protection against such impacts. This situation should not occur, however, if reservoir temperature changes in and around project areas are detected by the monitoring program in the early stages of development, and suitable mitigation measures are then implemented.

United States Department of the Interior

GEOLOGICAL SURVEY

January 4, 1988

Comments on impacts of the Mammoth/Chance geothermal development on thermal springs at the Fish Hatchery and Hot Creek gorge

Michael L. Sorey
U.S. Geological Survey
Menlo Park, California

The following comments are intended to more clearly state my opinions and recommendations regarding potential impacts of the proposed Mammoth/Chance development by Bonneville Pacific Corporation on thermal springs at the Fish Hatchery and Hot Creek gorge. My testimony at the appeals hearing on December 14, 1987, may have cast an overly negative light on the geologic and hydrologic uncertainties which exist and the consequent level of risk that this project poses to the thermal springs. I still maintain that the source and extent of hot water to be produced by this project are poorly known at present and that flow tests conducted by Bonneville Pacific in 1985 did not provide sufficient information in this regard. However, I believe it is possible to proceed with this development in a manner that would avoid significant hydrologic impacts, provided several conditions are met.

The first condition is that one or more observation wells be completed in such a way that they are in hydrologic connection with the production reservoir and located between the production area and the thermal springs. Successful completion of such wells may need to await new subsurface information from exploratory drilling and may require several attempts to drill in different locations and to defferent depths. The responsibility for this work should rest with Bonneville Pacific, whereas the responsibility for verifying that the wells are adequate for the intended purpose should rest with Mono County and the Long Valley Hydrologic Advisory Committee. Wells to monitor the impacts of reinjection may also be required if it is determined that changes induced by reinjection could reach the springs before changes induced by production.

With suitable observation wells in place, flow tests on production wells should be carried out to adequately stress the production reservoir, so as to make possible determinations of the source and extent of the available resource and the potential for lateral migration of induced pressure changes toward the thermal springs. Such tests would require that fluid be reinjected as far as possible from production wells. By comparing the results of such tests with additional tests involving reinjection closer in, it should be possible to delineate the degree of pressure support to be provided by reinjection and the likelihood of premature breakthrough of cooler water in production wells.

Recent consultations with Bonneville Pacific representatives has indicated to me their willingness to meet these conditions, as outlined in their draft proposal for short-term resource testing and monitoring. It is my opinion that if observation well drilling and well testing were properly carried out, a satifactory long-term monitoring program were in place, and mitigation measures set forth in the Conditional Use Permit were enforced as needed, the hydrologic impacts of the Mammoth/Chance development would be relatively minor. The same would be true for the Mammoth Pacific developments at Casa Diablo. Furthermore, information and experience that could be gained if these relatively small-scale projects were allowed to proceed would undoubtably assist in determining potential impacts of larger-scale geothermal developments that may occur on adjacent federal lands.

State of California — The Resources Agency

Memorandum

To : 1. Projects Coordinator
Resources Agency

2. Ms. Ellen Hardebeck, APCO
Great Basin Unified Air
Pollution Control District
157 Short Street, Suite 6
Bishop, CA 93514

Date : October 26, 1988

From : Department of Fish and Game

Subject : PLES I Geothermal Development Project: Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) Supplement, Mono County - SCH 86122913

The Department of Fish and Game commented on the joint DEIS/EIR for the subject project located in the Casa Diablo area of the southwestern part of Long Valley, Mono County. The DEIS supersedes the Final EIR for this project, that was released in May 1988. We, therefore, regard this supplement as an EIR if it is to be considered a joint California Environmental Quality Act/National Environmental Policy Act (CEQA/NEPA) document.

Attached is a copy of our letter dated October 21, 1988 to Mr. Jim Morrison, Area Manager, Bureau of Land Management. This attached letter constitutes the Department's comments to the Great Basin Unified Air Pollution Control District. As the letter concludes, the Department believes that the DEIS/EIR is substantially flawed and fails in several aspects to comply with crucially important sections of CEQA and NEPA.

Thank you for the opportunity to review and comment on this project. If you have any questions, please contact Fred Worthley, Regional Manager of Region 5, at 330 Golden Shore, Suite 50, Long Beach, CA 90802 or by telephone at (213) 590-5113.

Pete Bontadelli
Pete Bontadelli
Director

Attachment

NOV 0 2 1988

STATE OF CALIFORNIA—THE RESOURCES AGENCY GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-5095

October 21, 1988

Mr. Jim Morrison, Area Manager
Bureau of Land Management
Bishop Resources Area
787 North Main Street, Suite P
Bishop, CA 93514-2498

Dear Mr. Morrison:

PLES I Geothermal Development Project: Draft EIS/EIR Supplement, Inyo County - SCH 86122913

The Department of Fish and Game has reviewed the joint Draft EIS/EIR for the subject project located in the Casa Diablo area of the southwestern part of Long Valley in Mono County. The Draft EIS supercedes the Final EIR for this project that was released in May, 1988. We therefore regard this Supplement as an EIR if it is to be considered a joint CEQA/NEPA document.

2-1 The proposed project poses serious threats to the Mammoth and Hot Creek ecosystems, the flora and fauna that are obligate residents of thermal springs, and the habitat types dependent upon these thermal springs in and around the project area. The potential for irreversible and unmitigable adverse impacts to these ecosystems and wildlife in the area greatly increases as several geothermal power producing projects are constructed. We find the joint document inadequate in meeting CEQA and NEPA requirements and therefore recommend adoption of the "No Project" alternative for the following reasons:

1. Impacts to the Geothermal Resources Supporting Hot Creek Hatchery and Hot Creek Gorge.

   Among the major concerns to the Department is the loss or degradation of geothermal resources in the Long Valley Known Geothermal Resource Area (KGRA) which supports recreational needs for an expanding number of people. An unmitigable impact to this highly valued resource is unacceptable. The Department does not concur with the analysis of the Long Valley hydrologic system (BGI Report), given the potential for irreversible impacts and the importance of the system to local and statewide recreation. Our consulting groundwater hydrologists, S.S. Papadopulos & Associates, Inc., is conducting a separate hydrologic resource analysis of the Long Valley KGRA, which is likely to be completed by December 10, 1988. Therefore, our comments on the hydrologic system are based on Papadopulos's initial findings and are presented in Attachment A which henceforth represents the Department position relating to the applicable hydrologic sections of the DEIS/EIR Supplement.

   2-2

With regard to the Long Valley KGRA, Papadopulos concludes (1) that geothermal development will create thermal "pits" within the geothermal system, (2) that "pits" will ultimately migrate to areas of natural thermal discharge (Hot Creek Hatchery and Hot Creek Gorge springs), and (3) that the temperatures or heat flux of the natural discharges will be reduced.
2-2 Calculations on the amount of heat removed through energy production indicate that a significant and unmitigable impact to the Hot Creek spring system is to be expected with further development. The issues identified by Papadopulos are based on an entirely new concept which accurately predicts that impacts to the Long Valley KGRA would be significant. Furthermore, since ". . . the exact nature of the hydrologic system and how the subsurface system and the surface features are interrelated cannot be defined at this time" (see document Appendix C, Page 4-43), it is required by NEPA that a reasoned assessment of the environmental impacts of a course of action be based on a "worst-case" analysis.

2-3

Our Department has recently contracted with Papadopulos to develop a physically based model for predicting the impacts of geothermal development on the natural discharge areas. A three-dimensional model will be used for correctly predicting the formation and migration of the "thermal pits". The model will be capable of predicting the impacts of development based on hydrologic and geologic data already available for the actual geothermal system.

2. Potential for and Realized Loss of Thermal Springs and Related Fauna, Flora, and Habitats in the Proximity of the Existing Development and Future Developments.

Further development of the Long Valley geothermal resource will result in incremental loss of thermal springs and an associated impact on all dependent flora, fauna, and habitat types (i.e. botanically sensitive thermal marsh). The document does not identify existing and potential impacts to plants, animals, or habitat types obligate to the thermal springs located throughout the Long Valley KGRA even though the Department has on several occasions requested that the results of appropriate studies be incorporated into the
2-4 document. We hereby incorporate by reference Department comments on Revised Draft Joint EA and EIR, the Department's Statement of Reasons for the April 8, 1988 Notice of Appeal of the Plan of Baseline Data Collection, and BLM notes from May 23, 1988 meeting with Department representatives. The lead agency has failed to provide results of surveys at all thermal springs such as outlined in Dr. Herbst's invertebrate survey proposal (see Attachment B). Other organisms may reside in these springs such as unique forms of anaerobic bacteria which as a primitive life form present valuable insight into how

life on earth evolved in an anaerobic atmosphere (Brock, T.D., "Life at High Temperatures", Science 158 (1967): 1012-19). The Department is mandated by the State Legislature to maintain sufficient populations of all species of aquatic organisms to ensure their continued existence. In the absence

2-4 of such surveys, the Department cannot evaluate project impacts or identify those sites which may currently harbor unique, rare, threatened, or endangered species and thereby require protection.

Dr. Sorey of the U.S. Geological Survey states ". . . it should be noted that there are as yet no examples to be cited of long-term development of geothermal fields where nearby hot springs have been protected from the impacts of development, and many examples where development has had negative impacts on such springs" (Sorey 1987 "Comments on Effects of Geothermal Development on Thermal Spring at the Hot Creek Fish Hatchery and Hot Creek Gorge Near Mammoth Lakes, California, .5 p."). Furthermore, he states ". . . detailed records collected by the U.S. Geological Survey during the 1985-87

2-5 period show that the flow of hot springs on the west side of Hot Springs Road at Casa Diablo has been affected by geothermal fluid production. In fact, the flow of these springs decreased to zero in March 1987 and the springs have remained dry or nearly so since that time". Dr. Sorey has documented that the existing level of geothermal development at Casa Diablo has resulted in the loss of thermal springs. A loss of the species dependent on those springs is assumed. The proposed buildup of nearly seven times the current development will almost certainly destroy all nearby thermal springs and ecosystems.

3. Potential for Impacts to Thermal Marsh Habitat (Wetland).

The existence of a thermal marsh (wetland habitat) located in the Casa Diablo Hot Springs area is identified as a botanically sensitive area (Page 3-39 and Appendix D). This habitat type is supported by some of the same local thermal springs which are likely to be further impacted by continued geothermal development.

Additionally, the pumping of groundwater for use in power

2-6 plant maintenance and fire safety purposes can lower the water level of the shallow fresh water aquifer at Casa Diablo, thereby impacting shallow rooted vegetation (Page 4-35). The document refers to the potential loss of thermal marsh only in the context of direct ground disturbances (Page 4-65) but ignores the potential loss of source water, that of thermal springs probably draining to ground water. The impact of groundwater pumping and subsequent lowering of the water table on thermal marsh habitat is not addressed in the document.

2-6 The U.S. Forest Service, the federal agency responsible for surface resources at the proposed PLES I project site, is mandated under Executive Orders 11990 and 11988 to protect riparian and wetland resources. These Orders are consistent with Department policy for protection of wetlands. Mitigation is required in the event any development or conversion would result in a net reduction of wetland acreage or wetland habitat values. This document is inadequate in identifying impacts to riparian/wetland habitat and the mitigation measures necessary to offset such impacts.

4. Temperature Data at Hot Creek Hatchery Springs.

2-7 Throughout the document reference is made to variable temperatures and flows of the springs supplying Hot Creek Hatchery (Pages 3-27, 2-47, -48, 4-37, 12-14 and Figures 1-10 through 1-14, Appendix C). Although flows at these springs do seem to vary, temperatures remain relatively constant (C.D. Farrar, U.S. Geological Survey, personal communication) (see Attachment D). The temperature data cited in the document was supplied by the Hot Creek Hatchery manager at the request of the Forest Service hydrologist, project proponents, and consultants. The data set used in the document provides only a rough approximation of average temperatures at the four major Hatchery spring sources and thus cannot be used to represent spring temperature variability or stability. The current monitoring effort will allow for accurate assessment of the variability at these springs, which is important when determining the impacts of geothermal development on the thermal reservoir.

2-8 The temperature data on Hot Creek Hatchery in the section on "Affected Environment" (Pages 3-47 and 3-48) are given in Farenheit, but in the section on "Environmental Consequences" the temperature figures are in Celsius degrees. The document states that "A reduction of 2°F in the present temperature range would delay spawning until Spring due to the increased time period necessary for egg maturation. This would, for all practical purposes eliminate the Coleman and Hot Creek strains and severely impact the hatchery's statewide trout planting program." The impacts to the hatchery resulting from a 0.2°C temperature decline after 20 years should be given in Farenheit and projected over the life of the project after 20, 40, 60, 80, and 100 years.

5. Direct, Indirect, and Cumulative Impacts to Terrestrial Wildlife and Mule Deer.

2-9 The document provides a vague and misleading discussion of some direct project impacts to wildlife resources, especially migratory deer. Secondary and cumulative impacts are also inadequately discussed. The document concludes that impacts are insignificant while areas of disagreement exist in the discussion on impacts to wildlife in the Biotic Assessment (Appendix D) and the Deer Study Report (Appendix E). Such disagreement shows substantial uncertainty of project impacts. The section on "Environmental Consequences, Terrestrial Wildlife" does contain some vague reference to impacts which "may" occur or which are "possible", but no meaningful mitigation measures are proposed for impacts to terrestrial wildlife. Similarly, the document does not undertake a reasoned analysis of cumulative impacts to migratory deer or other wildlife.

2-9

In our appeal IBLA No. 88-303 of the prior Environmental Assessment for this project the Department stated that no major development should be approved in the Mammoth Basin vicinity prior to completion of a comprehensive cumulative impacts study to examine all reasonably foreseeable projects and their additive effects on all natural resources. Such an interagency effort is now being proposed by the Mono County Planning Department.

2-10

The document's deer study (Appendix E) mentions that "the initially proposed site" for the plant would be preferable to the currently proposed configuration "From the standpoint of deer migration and summer use . . .". This refers to the location site as proposed in the Finding of No Significant Impact (FONSI) dated February 11, 1988. However, this site location alternative is not mentioned or analyzed in the draft document. In Methow Valley Citizens Council vs. Regional Forester the Court found in regard to discussions of project alternatives that "an EIS is rendered inadequate by existence of a viable but unexamined alternative".

2-11

From the above, we conclude that the project as proposed would result in non-compliance with the existing Buttermilk, Sherwin Grade, and Casa Diablo Deer Herd Plans, which were jointly approved and adopted by the U.S. Bureau of Land Management, U.S. Forest Service, and the Department. These plans present the creation of specific management guidelines, including preservation of migratory deer habitats. This project site is such a habitat, thereby effectively becoming a federal cooperatively designated deer herd management area (see Department EA Appeal, Statement of Reasons, Page 2).

6. Inadequacy of Proposed Mitigations.

2-12a

The Draft EIS/EIR Supplement is inadequate because it lacks specific mitigation measures to offset the adverse impacts identified in the document, which in most cases are considered significant. A vast majority of the impacts lack a thorough discussion of the reasons why "No mitigation is recommended". Such statements are contrary to CEQA/NEPA requirements (Sundstrom vs. County of Mendocino and Methow Valley Citizens Council vs. Regional Forester). Several examples are given in our specific comments on this project in Attachment C to this memorandum. Additionally, under cumulative impacts for

2-12b biological, recreational, and hydrological resources, the mitigation provided is some sort of advisory opinions to other permitting agencies. For example, on Page 4-65 the document states "Responsible agencies should require revegetation plans for all projects.". Such mitigation measures are non-specific and meaningless because they neither identify the responsible agency nor do they disclose for public and agency review the specific measures required for this project. Again, on Page 4-69 the document states that "Cumulative impacts to local deer herds are potentially significant." However, under mitigation the document states "New projects should contribute to off-site mitigation measures proportioned to their relative impacts on deer." The document fails to discuss the off-site mitigation measures and why this project should not be required to provide mitigation.

2-13 a For the above reasons, the Department concludes that the DEIS/EIR is substantially flawed and fails in several aspects to comply with crucially important sections in CEQA and NEPA. b We hereby incorporate by reference all documents and correspondence filed by the Department in its appeal of the FONSI and the Plan of Baseline Data Collection and all comments filed during scoping meetings for this project.

Thank you for the opportunity to review and comment on this project. If you have any questions, please contact Fred Worthley, Regional Manager of Region 5, at 330 Golden Shore, Suite 50, Long Beach, CA 90802 or by telephone at (213) 590-5113.

Eugene V. Toffoli
Legal Advisor

Attachments

Attachment A

General Comments

Impacts to the Hydrologic Resources of the Natural Geothermal System Supporting Hot Creek Hatchery and Hot Creek Gorge

Important environmental issues regarding the proposed project are (1) the individual impacts of the PLES I project on spring discharges and (2) the cumulative impacts of the PLES I project together with other projects on those discharges. The principal springs at issue include the springs in the Hot Creek Gorge area and the springs in the Fish Hatchery area. The PLES I project and
2-14 other existing and proposed projects will have a significant adverse impact on the thermal component of spring discharges, but an adequate evaluation has not been made of the impacts.

The projects will "mine" heat from the natural geothermal system in order to produce electrical power. The cumulative rate of heat production, or rate of mining, for the existing and proposed projects will be about 1.5 x 10 (8) calories per second. Over the planned 30-year life of the projects, a total of 1.4 x 10 (17) calories of heat will be removed. This will result in the cooling of part of the geothermal system. In the affected areas the temperature within the geothermal system will be reduced by as much as 100 degrees Centigrade. The affected volume of the geothermal system will be 2.6 x 10 (9) cubic meters. If the assumption is made that the system is 150 meters or 500 feet in thickness, the affected surface area will be 170 square kilometers or 7 square miles. Therefore, the mining of heat will create thermal "pits" within the geothermal system that have a depth of 500 feet and a cumulative surface area of 7 square miles. These "pits" are analogous to the excavations of open-pit mines. However, in the case of geothermal development, heat is excavated
2-15 instead of mineral ore.

The cumulative volume of the thermal pits is independent of whether the source of the mined heat is stored or replenished heat. As a more general statement, it is also independent of the conceptual model that applies to the geothermal system. This can be understood from the following analogy: Imagine a barrel that has been filled with water to overflowing from a garden hose. Now consider the first of two situations. The tap is still on and water is overflowing from the barrel. Then, a bucket is dipped into the barrel, and a bucket-full of water is removed. The overflow from the barrel stops because the water level in the barrel is now below its top. The overflow remains stopped until the barrel refills from the flow in the hose. Now, consider the second situation. Instead of dipping the bucket into the barrel, the hose is removed from the barrel in order to fill the bucket. While the hose is removed from the barrel, the overflow from the barrel stops. In each case the flow stopped, and the length of time that the overflow is stopped is identical. Accordingly, no difference exists between taking water from storage (the first case) or taking water from the supply (the second case). Exactly the same result applies to the removal of heat from the geothermal system, where in the analogy the overflow is the natural heat discharge from the geothermal system. The source of the heat has no influence on the ultimate impact.

Initially, individual pits will form around each of the existing and proposed projects. However, as geothermal projects are operated over a 30-year period or longer, the pits will increase continuously in size. In some instances, the pits of adjacent projects may eventually merge to form a single larger pit. Ultimately, heat will have been excavated beneath a surface area of 7 square miles.

However, these thermal pits will not remain stationary. They will be swept from the project area toward the southeast to the vicinity of Hot Creek Gorge and the Fish Hatchery springs. The pits will migrate because they will move with the water that flows within the geothermal system. Data are not available to determine the rate of migration. However, based upon reasonable assumptions regarding the possible ranges of the determining factors, the pits probably will migrate at a rate between 50 to 500 meters per year. These rates translate into travel times of 80 and 8 years. Regardless of the rate of migration, however, the pits eventually will reach the Hot Creek Gorge and the Fish Hatchery springs.

2-15 The mining of heat from the geothermal system will create a heat deficit in that system. That deficit ultimately will be manifested in part as decreased temperatures in the thermal component of the spring discharges. The heat deficit might be thought of as a "pollutant" within the natural geothermal system. The mining of heat by the projects will introduce the pollutants into the system. After project operations have been terminated, the pollutants will remain within the system until they are discharged from the geothermal system in the areas of natural thermal discharge, where the discharges include the convective heat flow from springs and conductive heat flow to the land surface.

The Draft EIR neither acknowledges this ultimate outcome nor attempts to analyze it in any meaningful manner. Crude models have been developed in order to predict the impacts of geothermal development on Hot Creek Gorge and the Fish Hatchery springs. However, these models do not represent the essential elements of the geothermal system with regard to the response of the system to development. The most important element is that the development and migration of the thermal pits is a transport phenomenon, and at least the migration of the pits must be treated explicitly as such in any model that is proposed as a tool for predicting the impact of geothermal development. A second element is that the relevant transport processes occur within a particular hydrogeologic environment, and the model must incorporate information about the local properties of the hydrogeologic system. The existing models that were used in the preparation of the EIR incorporate neither of these essential elements.

2-15 The EIR is flawed both in the methods that are used and in the conclusions that are reached, and it should be rejected as a statement of the impact of development on the geothermal system. From consideration of just the most basic physical laws of the conservation of mass and the conservation of energy, the only possible conclusions regarding the impacts are (1) that geothermal development will create thermal pits within the geothermal system, (2) that pits will ultimately migrate to areas of natural thermal discharge, and (3) that the temperatures or heat flux of the natural discharges will be reduced. These conclusions hold regardless of the conceptual model that is applied to the geothermal system. The issues represented by these conclusions are not addressed in the EIR.

Specific Comments

2-16 1. Page 4-36, Paragraph 2: The design of a viable monitoring program demands that the phenomenon to be properly monitored be properly considered. Owing to reinjection, significant pressure changes will not occur within the regional geothermal system. However, reinjection of colder water will create the thermal pits that were described above. Once the pits are created, they cannot be removed in any practical manner. The pits will migrate within the regional geothermal system. Then, especially if the rate of migration is slow, all that a monitoring program will do is to track the inevitable migration of the pits to the areas of natural thermal discharge.

2-17 2. Page 3-40, Paragraph 1: Considering the cumulative impact of the PLES I project, together with other existing and proposed projects, the projects will produce thermal pits with a surface area of 7 square miles. This value is calculated by assuming a rock-water heart capacity of 5.5 x 10 (5) calories per cubic meter, a thickness of 150 meters, a temperature differential of 100 degrees Centigrade, and a cumulative production over 30 years of 1.4 x 10 (17) calories. The conclusion is that the projects cumulatively will create very significant thermal pits within the natural geothermal system.

2-18 3. Page 4-41. Paragraph 1: The migration of the thermal pits to Hot Creek Gorge or to the Fish Hatchery springs does not require an "extremely abnormal" flow pattern. It simply requires the consideration of alternative flow patterns. Nevertheless, the important fact is that the thermal pits

2-18 inevitably will migrate to the areas of natural thermal discharge. That outcome holds regardless of the conceptual model or flow patterns that apply to the actual system and that outcome should not be in dispute.

4. Page 4-41, Paragraphs 3 and 4: Little is known about the large-scale bulk permeability of the geothermal system. Accordingly, statements about fluid velocities are merely speculations. The actual velocities easily could be an order of magnitude higher than stated and the travel times
2-19 concomittantly could be an order of magnitude shorter. Regardless of the fluid velocity, the thermal pits will inevitably migrate to the areas of natural thermal discharge. Furthermore, impacts will always be impacts regardless of the time at which they occur.

5. Page 4-43, Paragraph 2: The fact that impacts have not yet occurred is absolutely no evidence that impacts will not occur at some future time. The model calculations are no evidence that impacts will not occur because the models do not represent the essential features of the geothermal system.

Models can be valuable tools for the assessment of the impacts of development on the geothermal system. However, models easily can be misused by accident or for other reasons.
2-20 Models are nothing more than a formal statement of the modeler's assumptions regarding a specified system. If the modeler's underlying concepts of how the system behaves are incorrect or overly simplified, then the predictions that are made using the model will be incorrect. The art of model building is to identify the essential elements of the system and to incorporate those elements into the model. However, the models that were used in the development of the EIR are based on an overly simplified conceptualization of the system, and are therefore not valid predictors of the response of the system to development.

6. Appendix C, Page 32, Paragraph 3: The pressure-response and bulk models probably provide a reasonable gross assessment of the pressure effects within the geothermal system and of the initial development of the thermal "pits" within the vicinity of the reinjection wells. The heat-balance model can only provide qualitative indications of the direction of long-term
2-21 regional impacts, and it cannot produce quantitative predictions of the magnitude of the impacts. The problem with the heat-balance model is that it does not sufficiently represent the essential features of the actual geothermal system. Additionally, certain parameter values of the model (such as the reservoir volume) are difficult to assign

2-21 properly, and the quantitative predictions are sensitive to the selected values. To assess the long-term regional impacts, a more physically based model would be required.

7. Appendix C, Page 45, Paragraph 2: The block sizes that are used in the heat-balance model should be selected to encompass just the area over which temperature changes will occur. Likewise, the blocks should not include areas in which temperature changes do not occur. The block sizes used in the Papadopulos model assume that temperature declines will spread laterally over a width of about 1,300 meters. The heat-balance model that is described in Appendix C implicitly
2-22 assumes that temperature declines will spread laterally over a width of 3,700 meters. However, calculations in Appendix C using the bulk model state that the thermal front would spread laterally 800 meters. Therefore, the heat-balance model that is described in Appendix C is inconsistent with the bulk mode. However, the Papadopulos model is more consistent, but an even smaller reservoir volume might have been used in that model.

8. Appendix C, Page 46, Paragraph 1: Given the actual magnitude of the resource and the environmental constraints on its development, the combination for the existing and proposed projects taken together represent an unreasonable expectation regarding the magnitude of possible development. The projects
2-23 taken individually and in aggregate represent a significant risk to the environment and perhaps a significant risk in terms of economic viability of the projects.

9. Appendix C, Page 47, Paragraph 1: The results obtained with the heat-balance model that is described in Appendix C do not indicate what actually might occur within the geothermal system. The arbitrary use of a reservoir volume that is much too large results in computed temperature declines that are much too small. As discussed in Item 7 above, the block
2-24a widths should be equal to the width that will be affected by temperature declines. That width is significantly smaller than that which has been used in the heat-budget model described in Appendix C. Accordingly, the simulation results are meaningless regarding the magnitude of impacts.

<u>Summary Remarks</u>

Much has been made in the EIR and elsewhere of the controversy regarding the conceptual model that applies to the geothermal system. However, that controversy has little relevance to the
2-24b larger picture, because the general impacts of the projects will occur regardless of which model ("lateral flow" or "upwelling") properly describes the actual system. Most of the remarks that have been made above are not based on any particular conceptual

mode. Regardless of which conceptual model applies, the project will impact the areas of natural thermal discharge. The only relevance of the conceptual model to a discussion of impacts is
2-24c with regard to the temporal and spatial distributions of those impacts. Nevertheless, the total "mass" of the impact is independent of the conceptual model.

Assessing the Impact of Geothermal Development in the Casa Diablo Area on Spring-Source Aquatic Habitats and Wildlife

Natural resources potentially affected:

Although variability in surface flow rates and temperatures are natural for many thermal springs, the potential ecological effects of any permanent or transient changes in spring activity produced by geothermal fluid extraction need to be considered as an element of environmental impact assessment and monitoring. Geothermal development has an unknown impact on the uniquely adapted flora and fauna of local surface flows (hot springs, mineral springs, outflow ponds and marshes) that are supplied by the geothermal reservoir of the Long Valley caldera. The microbial, plant, and animal communities of thermal waters in this area have not been surveyed.

2-25

Unique and endemic species are often found in these habitat types because of the isolation of populations in small springs, and adaptation to a narrow range of locally unique conditions (of temperature and mineral content). The inhabitants of these springs are primarily invertebrates, especially insects, but may include vertebrates such as fish and amphibians, and water birds that often feed at and nest around these habitats.

Some of the possible impacts of geothermal development include the loss of habitat and rare or endemic species if spring flows run dry, elimination of certain flow- and temperature-sensitive species if physical conditions change, and reduced habitat quality for birds and other vertebrate wildlife if the biological community of springs become less productive. In addition, pristine hot spring habitats, like other desert waters, are becoming more and more rare, and representative ecosystems need to be preserved as part of the natural heritage of this region.

Surveying the problem:

2-26

Before it is possible to develop a resource management strategy, it is necessary to survey and inventory the resource. The spring-source aquatic habitats of the Long Valley caldera include thermal and mineral springs, streams, and outflow marshes and ponds. These all may be directly or indirectly dependent on the geothermal reservoir as a water source. The objective of surveying these habitats is to establish what species are present, whether certain species or springs are rare or threatened by geothermal extraction, and how sensitive habitats may be protected. The scope of the survey should include the following elements:

(1) Seasonal sample collections of invertebrates in all spring-source habitats identified in the area affected by geothermal development at Casa Diablo (species will be identified from these samples, and their prevalence recorded as common, rare, or endemic). Community composition may be used as a baseline for monitoring changes, and the presence of rare species used as a criterion for identifying habitats to be protected.

The area to be surveyed is essentially the same region as that proposed for monitoring under the USGS sampling scheme of Farrar and Sorey (1987). Integration of the surveys suggested here with the USGS hydrological monitoring program would provide a valuable bio-monitoring component to the system to detect changes in habitat quality and gaurd against the loss of sensitive and/or rare species.

The survey area should include:

* springs and geyser outflow at Casa Diablo
* Colton springs and Meadow spring
* springs in Fish Hatchery area, including Hot Bubbling Pool
* springs in Hot Creek Gorge area
* springs in Little Hot Creek Gorge area
* Big and Little Alkali Lakes
* Mammoth Creek (in Chance Meadow)
* Hot Creek
* Hot springs and outflows in Whitmore area

2-26

These areas are all to the east and south of Casa Diablo, within the region expected to be influenced if lateral flow from the geothermal reservoir is the accepted hydrologic model. Sorey (1985) suggests that the shallow (500 ft depth) reservoir that supplies the geothermal fluid from which power is generated at Casa Diablo, continues eastward from this area, to Lake Crowley, dropping in temperature from 170 C to 70 C.

(2) Monitoring of temperatures and flows of surface waters to provide a baseline for assessing natural variation and changes due to geothermal development (the monitoring outlined by USGS).

(3) Determine temperature tolerance range for selected species in relation to natural variation and potential thermal changes associated with geothermal development.

(4) Collect field records of the usage of aquatic habitats by birds and other vertebrate wildlife.

References:

Farrar, C.D. and M.L. Sorey. 1987. Plan for hydrologic monitoring of thermal and nonthermal water resources of the Long Valley caldera, Mono County, California. Final draft report sent to Mono County Planning Commission, September 1987.

Sorey, M.L. 1985. Evolution and present state of the hydrothermal system in Long Valley caldera. J. Geophy. Res. 90:11219-11228.

Consultation and advice on these geothermal aquatic habitat surveys was provided by Dr. David B. Herbst of the Sierra Nevada Aquatic Research Lab (University of California). Dr. Herbst holds a degree in entomology and zoology, and specializes in research on the dipterans (flies) of desert waters, the most common group of invertebrates found in thermal springs. He has studied aquatic invertebrates of the Eastern Sierra and Great Basin for over 12 years. The Department of Fish and Game recommends that Dr. Herbst be given high consideration as principal investigator when such survey work is undertaken.

Attachment C

Specific Comments

1. Page ES-22: The value of the eggs at the Hot Creek Hatchery is in some ways undeterminable since many of the eggs produced there are of a unique strain and not replaceable at this time.
2-27 The document states that the current market value is up to $16,000. This figure is incorrect. The current market value is approximately $250,000 if they were available.

2. Page 1-3, Bottom Paragraph: We strongly disagree with the first statement in this paragraph. The Department position has been that an EIS/EIR must provide a thorough discussion of
2-28 project impacts, mitigation measures, and a wide array of alternatives in order to fulfill the requirements of CEQA and NEPA.

3. Page 1-6: The Department has also raised concerns over the
2-29 loss of springs in the Casa Diablo area.

4. Page 2-5, Paragraph 5: The statement that the project will
2-30 avoid mature trees "whenever possible" is vague. For this mitigation to be feasible and effective specificity is needed.

5. Page 2-5, Paragraph 8: The statement that pipelines will be buried or screened "as appropriate" is vague. Specific
2-31 measures and locations should be described to mitigate impacts to migrating deer, visual quality, and other resources.

6. Page 2-6, No. 12: The statement that ". . . noise intensive activities may be limited" lacks specificity. The deer migration periods should be extended from April 1 through June
2-32 30 and October 1 through November 30 to provide for known variability due to annual weather variations. The document should prohibit construction activities during these periods to provide allowance for the needs of migrating mule deer.

7. Page 2-6, No. 13: Provides inadequate fencing specifications.
2-33 This section should be reworded to provide for the needs of migrating mule deer.

8. Page 2-7: The Department is not listed as one of the
2-34 consulting agencies here but is elsewhere.

9. Page 2-29, 2nd Paragraph: In this section, or elsewhere, the document should thoroughly discuss effects of trenching,
2-35 retaining walls, pipelines, and all other project disturbances on migrating deer and measures to provide for deer passage in such areas throughout the project.

10. Page 2-48, Impacts of Alternatives: Table 2.5 lacks discussion of project impacts and mitigation measures for two
2-36a biologically sensitive habitats present, the thermal marsh, and rhyolite buckwheat. Additionally, the description of impacts to migrating deer does not take into consideration construction-related impacts and impedence of deer movements.
2-36b The document does not give a specific reason why "No mitigation is recommended" for this project. Any suggestion that "new projects" in the future "could contribute to off-site mitigation" does not exempt this project from its
2-36c share of mitigation for adverse impacts. This Table is seriously flawed in many other aspects as well.

11. 2-37 Page 3-20: This discussion leaves out the numerous thermal springs located throughout the Long Valley KGRA.

12. 2-38 Page 3-42, Paragraph 3 and Page 3-43, 1st Paragraph: The discussion regarding the migratory habits of the Casa Diablo deer herd is incorrect. A portion of this herd is known to move through or very near the project area, as evidenced by sightings of marked animals.

13. 2-39 Page 3-43, Paragraph 3: The Biotic Assessment (Appendix D) and the Deer Migration Study (Appendix E) reports do not agree with the statement that "This deer movement does not appear to be concentrated in any localized portion of the survey area, but is dispersed throughout it."

14. 2-40 Page 3-47: There are numerous mistakes in the list of Hot Creek Hatchery facts and information, such as: There are more than four state hatcheries in California. Add Madera County to the list of counties stocked with catchable trout. Under natural conditions rainbow trout spawn in the Spring. Temperatures reported are not representative of actual source water temperatures. A temperature of 58°F would not kill eggs that were in incubators but would certainly affect eggs and sperm development prior to spawning.

15. 2-41 Page 4-13: Mitigation Measures 2 and 4 require completion of a study, the results of which are not available to the permitting agencies prior to certification of the document. In addition, moving the power plant to another site would require a new document.

16. 2-42 Page 4-14: Mitigation Measure 5 is strictly a measure aimed at reducing impacts to the project facilities after construction at the expense of increased environmental impacts.

17. 2-43 Page 4-14: An impact to the project area through catastrophic spill requires mitigation to offset the adverse environmental effects.

18. 2-44 Page 4-17: The listed mitigation measure is a reference to another document not readily available to the reader. Thus, one cannot examine its adequacy.

19. 2-45 Page 4-21, Paragraph 3: This section fails to adequately describe the impacts of noise created by the project. It refers to the closest sensitive receptors as the County office buildings. Department concern is for the on-site wildlife receptors of this noise impact, particularly mule deer. No mitigation of impacts to wildlife is proposed.

20. 2-46 Pages 4-29 and 4-32: The calculations presented on expected temperatures at Hot Creek, should a major spill of geothermal fluid occur, are wrong. In one case a mixed temperature of 100°F in Mammoth Creek produces a mixed temperature in Hot Creek of approximately 80°F. In the other case a higher mixed temperature in Mammoth Creek (118°F) produces a lower mixed temperature in Hot Creek (75°F) even though all other conditions remain equal.

21. 2-47 Page 4-30: The suggested mitigation refers to a later section, which turns out to be a bioassay study.

22. 2-48 Page 4-32: In this case the referenced mitigation measure does not even exist.

23. 2-49 Page 4-34: Impact does not identify habitat types which would be affected.

24. 2-50 Page 4-34: The effectiveness of Mitigation Measure 7 is based on information which is not available at this time.

25. 2-51 Page 4-35: The statement that "Shallow-rooted vegetation could be affected if drawdown of the local groundwater should occur from excess pumping at Casa Diablo" supports the Department concern that a substantial, but unknown, risk to wetlands exists. Any net loss of wetlands without compensation is contrary to Fish and Game Commission policy regarding protection of wetlands as well as Section 404 of the Clean Water Act. The document proposes no measures to prevent or offset wetland losses that could occur during the life of the project.

26. 2-52 Page 4-43: The stated impacts are based on a flawed conception of the resource in question. Please refer to Attachment A for a discussion on geothermal development in the Long Valley KGRA and the potential for project-related impacts.

27. Pages 4-47 through 4-56: Mitigation Measure 8 is largely a study aimed at determining when the impacts to the geothermal reservoir from project production activities will reach and impact critical spring flow areas. Within the study design there exists only cursory mention of ways to supply the Hatchery with hot water and the Gorge with makeup flows once these areas are impacted; however, these mitigation measures

2-53 are not presented in sufficient detail to allow decision makers the ability to make informed decisions. The proposed mitigation measures may induce to the system more impacts of the kind they are meant to mitigate. No mention is made of maintaining or restoring the temperature regime to the Gorge area once project-related temperature declines reach this valued resource. The Department finds the discussion centering around the monitoring plan to be inadequate in terms of meeting NEPA requirements.

Also mentioned in this section are two ways in which the project proponent could provide cool water to the Hatchery if water temperatures were to rise due to project power production. The first proposed method, that of drilling new shallow cold water wells, is completely unacceptable and in

2-54 fact was a major reason for the proposed Bonneville Pacific geothermal project. The second method proposed is to recycle water from Hot Creek as it leaves the Hatchery. This method is not as simple as it may appear. The water would need to be cleansed of excess nitrate buildup and reoxygenated. In essence, the water would need to be cycled through a tertiary water treatment plant. This measure is likely to be infeasible.

28. Page 4-56: Mitigation Measure 10 needs to be completed prior

2-55 to granting any permits.

29. Page 4-57: Mitigation Measure 11 does not compensate for the loss of heat due to project impacts. Hot water is the crucial element necessary to support the public swimming area which

2-56 attracts many of the people that make up the annual 95,000 visitor use days (a visitor use day is equal to 12 man hours of use).

30. Page 4-63, Paragraph 1: This paragraph is self-contradictory as evidenced by the statements that "No botanically sensitive areas and no riparian areas would be directly impacted by the proposed project." and "It is possible that botanically

2-57 sensitive rhyolite buckwheat areas could be damaged by activities near injection wells.". We believe that damage to both sensitive habitats (rhyolite buckwheat and thermal marsh) are likely project impacts. Page 4-65 (paragraph 2) admits the fact that cumulative impacts from other projects could be significant to riparian corridors and thermal marshes. The

2-57 proposed revegetation as mitigation for replacement of the sensitive thermal marsh habitat which will be irretrievably lost when surface hydro thermal flows are halted or degraded is inappropriate and infeasible.

31. Page 4-63, Paragraph 2: No specific mitigation is recommended to offset for "possible" damage to the sensitive rhyolite buckwheat ecosystem. Rather, several vague, unquantified and likely ineffectual measures are listed, such as ". . . care should be taken to avoid existing vegetation whenever
2-58 possible" (emphasis added), ". . . only minimum made to vegetation and soil would occur", and "Revegetation would be done as soon as practical" (emphasis added). These statements give the misleading impression of a benign project based on good intentions. This approach is contrary to NEPA and CEQA regulations and court interpretations which require that for mitigation measures to be effective they must be site-specific.

32. Page 4-64 to 4-65: The impact section does not recognize the
2-59 loss of thermal marsh (wetland habitat type) due to loss of thermal springs, and thus it is incomplete.

33. Page 4-65, Paragraph 2: Another example of inadequate impact analysis is presented here due to lack of discussion of possible effects of dewatering of thermal and freshwater
2-60 surface flows or resultant impacts to wetlands. The mitigation measure to require revegetation plans is unproven and nonspecific and therefore unacceptable.

34. Page 4-65, Environmental Consequences - Terrestrial Wildlife: This entire section fails to meet NEPA and CEQA requirements
2-61 by repeatedly citing unknown impacts to resources and by recommending either no mitigation or inappropriate, unproven, or infeasible mitigation.

35. Page 4-65, Bottom Paragraph: This section could be made accurate by restating that populations of wildlife dependent
2-62 upon sage brush scrub and Jeffrey pine habitats would be reduced commensurate with the loss of up to 13 acres of these habitats. No mitigation is recommended for this unavoidable habitat loss.

36. Page 4-66, Paragraph 1 and Page 4-67, Paragraph 3: This section states that the effects of project noise on mule deer
2-63 and songbirds cannot be known or predicted, and thus wrongly concludes, that no effects to populations will occur. A worst-case analysis is required for appropriate mitigation.

37. Page 4-66, Paragraph 2 and Page 4-67, Last Paragraph and Page 4-68, Paragraph 1: This paragraph contains several contradictions and unjustified conclusions. For example: If pipelines are aligned to funnel (trap) deer into impassable areas, what opportunity will they then have to avoid the project area? No mapping of pipeline configuration is provided. No attempt is made to preclude such deleterious, even fatal, trapping of deer by project facilities. This discussion then provides the irrelevant analogy of deer jumping eight-foot fences to reach succulent forage, ignoring the fact that the animals at Casa Diablo are not going to be willingly jumping to highly desirable feed but will be pregnant does under nutritional stress on a rigorous migration. The section also states "It is therefore likely that some, or perhaps many, of the adult deer could jump single pipelines along most of the length.". This statement does not take into consideration many adults and sub-adult deer that won't make it over the pipeline.

2-64

We do agree with the final three sentences in this paragraph - "However, there is no information available on how effective a deterrant the pipeline would be to normal migration or what the effect would be on pregnant deer in the spring migration or young deer in the fall migration. It is possible that some deer would be adversely impacted. Does carrying fawn may be more vulnerable to stress from disruptions.". Despite this information, no specific recommendations for mitigation are provided. Rather, the document provides the highly ineffective and vague measures to require ". . . below grade installation or screening of pipelines as appropriate" (emphasis added). Vague reference to fencing approval is also mentioned, meaning measures such as pipeline burial, crossing ramps, specified fencing designs, or the designation of an inviolate deer migration corridor (with Department and U.S. Forest Service input), or others are deleted.

2-65

Additionally, both wildlife studies (Appendices D and E) discuss several mitigation measures, none of which are incorporated into the proposed project design. Results of current, expanded deer surveys should be incorporated to more adequately describe the deer resource present. Due to the unknown nature of impacts, the document is required under NEPA and CEQA to display a worst-case analysis of impacts to mule deer.

38. Page 4-67, Paragraph 2: If fewer than 10 acres (e.g. 8 acres) of Jeffrey pine habitat is lost, then the wildlife using that habitat will also be lost. Thus, it is wrong to assume that no significant impacts to populations of residential species will occur. The Department considers significant over time

2-66

2-66 the annual loss of up to 10 summering mule deer does and their annual production of up to 15 fawns. Mitigation for this loss is warranted.

39. Page 4-68, Paragraph 2: This passage misinterprets the Deer Migration Studies (Appendix E). Kucera actually said that the initially proposed site, adjacent to the existing MPI plant, would have less impact on mule deer than the site now proposed in this document. This fact renders ineffectual the
2-67 mitigation to locate the plant as proposed in this document since that alternative does not represent a benefit to mule deer or other wildlife. In essence this section attempts to make the case that this proposal is self-mitigating regarding mule deer since this proposed alternative has lesser impacts than some other proposal having greater impacts without making a detailed analysis of both alternatives

40. Page 4-69, Section 4.2.2.5, Abandonment and Reclamation Impacts: The Department must conclude that ". . . The habitat
2-68 value of the site would be regained" only if all vegetation were guaranteed (by bonding, letter of credit, or other financial means) replaced in kind and quantity.

41. Page 4-69, Section 4.2.2.6, Cumulative Impacts: We find that habitat destruction will impact the species and that such loss
2-69 should be mitigated but not as vaguely proposed by "minimizing" timber harvest.

42. Page 4-69, Cumulative Impacts to Deer Herds: We consider cumulative impacts to deer to be significant and disagree that summer ranges will be unaffected due to project impacts on known summer/fawning use areas. However, winter ranges will be unaffected, but the disruption of migration routes will lead to deer population declines. The statement that the projects are in the "potential" migration routes is misleading because all data demonstrates these projects bisect the actual
2-70 migration route. Yet no on-site mitigation is proposed in terms of project design or other measures. The document, through the proposed mitigation in this section, attempts to relieve the current project of its specific mitigation responsibilities. In fact, the DEIS/EIR is entirely lacking a reasoned analysis of cumulative adverse impacts to migratory mule deer herds and is lacking any meaningful mitigation proposals.

43. Page 4-70, Mitigation of Cumulative Impacts to Mule Deer: This entire section proposes vague, ineffective, and
2-71 therefore, unacceptable mitigation measures such as: While it is reasonable to state that mitigation "could" be pursued by "regulating and limiting development", no specifics are given

2-71 regarding who will mitigate, where, or when such mitigation will be undertaken, or how effective such attempts are likely to be. What will be the resultant effect on the deer herds?

2-72 The proposals to acquire winter range and/or develop water sources on winter range have value for deer herd management. In fact, the Department is now proposing for state funding the installation of Casa Diablo winter range water sources, the acquisition of acreage at Swall Meadow, and the improvement of winter range condition in Round Valley. The Department must now question the effectiveness/appropriateness of these mitigation measures designed to improve winter ranges while at the same time impacts to the migration corridor and to summer/fawning habitat will be allowed to occur by new projects. In fact, improving winter ranges will not offset the effects of blocked or impaired migration routes. Further, if such measures were adopted, it must be stated that all costs are the responsibility of the projects creating the impacts. It is inappropriate to suggest that the public should fund mitigation measures necessitated by the profit-generating projects of private enterprise. Additionally, the document accurately cites the unknown effectiveness of the proposed measures (see Methow Valley Citizens Council vs. Regional Forester).

44. 2-73 Page 4-70: No mitigation was recommended for an impact to aquatic and terrestrial life impacted by geothermal fluid spills. Such mitigation measures as removal of sediment, habitat enhancement, increased angler use, and monetary compensation for recreational loss may be applicable.

45. 2-74 Page 4-83: No mention is made of the loss of hot water at the Gorge or the importance of this loss.

46. 2-75 Page 4-84: Loss of hot water at the Gorge is not mitigated.

47. a Page 4-90, Visual Resources: Our comments in the Department's Appeal on the FONSI for this project (Statement of Reasons) are hereby incorporated by reference.

2-76 b Specifically, we find unacceptable the planned reduction of visual quality along the State-designated scenic corridor of Highway 395. We conclude that such degradation will adversely affect fish and wildlife resource users as well as these resources. Additionally, we find the proposed measures to reduce visual impacts to be vague and ineffective by employing such wording as ". . . will avoid mature trees whenever possible" (emphasis added), ". . . partially or completely revegetated as soon as practical . . ." (emphasis added), "to the extent compatible with engineering. . . " and ". . . provide visual screening to the extent possible " (emphasis added). No meaningful, assured mitigation is recommended, and the discussion of cumulative visual impacts is inaccurate and cursory.

APPENDIX B

48. 2-77 Landscape and Revegetation Master Plan, Pages 4 and 5: This discussion stimulated thinking on a possible option for meaningful mitigation. The designation of a negotiated, inviolate migration corridor could partially offset project impacts. The value of such designated habitat could be increased through vegetation enhancement such as plantings of desirable plants, fertilization, irrigation, or other means.

49. 2-78 Page 6: The discussion of "trenching" is a logical place to mention pipeline burial or, at a minimum, the construction of sizeable earth ramps to facilitate deer movement.

APPENDIX D

50. 2-79 Biotic Assessment, Page 18, Paragraph 5: The mention of existing impacts to the thermal marsh ecosystem underscores the lack of and the need for more adequate discussion of cumulative impacts created by this and other development projects on botanically sensitive habitats and other natural resources.

51. 2-80 Biotic Assessment, Page 31, Paragraphs 1 and 2: This section provides possible measures to at least partially mitigate impacts to sensitive habitats. No such measures are mentioned in the DEIS/EIR.

52. 2-81 Page 31, Paragraph 4: This section reemphasizes the need for a cumulative study of projects in the Mammoth Basin vicinity and their impacts on the resources.

53. 2-82 Page 32, Paragraph 1: This section testifies to the "heavy" use by deer of a portion of the project site based on biological observations. It contradicts the Kucera (1987) report in this respect, creating a degree of uncertainty of impacts.

54. 2-83 Page 32, Paragraph 2: This discussion supports the Department conclusion of decreased wildlife populations resulting from habitat loss.

55. 2-84a Page 32, Paragraphs 3 and 4: This discussion supports the Department conclusion of significant net impacts of construction and habitat loss to wildlife reproduction, including songbirds and mule deer. 2-84b It also supports the need for specific mitigation for probable impacts of pipelines.

56. 2-85 Page 33, Paragraph 2: Our Appeal (Statement of Reasons) states that migratory deer are ". . . known to avoid areas of human occupation . . . high noise level, . . . (facilities)

2-85 with a high visual relief." We disagree that the animals "may habituate to any acceptable degree. Experiences at Colorado ski areas substantiate our position (Czencush, 1986).

57. Page 36, Paragraph 2: We agree that project facilities (especially pipelines) ". . . most likely will affect staging areas for the spring migration of mule deer . . ." and with the stated impacts to habitats, increased road kills, disturbance, and the stated potential cumulative effects, and

2-86a suggested mitigation measures. In spite of this valuable and objective discussion, the DEIR/EIR fails to recognize potential impacts or to provide meaningful mitigation measures for mule deer impacts. The discussion also describes deer use concentrated in the eastern and northern portions,

2-86b contradicting the Kucera report and emphasizing the need for the document to evaluate another viable alternative.

APPENDIX E

58. Deer Migration Studies, Kucera, Page 22, Paragraph 3: This

2-87 section suggests the need for a comprehensive, cumulative impact study.

APPENDIX F

59. Cumulative Development: This appendix, and the whole DEIS/EIR provide only a mere listing of area projects which can reasonably be expected to create impacts to resources. No reasoned impact analysis is provided. THIS DEFICIENCY IS

2-88a ESPECIALLY APPARENT IN REGARD TO MULE DEER AND OTHER WILDLIFE. On the final page of this appendix there is a lack of data necessary for cumulative impact analysis of effects to freshwater and thermal components of Hot Creek. This justifies the need for a worst-case analysis.

2-88b

END OF COMMENTS

United States Department of the Interior

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
Post Office Box 1298
Santa Rosa, California 95402

Telephone: (707)-576-1740

August 8, 1988

Mr. Curtis Milliron
California Department of Fish and Game
407 West Line Street
Bishop, CA 93514

Dear Curtis:

Water temperature measurements have been made at the Hot Creek Fish Hatchery
H-2, 3 supply spring over the course of the last few years. Below is a tabula
tion of water temperatures measured in one of the source vents for H-2, 3. All
the measurements listed were made by me, using care to take consistent readings
in the same vent on each visit. All temperatures were measured with an ASTM
certified laboratory thermometer except for the measurement on November 18, 1986
(in which case a thermometer tested for accuracy to 0.5°C was substituted). ~~The~~
temperatures measured with an ASTM thermometer are accurate to within 0.1° Celsius.

2-89

Date	Temperature (°C)
June 21, 1984	11.1
April 28, 1985	10.8
April 8, 1986	11.0
July 19, 1986	10.9
August 29, 1986	11.1
October 10, 1986	11.2
November 18, 1986	11.5 – ± 0.5°C
April 21, 1987	10.8
May 27, 1987	10.8
June 18, 1987	10.8
July 28, 1987	10.9
June 2, 1988	10.8
June 3, 1988	10.8
June 21, 1988	10.9
July 11, 1988	10.9

As record becomes available from the Geological Survey's continuous water
temperature monitor at the H-2, 3 vent, I will keep you informed.

Sincerely,

Christopher D. Farrar
Hydrologist

ATTACHMENT D

requires the Secretary of Commerce to obtain the views of Federal agencies affected by the program, including the Department of the Interior, and to ensure that these views have been given adequate consideration before approval of Coastal Zone Management Plans. The Service provides the Department's views about fish and wildlife resources. Pursuant to the Coastal Zone Management Act Amendments of 1980 (Pub. L. 96-464) the Department of Interior provides comments on Federal grants to help States protect and preserve coastal areas because of their ". . . conservational, recreational, ecological or aesthetic values." The 1980 Amendments also authorize the Department of Interior to enter into Special Area Management Planning to ". . . provide for increased specificity in protecting natural resources, reasonable coast dependent economic growth . . . and improved predictability in government decisionmaking."

Water Bank Act (16 U.S.C. 1301-1311). This Act requires that the Secretary of Agriculture ". . . shall consult with the Secretary of Interior and take appropriate measures to insure that the program carried out . . . is in harmony
2-90 with wetlands programs administered by the Secretary of the Interior."

Wild and Scenic Rivers Act (16 U.S.C. 1271-1287). This Act requires the Secretary of the Interior to comment on such proposals. The Fish and Wildlife Service provides the Department's views with regard to fish and wildlife resources.

Geothermal Steam Act of 1970 (30 U.S.C. 1001-1025). This Act requires that the Fish and Wildlife Service recommend to the Secretary those lands that shall not be leased for geothermal development by reason of their status as ". . . a fish hatchery administered by the Secretary, wildlife refuge, wildlife range, game range, wildlife management area, waterfowl production area, or for lands acquired or reserved for the protection and conservation of fish and wildlife that are threatened with extinction."

Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.). This Act requires the Department of the Interior to regulate surface mining and reclamation at existing and future mining areas. The Fish and Wildlife Service provides the Department with technical assistance regarding fish and wildlife aspects of Department programs on active and abandoned mine lands, including review of State regulatory submissions and mining plans, and comments on mining and reclamation plans.

Outer Continental Shelf Lands Act Amendments of 1978 (43 U.S.C. 1801). This Act requires the Secretary of the Interior to manage an environmentally sound oil and natural gas development program on the outer continental shelf. The Fish and Wildlife Service provides recommendations for the Department regarding potential ecological impacts before leasing in specific areas and contributes to environmental studies undertaken subsequent to leasing.

Mineral Leasing Act of 1920, as amended (30 U.S.C. 185). This Act authorizes the Secretary of the Interior to grant rights-of-way through Federal lands for pipelines transporting oil, natural gas, synthetic liquids or gaseous fuels, or any other refined liquid fuel. Prior to granting a right-of-way for a project which may have a significant impact on the environment, the Secretary is required by this Act to request and review the applicant's plan for construction, operation, and

We wonder why the obvious intent of this law was overlooked when the leases in Long Valley were being drafted. We frequently supply trout eggs from Hot Creek Hatchery to Federal hatcheries throughout the Nation.

(49 U.S.C. 1716). This Act requires the Secretary of Transportation to ". . . consult with the Secretary of the Interior with regard to the effect that any project . . . may have on natural resources including, but not limited to, fish and wildlife, natural, scenic, and recreation assets, water and air quality, and other factors affecting the environment . . .".

Department of Transportation Act (49 U.S.C. 1653(f)). This Act makes it national policy that ". . . special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites . . ." and requires that the Secretary of Transportation ". . . cooperate and consult with the Secretary of the Interior in developing transportation plans and programs that include measures to maintain or enhance the natural beauty of the lands traversed." The Departı of Transportation projects using protected lands cannot be approveс unless there are no feasible and pru alternatives to avoid such use and, i none, all possible measures to minir harm have been considered.

EXECUTIVE

President's Water Policy Messag (June 6, 1978). This Message directs Secretary of the Interior to promulga procedures for determination of measures to mitigate losses of fish a wildlife resources.

Water Resources Council's *Final Rules; Principles and Standards for Water and Related Land Resources Planning—Level C* (September 29, 1 These rules reiterate the importance participation in the development planning process by interested Fede agencies, including the Department o the Interior. This participation incluc review, coordination, or consultatior

and Wildlife Coordination Act of 19 (16 U.S.C. 661-664) (sic)."

Executive Order 11990—Protectio Wetlands (May 24, 1977). This Execu Order requires that each Federal age ". . . take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhan the natural and beneficial values of wetlands in carrying out the agency's responsibilities for: (1) acquiring, managing and disposing of Federal lands and facilities; and (2) providing federally undertaken, financed or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation and licensing activities." Relevant wetlan concerns and values include, but are

SIERRA CLUB
CALIFORNIA

22 October 1988

RECEIVED
OCT 31 1988
GREAT BASIN
UNIFIED APCD

Mr. James S. Morrison, Area Manager
U.S. Department of the Interior
Bureau of Land Management
787 North Main Street, Suite P
Bishop, CA 93514

Dear Mr. Morrison:

Sierra Club comments on the Draft PLES I Geothermal Project Environmental Impact Statement are being submitted by Mr. Frank Stewart on behalf of the Toiyabe Chapter and by myself on behalf of the Sierra Club of California. My comments are as follows.

Despite its length, the Draft EIS is in many respects superficial in its treatment and it fails to address in requisite depth several critical issues upon which a responsible decision to permit or to deny the project depends. It displays a generally pro-project bias, and accordingly concludes that in most cases the project impacts would be insignificant. The reality of the matter as perceived by informed critics of the project is precisely the opposite.

These shortcomings, in our opinion, are attributable at least in part to the failure of your consultants, ESA, Inc., to respond in depth, or in some cases to respond at all, to the issues which we and other commentators identified in the scoping process prior to the preparation of the EIS. With specific reference to the issues identified in my own letter of 20 July 1988 in response to your solicitation of scoping comments (referred to as Letter and herewith attached), I would note the failure of the EIS to deal with the following.

1. Specific information should have been given in the project description (EIS, Section 2) relating to the proposed and alternate power plant sites. This should have included soil conditions including the proximity of hydrothermal fluids to the surface, geologic structure including possible faulting and potential tectonic activity on the sites, slope, a plot plant of the proposed and alternate sites inclusive of elevations for cuts proposed, volume of soil to be removed, spoil sites planned, and width of roads. It is evident that none of this information is available and that the studies that would produce it have not been undertaken. **3-1**

Pages 4-12 and 4-13 reveal how provisional and contingent the proposed and alternate sites are in face of this lack of information. It is acknowledged that a recent and possibly active fault may underlie the proposed site and that hydrothermal fluid may closely underlie its surface soils, and that the one could cause structural damage and the other could cause foundation problems. For both **3-2**

of these situations it is proposed to move the power plant site as a "mitigation". The author acknowledges that this could "adversely affect other resources", which seems to be a veiled way of saying that project impacts would change, which indeed they would if the plant were to be put in a different location. As for the alternative site given in the EIS, it is stated that that too may be underlain by an active fault, and there, also, the proposed mitigation is to relocate the power plant. A project simply cannot
3-2
dealt with in this way under NEPA. The project location itself must be known and its conditions and its effects on the project must be known in all respects. The EIS cannot be completed until the plant site (as well as the sites for wells and all appurtenant facilties) has been finally determined and its suitability has been verified. Furthermore, it is then, and only then, that the impacts of the project can be adequately assessed and mitigations can be . determined.

2. The EIS fails to identify the Long Valley/Mammoth Lake/June Lake region as one of the most highly prized and heavily used recreational areas in the nation -- as the heartland of the Inyo National Forest, which enjoys over six million recreational visitor days per year -- and it fails to note that the proposed project as well as its proposed sister projects would constitute an expanding industrial complex at literal crossroads of and in the landing and take-off flight path for air travel to and from this region. A document which purports under NEPA to provide an objective evaluation of a proposed project on the human environment cannot avoid dealing
3-3
straightforwardly with issues of land use conflicts and priorities of public benefit which arise in this case. This discussion, together with supporting documentation, should have been provided in the alternatives section of the EIS, with a specific consideration of the "no project" alternative as a means of protecting and enhancing recreational land use in the region. These discussion should have been documented with data regarding recreational visitor uses, habits and attitudes, projections for the recreational future of the region, and current recreationally oriented projects such as the Mammoth Basin Fisheries Management Plan being advanced by California Trout and the California Department of Fish and Game. The same factors should have been brought into the discussion of cumulative impacts.

3. It is evident to all parties that the major issue of public controversy over the proposed PLES I power plant project concerns the effects of the operation of this plant, together with other plants, on the hydrothermal reservoir and its naturally occurring discharges. It is, presumably, controversy over this issue, above all, that led to the decision to prepare an EIS. In light of this,
3-4
it is incomprehensible that the preparation of the Draft EIS would have been brought to conclusion prior to the completion and full consideration of the major study of the reservoir being presently conduscted by S.S. Papadopulos & Associates, Inc. for the California Department of Fish and Game. This constitutes a serious failure to consider all relevant evidence in the preparation of the EIS, as required by NEPA, and ignores the policy established by the Mono County Board of Supervisors requiring comprehensive study of

further geothermal projects on the reservoir before such projects are undertaken (Minute Order 88-119, copy attached).

4. 3-5 The EIS fails to answer a number of vital questions regarding proposed reservoir monitoring and management policies and techniques found in paragraph J of my attached letter of 20 July 1988. Unanswered questions remain as follows. Who will be the "Authorized Officer"? What are his qualifications to make the decisions for which he is given responsibility? Will he make these decisions alone, or with expert counsel? If the latter, how will this be guaranteed and who will these persons be? Will such decisions, the information upon which they are based and their criteria be open to public review and appeal? What opportunity will governmental agencies and interested parties have to participate in the decision-making process? What role will the Long Valley Hydrologic Advisory Committee play in the interpretation of data and in the design and selection of controls or mitigations to be employed? What are the operational rules of that committee? What authority does it have? What kinds of decisions can it make? Will temporary or, if necessary, permanent cessation of project operations be written into the project permit as a mitigation measure? Is this legally possible Is it politically feasible? Can possible effects on hot springs caus by one project (in this case PLES I) be differentiated from those of other projects to the extent that reponsibility can be assigned to one specific project? If not, does this not cloud the legal and/or political possibility of project production being terminated? What assurance can be given that hot springs and other naturally occurring hydrothermal phenomena can be restored, or will restore themselves, even if project operation ceases when changes are detected? If no su assurance is possible, how can the implementation of the PLES I or other projects be justified?

5. 3-6 In its treatment of the visual impacts of the project the EIS fails to acknowledge or to take into consideration, as we requested, the refusal of the Mono County Board of Supervisors to permit the Mammoth Pacific II power plant on a site adjacent to the proposed site for PLES I because, among other reasons, of its "highly visible location near U.S. Highway 395 and the intersection of Hot Springs Road and the extension of State Route 203 (Minute Order 88-118, attached. The Supervisors also record similar findings with respect to the MP II plant in Minute Order 88-122 and with regard to the cumulative visual impacts of MP I, PLES I and MP II in Minute Order 88-121, also attached). The EIS also fails to respond to our observation that re reationists arriving in the Mammoth area by air will be introduced t their recreational destination by a close panoramic view of an industrial facility. We can imagine no possible mitigation for this impact (see Letter, paragraph G).

6. 3-7 The EIS fails to address the issue of the quasi-permanent impacts on land form that would result from the implementation of the project and which would remain long after project abandonment. Restoration attempts would only partially erase the alterations affected by plant sites, roads and retention basins (see Letter, par.

7. Stream rehabilitation in the event of a major spill has not been addressed. Simply restocking with fish if a fish kill should occur (EIS, page 4-72) may not be enough and may be futile if the organisms upon which the fish depend for food supply have also
3-8 been severely impacted. An adequately comprehensive stream rehibilitation program must be developed and proposed as a mitigation. Who will bear responsibility for such a program? Who will pay for it and how will this be assured? Will bonding for this purpose be required of the permittee? If not, why not? (see Letter, paragraph M).

8. The unique ecosystem of Hot Creek and its outstanding fishery and high recreational value is one of the priceless natural features of the Long Valley/Mammoth area. We have asked for and have not received a credible justification for subjecting these values to risk with the implementation of the proposed project. In fact, we have received no justification at all. We have only been assured that the risk is non-existent, but that if degradation should
3-9 occur "thermal water shall be conveyed to the Hot Creek headspring(s)' This says nothing about the present natural mix of thermal and cold surface water, of the maintenance of the natural chemistry of Hot Creek, of possible effects which may occur in relation to the natural thermal discharges downstream in the Hot Creek Gorge, nor of degradation of the Hot Creek aquatic ecosystem. Nor does it assure who will supply hot water to Hot Creek and the Hatchery into the distant future. All of these together require discussion as a public trust issu

I emphasize the fact that all of these questions were asked by ourselves and by others during the scoping period and that they have not been answered.

Specific comments on the contents of the EIS are as follows.

<u>page 1-10, second paragraph</u> -- The dismissal of our assertion of the relevance of geothermal steam condensate spills at The Geysers to the presently proposed project at Casa Diablo has been endemic in these proceedings. Here it is stated in this EIS that ". . . over 80% of the Geysers spills are related to water cooling. At PLES I the geo-
-10 thermal fluid would be circulated in a closed system and the working fluid would be air cooled, so there would be no condensate nor would treatment of it be necessary". This statement completely misses the point! Whether this is by virtue of simple ignorance on the part of the author or whether it is by deliberate avoidance of the point, only the author knows. We ask you to read again and respond to the issue as stated in paragraph K of Letter, attached.

<u>page 2-22, 2.1.5.1.1</u> -- It is stated that the mud pit will be lined. Presumably it will be lined in accordance with the spefications of the
-11 Regional Water Quality Control Board in conformance with the State of California Health and Safety Code.

<u>page 2-27, 2.1.6.4 and 2.1.6.5</u> -- Where are the "some" areas located
-12 in which seedlings and larger plants will be planted? These are not identified in the Landscape and Revegetation Plan.

pages 2-10 to 2-18 -- The project description lacks specificity in
a number of respects. In addition to a need for geological and soils
data with respect to the proposed and alternate power plant sites (see
pages 1 and 2 above), there is a need for the same information regarding
each well site (page 2-11) and the O/CR building site (page 2-18). Is this
3-13 information presently available for the well sites? If so, have these
been finally established? If not, where may they be moved if the sites
are found unsuitable? Where is the O/CR building to be located? It
is a large building (up to 30' x 100'), and it will have its own im-
pacts on the environment. These are nowhere described. On page 2-10
it is stated that the revegetation program will be evaluated after the
3-14 second year. Is this the only evaluation that will take place? The
program should be evaluated every year for at least the first two years
and then every two years with replanting as necessary.

page 3-17, first paragraph -- See comments on noise levels below in
3-15 relation to treatment of noise impacts on pages 4-21 to 4-26.

pages 3-42 to 3-43 -- Tracking studies presently in progress and
further evaluation of existing data may cause modification of the
3-16 conclusions presented in these pages regarding deer migration through
the project area.

page 4-3 -- The same mitigations for dust control should be applied
3-17 during abandonment activities as during the construction period.

pages 4-6 to 4-8 -- Data and calculations for H_2S emissions figures
3-18 and for maximum credible sustained flow from a blowout well (p. 4-7,
first paragraph) should be given.

page 4-6, second paragraph -- What would H_2S levels be at the open
3-19 fluid tanks? How can it be stated that H_2S odor would not be a
nuisance to workers?

page 4-13 -- Mitigations 2 and 4 are not mitigations. They involve
3-20 studies and planning that should have taken place before the writing
of the project description.

3-21 page 4-14 -- The same as above is to be said of mitigation 5.

page 4-14 -- No mitigtations are recommended for the effects of
volcanic eruption or of subsidence. It seems to us that prudent pro-
3-22 ject planning would involve design features and contingency measures
for the protection of the facilites as well as the environment from
damage and spills resulting from these causes.

pages 4-15 to 4-16 -- The same comments as above apply to mitigations,
3-23 and the lack thereof, for the alternate power plant location as for the
proposed location.

3-24 page 4-17 -- The mitigation for subsidence is not a mitigation but a
recommended study.

pages 4-18 to 4-19 -- As noted above, the design and operation of the

3-25 containment basinsseems very vague as they are presented in the Draft EIS. The Effectiveness/Impact analysis (top of page 4-19) of mitigation 6 is not reassuring. Dependence on manual closure of sluice gates in the event of a spill seems fraught with uncertainty. Cannot a more fail-safe procedure be devised? What does "No mitigation is recommended" mean following the Effectiveness/impact analysis?

3-26 page 4-19 -- It is evident that no drainage studies have been conducted for the alternate plant site. This should have been done so that its results clould have been integrated into the project description. From the map of the study area on page 3-36, the ephemeral lakes to which drainage from the alternate site may flow are outside the study area. Why is this the case? Their botanical and wildlife value should have been closely determined so that their sensitivity could have been accurately presented in the discussion of affected environment, and their protection detailed in the project description.

3-27 page 4-20 -- The statement of cumulative impact at the bottom of the page is misleading. While erosion from the PLES I site might be less than 2% of the total of all the projects named, the total will not all be directed toward Mammoth and Hot Creeks. Also, sources of data and calculations should be provided for numerical assertions of this kind.

3-28 pages 4-21 to 4-26 -- The noise section suffers the basic deficiency of failing to regard dispersed recreationists, passing recreational walkers, bikers and car travellers, and wildlife as sensitive receptors. The federal standard of 65 dBA is not satisfactory for this sensitive area. Due to the need for noise control in geothermal operations the Noise Element of the Lake County General Plan specifies 55 dBA (L_{dn}) in residential and other sensitive areas, and since 1984 the standard of 50 dBA has been applied by the Noise Control Officer (Draft Geothermal Resource & Transmission Element of the Lake County General Plan, Vol. 2 (dated 7/12/88)).

3-29 page 4-22 -- Instead of "No mitigation" for traffic noise from the project, car pooling or busing should be stipulated.

3-30 pages 4-23 to 4-26 -- The failure to specify mitigation for construction, well drilling and power plant operational noises from the proposed project is wholly unacceptable. Equipment mufflers, noise baffles, insulation and a variety of other means can be employed. Best Available Control Techology (BACT) as this has been developed for geothermal operations in The Geysers field should be used. Any location in the Inyo National Forest is a sensitive location because of the intermittent presence of sensitive recreationist receptors.

3-31 page 4-25 -- Noise impacts from PLES I are by no means diminished in their significance as seems to be implied by pointing out their incremental contribution to cumulative impacts!

3-32 page 4-27 -- The second sentence of the last paragraph is not clear.

3-33 page 4-34 -- Mitigation 7 is not a mitigation; it is a study.

3-34 page 4-43, last paragraph -- Is the monitoring program referred to as recommended for the project by LVHAC the same plan as that prepared and updated for LVHAC by C.D. Farrar and M.L. Sorey, May 1988? Is it this same plan that is represented in Table 2-4 on pages 2-30 and 2-31? Will BLM adhere to the Farrar/Sorey Plan in all respects? If not, why not, and what differences will there be?

3-35 page 4-63 -- The protective measures presented in the middle of the page are unduly vague: "whenever possible", "as soon as practical". Revegetation should take place during the year of construction, and operational limits should be staked on the ground for the protection of vegetation.

3-36 page 4-63, 4.2.1.2 -- Impacts on botanically sensitive areas should have been avoided in earlier project plannning.

3-37 page 4-64, 4.2.1.5 -- No mitigation is recommended, but it should be as a means of ensuring that the revegetation plan is successful.

3-38 page 4-66, first paragraph -- How is it known that to cause migratory deer to avoid the project area will not adversely affect the population.

3-39 page 4-66, middle paragraph -- Reference to the Sunset New Western Garden Book does not inspire confidence in the impact analysis undertaken in this paragraph. It would seem to us that much more specific information on deer movements than is reflected here is necessary, and that a specific layout design for buildings and piping relating to the facility must be developed in counsel with the Department of Fish and Game to provide uninhibited passage for migratory (and indeed locally moving) deer and to avoid funnelling effects where deer may be trapped.

3-40 page 4-71, top half -- No mitigtation is recommended for the protection of the environment from hazardous materials, but it seems to us that an obviously necessary action is to design and specify safe storage and safe handling procedures for all such materials.

3-41 page 4-72, Mitigation 12 -- A bioassay is not a mitigation. The mitigation after the following paragraph (referring to mitigations (8), (9) and (10) in Section 4.1.4.3.1) is also not a mitigation, for the "mitigations referred to are monitoring and planning measures.

3-42 page 4-74, top of page -- There are no mitigations recommended in Section 4.1.4.1.6 as is claimed here.

3-43 page 4-84, top of page -- As pointed out above, the mitigations referred to in Section 4.1.4.3.1 are not mitigations, but studies. The same, again, it true of mitigation 12 on this page.

3-44 page 4-84, lower middle of page -- No noise mitigation is recommended, but, as pointed out above, recreationists are sensitive receptors and mitigation is appropriate.

3-45 page 4-86, top -- Same comment again with respect to mitigations attributed to Section 4.1.4.3.1.

3-46 page 4-86, top -- It is stated, "no mitigation is recommended" if a spill and resulting fish mortality should occur. Why is this stated? Mitigation is obviously necessary.

3-47 page 4-86, middle -- The reasoning here seems to be faulty. Because a power plant is already near the proposed site and has attendant roads, transmission lines and tanks, the visual situation cannot be visibly worsened by introducing more of the same? As industrial development is expanded and also intensified in the Casa Diablo area it will certainly become more visually obtrusive (as well as obtrusive to ear and nose), and recreational experiences in the locality will certainly be less rewarding.

3-48 page 4-90, top -- No mitigation is recommended for the visual effects of drilling operations. At the very least it should be recommended that rig lighting should be shielded.

3-49 page 4-91, middle -- In the fifth listed impact-reducing measure the word "required" should be substituted for "encouraged" in the last line.

3-50 page 4-91, bottom -- It is stated that over a period of 10 to 15 years the VMO would be met in terms of project visibility. This means that the VMO will not be met until perhaps half way through the life of the project. This is not satisfactory.

3-51 page 4-95, second paragraph -- The reader is referred to Section 3.3.6.2 for existing visual intrusions from the view corridor toward Casa Diablo, but they are not described there. The sentence in which the reference is made is simply project serving. Because there are existing visual intrusions, more intrusions will not constitute significant visual impact!

3-52 page 4-95, middle paragraph -- We question whether the PLES I project can be called "light" industry.

3-53 page 4-102 -- If it is to be claimed that the County is to profit from tax revenues from the proposed project, a more detailed presentation of income and expenditure related to the project needs to be supplied.

I close with two general observations. First, the NEPA requirement for feasible and effective mitigation has not been met in this EIS. As noted throughout our comments, actions which are proposed for mitigations frequently are not mitigations but are studies instead, and we are often told that "no mitigation is recommended" in cases where mitigations are evidently needed.

Second, the treatment of cumulative impacts is regrettably fragmented, being accomplished by the inclusion of a brief paragraph at the conclusion of the discussion of each parameter of the anticipated impacts of the PLES I project. This fragmentation makes it impossible for the reader to gain a comprehensive understanding of the cumulative impacts and also prevents the author from presenting a comprehensive analysis. Further, the discussion is not infrequently focused in a project-serving manner on the relatively small degree of impact that would be caused by PLES I as compared with all other projects together, including three other geothermal projects, skiing development, golf courses, hotels, and airport expansion within the Mammoth/Long Valley region. It must also be noted that except for water use and stream siltation the proposed recreational developments are not relevant to the required discussion of geothermal industrial impacts in this EIS, except that their existence serves to underline the pervasive and continually expanding recreational use and values of the region.

3-54 The treatment of cumulative impacts in this EIS is not adequate.

Sincerely yours,

Hamilton Hess
Geothermal Coordinator

255 Ursuline Road
Santa Rosa, CA 95403

cc: Ms. Ellen Hardebeck
Mr. Dennis Martin
Mr. Frank Stewart
Ann H. Lyons, Esq.

SIERRA CLUB 730 Polk Street San Francisco, California 94109 415 776 · 2211

JUL 25 '88

A.
SFrm
NRM
Administration
Geology
Recreation
VSS
Realty
Archaeology
Range
Maintenance
Fire
Wildlife
Files

20 July 1988

Mr. James S. Morrison, Area Manager
U.S. Department of the Interior
Bureau of Land Management
787 North Main Street, Suite P
Bishop, CA 93514

Ref. CA-11667
3200
(CA-922.5)

Dear Mr. Morrison:

A The Sierra Club applauds the decision of your agency to prepare and Environmental Impact Statement for the proposed Pacific Energy PLES I geothermal power plant project at Casa Diablo in the Inyo National Forest, and we appreciate the opportunity to submit comments relating to critical issues of our concern. Our comments are being submitted both by Mr. Frank Stewart on behalf of the Toiyabe Chapter of the Sierra Club and by myself on behalf of the Northern California Regional Conservation Committee.

B First of all, as we have consistently maintained in the past, we believe that this and other geothermal projects in the Long Valley area are inappropriate and ill-conceived. We believe, together with many other interested parties of record, that such projects will inevitably degrade the scenic, wildland quality of one of the nation's most prized and heavily used recreational areas (more than 6,000,000 visitor days in the Inyo National Forest annually; a higher number than the annual visitor days in Yellowstone and Grand Teton National parks combined) with the situating of a growing complex of industrial facilities at the very crossroads of recreational travel, both by road and by air, to and from the larger region and specific recreational sites within the region itself, and that they are potentially destructive of the unique Hot Creek ecosystem and fishery and threaten the continued operation of the Hot Creek Fish Hatchery of the State of California. For these major reason we are opposed to the project, for we remain unconvinced that adequate mitigations can be devised or guaranteed. At the very least, we believe that this project should not be allowed to go forward at this time. We believe that the Mono County Board of Supervisors acted wisely in denying the Mammoth-Pacific II power plant proposal -- a sister plant to the PLES I plant proposed -- partially, and significantly, on the grounds that ". . . no further geothermal development should be allowed in the Casa Diablo area, whether on lands under County, Town or Federal jurisdiction, until a comprehensive study has been done of the impacts of this project, all other approved or proposed geothermal projects and all other approved or proposed projects of any type which may affect the geology, hydrothermal characteristics, and general hydrology of the area." (Mono County Board of Supervisors, Minute Order 88-119, attached as Appendix A)

To explore, enjoy, and protect the wild places of the earth . . .

We believe that on a scale of value the scenic, recreational and
C ecological assets of the area, which stand under threat of degradation, are vastly higher as a public benefit than the 10 or 20 or 40 megawatts of electricity that might be produced for thirty years by the proposed geothermal projects. This was also the opinion of the Mono County Board of Supervisors when they denied the Mammoth-Pacific II permit in asserting, "There are not benefits of the project sufficient to outweigh the unavoidable adverse impacts and that therefore a Statement of Overriding Consideration cannot be adopted and the project must therefore be denied." (Mono County Board of Supervisors, Minute Order 88-117, attached as Appendix B) The alternatives and cost/benefits sections of the EIS should address these issues forthrightly. From the standpoint of agency policy and action, would not the public good be better served by the Forest Service and the Bureau of Land Management supporting the Wild Trout Park proposal advanced by the California Department of Fish and Game, and by planning and promoting the scenic and ecologic integrity of the Long Valley/Mammoth Lakes/June Lake region as a formally designated National Recreation Area? These and other recreationally oriented programs should be discussed in the EIS for the Casa Diablo-Long Valley area as alternatives to the proposed geothermal electric program.

At least three areas of informational deficiency exist relating to
D the preparation of the EIS. The first is in the lack of site-specific information regarding the location of the proposed PLES I power plant, pipeline routes, and perhaps in some cases the location of well pads. This lack of information precludes an adequate study of visual impacts, and of impacts on land, vegetation and water caused by cut and fill operations. The information problem is even more acute in relation to the alternative location for the plant proposed by the applicant at the scoping session on July 8th. We find ourselves incapable of offering any comments at all on the alternative proposal at this time, and request an opportunity for this when the exact alternative plant site, well pads and pipeline routes have been mapped and staked on the ground. We believe that such information and opportunity for public comment in review of the proposed alternative site is required for the EIS process under NEPA.

The second major informational deficiency is found in the general
E agreement among experts that relatively little is known about the mechanisms and characteristics of the Long Valley hydrthermal reservoir and of the risk of degradation of naturally occurring hydrothermal features by the commercial production of hydrothermal fluids. A further major study of these questions is presently underway by S.S. Papadopulos and Associates, Inc. under the sponsorship of the California Department of Fish and Game. We request that the results of this study be incorporated into the analysis prepared for the EIS. While this would delay the preparation of the EIS beyond the time requested by the applicant, we believe that such delay would be reasonable, given the critical importance of the issue and the high level of public concern.

The third informational deficiency relates to the migratory movements
F of mule deer through the project area. We agree with Finding R of the Mono County Board of Supervisors relating to the denial of the Mammoth-

Pacific II power plant project that "Testimony from representatives of the California Department of Fish and Game shows that this project willadversely interfere with the migration and survival of deer in the project area. Further study is necessary to determine whether the project can be constructed without such interference." (Mono County Board of Supervisors, Minute Order 88-123, attached as Appendix C) We believe that delay in the completion of the EIS is also justified by the need for the information to be obtained.

G Further analysis, conclusions and mitigations must be included in the EIS in relation to visual impacts. These impacts would be generated by the power plant itself, the cooling tower, night lighting, tanks and other appurtenant plant facilities, pipelines, drilling pads, sumps, retention basins, roads, parking lots, and electric lines. On page 4-46 of the original PLES I EIR/EA (prepared forthe Great Basin Unified Air Pollution Control District) it is stated, "... even with mitigations, the plant would be noticed by casual observers and the Project would therefore be inconsistent with the Visual Management Objective of 'Retention'...". The proposed Mammoth-Pacific II plant which would have been closely adjacent to PLES I was denied by the Mono County Board of Supervisors for the following reason, among others: "Geothermal development at the proposed location of this project will create unacceptable visual impacts, which may adversely affect recreation and tourism and which will change the natural character of the environment in the area of the project. While the Mono County General Plan may encourage environmentally sound geothermal development, this Board is not required to and does not accede to this request to permit geothermal operations in the highly visible location near U.S. Highway 395 and the intersection of Hot Springs Road and the extension of State Route 203 where project construction and operation would occur". (Mono County Board of Supervisors, Minute Order 88-118, attached with Minute Orders 88-121 and 88-122 on the same issue, as Appendix) Both of these statements recognize the inherently unmitigable character of the visual intrusions of a geothermal electric power facility. In the case of PLES I (as in the case of Mammoth-Pacific II) the visual intrusion would be perceived not only from Highway 395, as the major route of travel in the highly scenic Long Valley area, but from Hot Springs Road, which is used as a route for recreational access, from higher terrestrial vantage points used by recreationists and sightseers, and from the air. Visual impacts from the air will likely be the most obtrusive to the recreationist whose inital close view of his recreational playground will be dominated by an industrial facility.

H Land form alteration for the construction of power plant sites, drilling pads, berms, sumps, retention basins and roads is not only visually obtrusive during the life of a geothermal project, but persists for an extensive period in human time beyond project termination and abandonment. While some aspects of such alteration can be erased by site reclamation, much of it will remain as an unnatural and undesirable, quasi-permanent feature of the landscape. This must be recognized in the EIS as an unmitigable and significant impact, and it must be credibly justified, if it can be, for imposition on a region valued for its natural beauty and high volume, constantly increasing recreational use.

Recent studies of the hydrothermal reservoir underlying the Long Valley Caldera conclude that too little is known of its sources, mechanisms and characteristics to predict with any certainty what effects any single geothermal project, let alone all proposed projects together, might have on the naturally occurring hydrothermal phenomena within the region in general and upon the springs which serve the fish hatchery and which feed Hot Creek in particular. The unique Hot Creek ecosystem and its outstanding fishery and other recreational uses, together with the $20,000,000 value of the annual production of the State fish hatchery and the monetary value of the hatchery itself, are resources and assets of outstanding public benefit which would be put to appreciable risk with the implementation of the proposed PLES I and related projects. The EIS must give straightforward and credible answers to the following questions: What, if any, protective measures or mitigations can be emplyoed to reduce this risk to zero? How feasible are they for actual implementation? What guarantees do they carry? If they cannot be guaranteed to reduce the risks to zero, how can the projects be justified? If they can be guaranteed and the guarantees fail, who is to pay for the damages or make other compensation if the damages cannot be remedied?

Monitoring programs have been proposed in relation to the PLES I and other geothermal projects to determine the effects of project operations. Although they are important sources of data from which mitigations can be designed, monitoring programs are not mitigations. What specific monitoring programs will be used in relation to the PLES I project? Will the "Plan for Hydrologic Monitoring of Thermal and Nonthermal Water Resources of the Long Valley Caldera, Mono County, California, For the Long Valley Hydrologic Advisory Committee", prepared by C.D. Farrar and M.L. Sorey (Revised May 1988) be used as the primary monitoring plan? If not, why not, and what plan will be used instead? Who will interpret the data gathered by the monitoring programs relative to the PLES I project's effects on the hydrothermal reservoir and regional hot springs? Who will decide what measures are to be employed if detrimental effects are observed? Upon what objective criteria will such decisions be based? Will such decisions and their criteia be open to review and to appeal? What opportunity will governmental agencies and interested parties have to participate in the decision-making process? What role will the Long Valley Hydrologic Advisory Committee play in the interpretation of data and in the design and selection of controls or mitigations to be employed? What are the operational rules of that committee? What authority does it have? What kinds of decisions can it make? Will temporary or, if necessary, permanent cessation of project operations be written into the project permit as a mitigation measure? Is this legally possible? Is it politically feasible? Can possible effects on hot springs caused by one project (in this case PLES I) be differentiated from those of other projects to the extent that reponsibility can be assigned to one specific project? If not, does this not cloud the legal and/or political possibility of project production being terminated? What assurance can be given that hot springs and other naturally occurring hydrothermal phenomena can be restored, or will restore themselves, even if project operation ceases when changes are detected? If no such assurance is possible, how can the implementation of the PLES I or other projects be justified? (We attach as relevant material the answers of Dr. Michael Sorey, U.S.G.S., to questions relating to the above at the February 22, 1988, Mammoth-Pacific II appeal hearing before the Mono County Board of Supervisors. The attachment is from the official transcript taken at that hearing and is herein included as Appendix E.)

Surface water degradation from spillage of geothermal fluids and chemical materials is endemic to geothermal operations. Operational
K history in The Geysers field is illustrative of this fact (please see partial history of spills at The Geysers attached as Appendix F). The Geysers water pollution history has been treated as irrelevant previously in the PLES I proceedings (<u>Final Environmental Impact Report PLES I Geothermal Development Project</u>, May 1988, prepared for Great Basin Unified Air Pollution Control District, pages 4-26 and 4-27), but this is not so. It is argued that steam condensate is not produced from the PLES I project and therefore could not be spilled. The fact is that steam condensate is geothermal fluid which is frequently spilled at The Geysers and which the PLES I plant and any other plant in Long Valley would produce in abundance. It is a further fact that the fluid that would be moved at a geothermal plant in Long Valley is much greater in volume per megawatt than at a plant in the dry steam field at The Geysers. Spillable fluids at The Geysers occur as 20% of the steam condensate; the other 80% re-evaporates and the fluid portion is carried in one direction only, from the cooling tower to the injection wells. In a hot water field, as in Long Valley, the resource itself is fluid and it moved both to and from the power plant. Consquently, in Long Valley operations the fluid moved is <u>eighty</u> times the quantity per megawatt as at The Geysers (basic data: Geysers - 600 gpm of fluid to reinjection for 120 MW; Long Valley - 5,000 gpm of fluid x 2 (to and from the power plant) = 10,000 gpm for 12 MW). This means that one 12 MW plant in Long Valley together with the present MP-I plant will move almost exactly <u>the same quantity</u> of fluid per minute as is moved per minute in the entire Geysers field at it current 2,000 MW of production. The common causes of spillage of geothermal fluids are failure of valves and other fittings, pipe rupture (always a lurking threat in a tectonicaly active area), and human error.

The introduction of geothermal fluids or chemical substances into
L Mammoth Creek and Hot Creek downgrade from the project area is totally unacceptable. Hot Creek is a world class trout stream and is also heavily used in its lower reaches for recreational bathing (80,000 visitor days per year). Its tributary, Mammoth Creek, also supports a fine trout population and is under consideration by the California Department of Fish and Game for nomination as a Wild Trout Park.

At least six major questions arise from these considerations for treatment in the EIS. First, what have been determined to be the
M effects of geothermal fluid from the Long Valley hydrothermal reservoir through a range of temperatures and concentrations on trout and on the aquatic organisms upon which they depend for their food supply? Second, what measures will be required to be undertaken for stream rehabilitation if a major damaging spill should occur, and how effective would these measures be? Third, what protective measures will be required to prevent spilled fluids and other materials from entering

the surface waters? Fourth, how effective will these measures be? Fifth, what impacts will these measues themselves (retention basin, etc.) inflict upon the environment? Sixth, in the event of a major spill, who will be responsible, who will pay for the damage and cleanup, and how will this be ensured? Given the supreme value of the down-stream waters, the power plant and related facilities must be designed, operated and guaranteed as a zero discharge operation. Sufficient bonding must be required of the permittee to cover the costs of complete stream rehabilitation in the event of unforeseen accidents.

N The problems of turbidity and stream bed siltation due to erosion arise as a second issue under surface water degradation. Erosion prevention measures, their effectiveness and feasibility need to be comprehensively treated in the EIS.

O Finally, in relation to surface water matters, a credible justification must be provided in the EIS for subjecting the Mammoth Creek and Hot Creek fisheries, recreational uses and ecosystems to the potential degradation which the implementation of the proposed geothermal project would involve. Will the public gain of 10 MW (net) for thirty years outweigh the potential public loss if periodic or chronic stream degradation should occur? Would even 40 or 60 MW as the possible productive capacity of the Long Valley area justify this risk in face of the fact that this area is also held in the public trust in perpetuity as an exceptionally valuable public recreation ground, with the Mammoth and Hot Creek fisheries and ecosystems as an important feature of its interest to the public? These large questions relating to the public good and to the inherent value of ecosystems (particularly unique ecosystems such as that of Hot Creek) in themselves must be dealt with fairly and credibly in the EIS.

P A full analysis must be made in the EIS with regard to recreationl values in the area, recreational uses, and recreational visitor habits and attitudes, the recreational future of the Long Valley/Mammoth Lakes area, and the relationship between recreational use and the proposed expansion of industrial use into the area in terms of compatibilities and conflicts. Acknowledged authorities on recreation in the area should be consulted and their knowledge and insights fully utilized. Among these are the Mammoth Lakes Resort Owners Association, the Mono County Chamber of Commerce, and the Sierra Club. One of the existing documents on the subject that should be consulted is "The Market for Summer Visitation to Mammoth Lakes and Mono County", December 7, 1987, prepared by Ragatz and Associates for the Mammoth Lakes Resort Owners Association.

Q As noted above, one of the reasons for the denial of the Mammoth-Pacific II power plant project by the Mono County Board of Supervisors on March 1, 1988, was the lack of available information relating to cumulative impacts that could be anticip ted with the construction and operation of the presently proposed cluster of power plants at Casa Diablo and downstream on Mammoth Creek. A realistic and comprehensive treatment of the cumulative impacts of these proposed plants and related facilities (all by the same applicant in the Casa Diablo area) must be preparedfor the EIS as a basis for a responsible final decision regarding the PLES I project. We are sure that you will agree. The parameters of the study should include visual, audial, olifactory and cultural impacts, the pollution of surface waters, stream siltation, effects on the aquatic ecosystems and fisheries of Mammoth Creek and Hot Creek, land form alteration, fresh water supply, impacts on the hydrothermal reservoir, and effects on toursim and recreation.

R A credibly comprehensive cumulative impacts study takes time. Again, this will exceed the time frame for completion of the EIS process requested by the project applicant, but again we believe that delay in the completion of the EIS is justifed. The PLES I power plant is at this time the key geothermal project proposal in the Casa Diablo area. We believe, for all of the reasons given above, that it should not go forward -- that the project should be denied. But we also believe that if the PLES I plant is permitted the permitting of other current power plant proposals will likely follow, and that they should not follow without a comprehensive and accurate understanding of what the consequences are likely to be. All of these proposals with the exception of the Bonnevile Pacific project are being advanced by the same proponent, Pacific Energy. This is clearly the time for a comprehensive study of cumulative impacts to be made.

Sincerely yours,

Hamilton Hess
Geothermal Coordinator

255 Ursuline Road
Santa Rosa, CA 95403

cc: Mr. Frank Stewart
Ann M. Lyons, Esq.

Appendix B

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-117

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Finding D, Sierra Club Appeal

At the regular meeting of the Mono County Board of Supervisors of March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and unanimously carried to approve Paragraph (D) of findings "There are not benefits of the project sufficient to outweigh the unavoidable adverse impacts and that therefore a Statement of Overriding Consideration cannot be adopted and the project must therefore be denied."

Ayes: Supervisors Lawrence, Stanford, Thompson
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain: None

Cc: County Counsel
Energy Director
Planning Director
Planning Commission
Mammoth Pacific Corporation

Directed to: Sierra Club

Response date: n/a

13
88-117

Appendix C

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-123

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Finding R, Sierra Club Appeal

At the regular meeting of the Mono County Board of Supervisors of March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and carried to approve Paragraph R of Findings, "Testimony from representatives of the California Department of Fish and Game shows that this project will adversely interfere with the migration and survival of deer in the project area. Further study is necessary to determine whether the project can be constructed without such interference.

Ayes: Supervisors Lawrence, Stanford, Thompson
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain: None

CC: County Counsel
Planning Director
Planning Commission
Energy Director
Mammoth Pacific Corporation

Directed to: Sierra Club

Response date: n/a

13
88-123

Appendix D

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-118

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Finding E, Sierra club Appeal

At the regular meeting of the Mono County Board of Supervisors of March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and carried to approve Paragraph (E) of Findings "Geothermal development at the proposed location of this project will create unacceptable visual impacts, which may adversely affect recreation and tourism and which will change the natural character of the environment in the area of the project. While the Mono County General Plan may encourage environmentally sound geothermal development, this Board is not required to and does not accede to this request to permit geothermal operations in the highly visible location near U. S. Highway 395 and the intersection of Hot Springs Road and the extension of State Route 203 where project construction and operation would occur.

Ayes: Supervisors Lawrence, Stanford, Thompson
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain: None

CC: County Counsel
Energy Director
Planning Director
Planning Commission
Mammoth Pacific Corporation

Directed to: Sierra Club

Response date: n/a

13
88-118

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-122

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Findings P, Sierra Club Appeal

At the regular meeting of the Mono County Board of Supervisors of March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and carried to approve Paragraph P of Findings, "The proposed project will be located in an area which the USFS has assigned a Visual Management Objective of 'Retention.' Any change in the area noticeable to a casual observer would therefore be in conflict with this management objective. The power plant, even with all the mitigation measures, would be noticed by a casual observer and would therefore not conform to the requirements for the area. For that reason, and the reason noted in Finding O, the project is not acceptable."

Ayes: Supervisors Lawrence, Stanford, Thompson
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain: None

CC: County Counsel
Energy Director
Planning Director
Planning Commission
Mammoth Pacific Corporation

Directed to: Sierra Club

Response date: n/a

13
88-122

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-121

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Findings O, Sierra Club Appeal

At the regular meeting of the Mono County Board of Supervisors of

March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and carried to approve Paragraph O of Findings "The draft EIR described the cumulative visual effect of the project in combination with the existing Mammoth-Pacific I project and the proposed PLES I as significant. The response to comments in the final EIR stated: 'The impact would be significant, even after mitigation.' This Board agrees and cannot therefore approve the project."

Ayes: Supervisors Lawrence, Stanford, Thompson.
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain:None

CC: County Counsel
Planning Director
Energy Director
Planning Commission
Mammoth Pacific Corporation

Directed to: Sierra Club

Response date: n/a

13
88-121

SIERRA CLUB
CALIFORNIA

24 October 1988

Mr. James S. Morrison, Area Manager
U.S. Department of the Interior
Bureau of Land Management
787 North Main Street, Suite P
Bishop, CA 93514

Dear Mr. Morrison:

I enclose a sheet which should have been attached to the comments which I mailed to you today on the EIS for the proposed PLES I geothermal power plant. I would appreciate your allowing it to be so attached.

Thank you.

Sincerely yours,

Hamilton Hess
Geothermal Coordinator

255 Ursuline Road
Santa Rosa, CA 95403

OCT 28 '88

Area Manager	SF	NR	Administration	Geology	Recreation	VSS	Realty	Archaeology	Range	Maintenance	Fire	Wildlife	Files

1014 Ninth Street, Suite 201 Sacramento, CA 95814 (916) 444-6906

OFFICE OF THE BOARD OF SUPERVISORS
COUNTY OF MONO
P. O. BOX 715, BRIDGEPORT, CA 93517
(619) 932-7911, EXT. 215

Nancy Wells
Clerk of the Board

MINUTE ORDER
88-119

TO: Sierra Club

FROM: Board of Supervisors

SUBJECT: Findings I, Sierra Club Appeal

At the regular meeting of the Mono County Board of Supervisors of March 1, 1988, it was:

Moved by Supervisor Lawrence, seconded by Supervisor Stanford and carried to approve Paragraph I, of findings "Despite the discussion of cumulative impacts in the project EIR, which may be technically adequate for purposes of CEQA, no further geothermal development should be allowed in the Casa Diablo area, whether on lands under County, Town or Federal jurisdiction, until a comprehensive study has been done of the impacts of this project, all other approved or proposed geothermal projects and all other approved or proposed projects of any other type which may affect the geology, hydrothermal characteristics, and general hydrology of the area."

Ayes: Supervisors Lawrence, Stanford, Thompson
Noes: Supervisors Alpers, Miltenburg
Absent: None
Abstain: None

CC: County Counsel
Planning Director
Planning Commission
Energy Director

Directed to: Sierra Club

Response date: n/a

13
88-119

RECEIVED
OCT 25 1988
GREAT BASIN
UNIFIED APCD

Oct. 23, 1988

Bureau of Land Management
787 N Main St. Suite P
Bishop, CA 93514

Dear BLM-

I am writing in regards to the proposed PLES I geothermal power plant. I feel that this plant should not be built--the risk to both the fishery and the avifauna is much too great.

The thermal marshes surrounding the Long Valley hot springs are important wintering oases for many otherwise scarce bird species. During the 1987 Mammoth Christmas Bird Count birds such as the snowy egret and marsh wren were sighted in these areas. Dave Gaines wrote "East of the Sierran escarpment, wintering birds huddle near hot springs, as along Hot Creek (7000') and at Dechambeau Ponds (6500')" (Birds of Yosemite and the East Slope, Artemisia Press, 1988, p. 234). One of only two winter records for spotted sandpiper was at Hot Creek (Gaines p. 125).

4-1 Thermal marshes are rare and important in the eastern Sierra. Going north from Hot Creek/Casa Diablo, the next notable oasis is 40 miles away at Dechambeau Ponds. Due perhaps to grazing, few of the Long Valley thermal springs besides those in the fish hatchery/ Hot Creek area support the riparian vegetation necessary to maintain extensive bird life.

4-2 Furthermore, the PLES plant may jeopardize the production of trout at the State Fish Hatchery. Fishing is very important to the economy of Mono County. It has already been strongly impacted through water diversions and through eutrophication of Crowley Lake. As California's population continues to grow, quality recreation will become increasingly important.

Therefore, I urge you to deny a permit to the PLES I geothermal plant. Wildlife and fishing are more important to Mono County than another geothermal plant.

Sincerely-

Emilie Strauss

Emilie Strauss
POB 184
Lee Vining, CA 93541

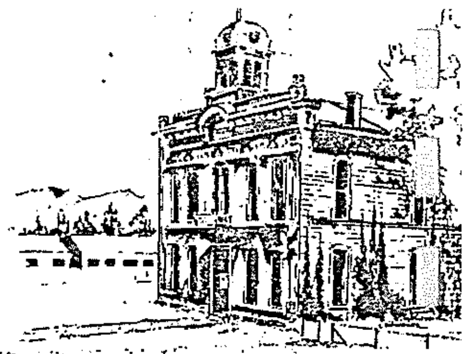
cc: Great Basin APCD
Fish and Game

COUNTY of MONO

ENERGY MANAGEMENT DEPARTMENT

HCR 79, Box 221
Mammoth Lakes, CA 93546
(619) 934-6704, Ext. 403

DANIEL L. LYSTER
Director



OCT - 7 1988
GREAT BASIN
UNIFIED APCD

October 5, 1988

Ms. Ellen Hardebeck
Air Pollution Control Officer
Great Basin Unified Air Pollution Control District
157 Short Street, Suite 6
Bishop, California 93514

Dear Ellen:

The Mono County Energy Management Department has reviewed the "Draft EIS/EIR Supplement" for the PLES-I Geothermal Project, proposed to be located on federal land in Mono County, and would like to submit the following comments:

(1) Acknowledging the need to consider the issues of fire safety, operational efficiency and the presence of heated soils below the ground surface, the feasibility of constructing the power plant upon an excavated pad site, below existing grade, should be evaluated. At the
5-1 very least, the placement of the power plant should be done in a manner that maximizes "cut" and minimizes "fill" activities. Such practices may help to reduce the possible visual impacts associated with the siting of the power plant.

(2) To the extent that slope stability and road access allow, the feasibility of placing the fluid conveyance pipelines in a lined trench should also be evaluated. In the event
5-2 of an accidental geothermal spill, fluids could be easily directed into a sedimentation/containment basin via the trench system. Additionally, the placement of pipelines below grade would reduce their visual impact.

(3) Based upon the information presented in Table 2-4, on Page
5-3 2-31, it is not clear whether the sampling frequency for Observation Well 65-32 is to be monthly or semiannually after the first year.

(4) There is a discrepancy between the information presented on Page 3-47 and that presented in Figure 1-10 (Appendix C)
5-4 regarding the natural variation of the temperature of

5-4 the AB springs at the Hot Creek Hatchery during the period of 1976 to 1987.

Thank you for the opportunity to comment on this document. If you have any questions regarding this letter, please contact me.

Sincerely,

Dan Lyster

Dan Lyster,
Director
Energy Management

DLL/sc

cc: Board of Supervisors

SIERRA CLUB

Toiyabe Chapter — Nevada and Eastern California

October 24, 1988

James Morrison
Area Manager
Bureau of Land Management
787 North Main Street, Suite B
Bishop Ca. 93514

OCT 26 '88

Dear Mr. Morrison

We applaud the decision to prepare this EIS and Supplemental EIR. We feel that this action is in keeping with the intent of the National Environmental Policy Act, and the California Environmental Quality Act. It is unfortunate that it was necessary for the Sierra Club, Caltrout, Mono Wildlife Council, and the California Department of Fish and Game to use the appeals process to get this environmental review process moving in the right direction. Obviously, it would have been a better use of the resources of all parties concerned, if the lead agencies had simply taken this action initially, by preparing an EIS back in 1987.

We have reviewed the PLES Draft Environmental Impact Statement, and have the following observations.

NEPA section 1502.22, "Incomplete or unavailable information", states that information necessary to make a reasoned choice among alternatives must be considered in the EIS as long as the overall costs of obtaining it are not exorbitant. In order for the DEIS to comply with NEPA and CEQA regulations, numerous pieces of "incomplete or unavailable" information must be provided. The DEIS indicates on page 4-102 that the property value is expected to increase to $23 million as a result of construction of this project. A substantial investment. Compared to this amount, it would take a pretty good sized sum of money to qualify as "exorbitant". We do not see where the DEIS indicates that the costs to gather the information that we
6-1 have referenced will be exorbitant, and we submit that the proponent has had plenty of time to do it.

This information, once it is present in the DEIS, will enable permitting agencies to make a fully informed decision regarding impacts to several natural resources, as well as choices among the various alternatives. If such information is not provided, then we believe that NEPA case law requires the development of "worst case scenarios" for impacts to resources.

In either case, until one or the other of these actions is taken, we must conclude that the DEIS, as written, is inadequate.

One of the definitions of NEPA regarding the treatment of alternatives in the EIS is found under section 1502.14,

"Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits."

This new DEIS reveals a couple of new alternatives not present in the original Environmental Assessment, those being the Alternative Location Action, and the Smaller Power Plant Alternative. The "Alternative Site Location" alternative in particular seems to suffer from a lack of "substantial treatment" in the DEIS.

6-2 Although it is very different from the preferred alternative, and although it may turn out to be an environmentally superior alternative, the basis upon which a reader could make such judgements is entirely lacking. For instance, compare the detail found in figure 2-1, and figure 2-6 site layout diagrams for each alternative. The lack of detail in the illustration for this new alternate location is obvious. The discussions of the alternate location as it relates to impacts and mitigations throughout the DEIS reflect this same treatment. A careful look at detailed mitigations is lacking.

The fabrication of workable mitigations is why NEPA requires that the EIS "rigorously explore" and "devote substantial treatment to <u>each alternative</u>". It is our opinion that this has not been done, and as a result, the "preferred alternative" is cast in a skewed and unrealistic positive light.

As for the other alternative, the "Smaller Power Plant Alternative", its inclusion in the DEIS seems to serve little purpose other than to give the impression that a "range of different actions" has been considered.

6-3 As presented in the DEIS the smaller power plant alternative is sort of a "tag along" to the preferred action..., being in the same location as the preferred action, and needing to construct very similar amounts of facilities, roads, wells and pipelines. Most importantly, this "similar design", as stated endlessly in the DEIS...., results in impacts that are "the same as for the proposed project". As we track this alternative through the document, we are shown that it is fundamentally the same as the preferred action, and so there is little need to elaborate on the few minor differences that surface. All the while the question at the back of our mind is "Is this project really a viable choice, given the fact that it is only 7 MW, and would therefore constitute a breach of the proponent's power purchase agreement"? (As pointed out on page ES-23)

This format has allowed the preparer to "fast-track" the preparation of this EIS, so that they may conform to the proponent's acknowledged pressured development agenda. This abbreviated consideration of alternatives does satisfy the intent of NEPA, and seriously undermines the legal adequacy of this document.

6-4 One last point regarding the treatment of alternatives, why was the original "Proposed Action" alternative of the EA/EIR dropped from consideration? From the standpoint of impacts to wildlife, it is a viable alternative and its absence contributes to the inadequacy of this document.

In conclusion, we believe that as written, the adequacy of this document pursuant to NEPA and CEQA regulations is questionable at best.

We have illustrated just a few of the deficiencies of the DEIS as it attempts to comply with NEPA regulations. We will illustrate others. We feel that, all told, these deficiencies are many in number and substantial in magnitude. In light of the underdeveloped action alternatives, and the missing or unavailable information, we are compelled to make the observation that this document is little more than the original EA/EIR with a new cover. It is our conclusion that this document should be withdrawn for the reasons set forth in this cover letter, as well as those that will be revealed in our written comments.

6-5 Therefore, we respectfully request that you resubmit this DEIS to Environmental Science Associates Inc. for further work. This work should include an expansion of the consideration of development alternatives, inclusion of the missing information necessary to make an informed decision, and the creation of true mitigation measures, the feasibility of which must be clearly demonstrated. This revised document should then be re-circulated for public review and comment as a Revised Draft EIS, Supplemental EIR. This would hopefully result in a document that will prove to be adequate under NEPA and CEQA guidelines. This procedure, painful as it may be, would clearly represent the most efficient use of the time of all parties involved.

Sincerely,

Frank Stewart

Frank Stewart
Toiyabe Chapter,
Sierra Club
Rt. 1 Box 37
Mammoth Lakes Ca. 93546

cc: Dennis Ghiglieri, Chapter Chair
Hamilton Hess, Geothermal Coordinator,
Northern Ca. Nevada Regional Conservation Committee

Items underlined are done so by us for emphasis unless otherwise indicated.

INTRODUCTION/BACKGROUND

Page 1-3 appears to be a disclaimer as to the reasons for which an EIS was prepared. It should be noted that the public controversy over this proposed project goes far beyond the topic of "surface hydrothermal features". This point is clearly indicated by the BLM's request for remand which states,

> "The Bureau has concluded that the threshold of "significance" as defined in 40 CFR 1508.27 (b) (4) which would require the preparation of an EIS for the project has arguably been crossed as a result of the controversy surrounding potential project impacts".

Agencies, organizations, and members of the public expressed a broad range of concerns that covered the entire spectrum of issues found in the "Affected Environment" section of the DEIS. It is controversy regarding all of these potential impacts that has contributed to the crossing of the threshold of "significance".

2.1 PROPOSED ACTION

The DEIS describes a rationale for needing to construct a 15 MW plant in order to generate 10 MW "net". However, no data is provided as backup for this relationship. At what ambient air temperatures is it necessary for greater generating capacity to get to a 10 MW net production? Similarly, cooler winter temperatures will allow 10 MW of power to be generated while pumping smaller volumes of geothermal fluid.

6-6 The DEIS should provide the data and technical analysis used to support its contention under footnote /1/ on page 2-3,

> "Therefore the contractual obligation to supply 10 MW of power year-round would require construction of a plant with gross capacity <u>of about</u> 15 MW to compensate for parasitic uses and the lower summertime efficiency".

In the absence of this data, the determination that its necessary to build a plant with a gross capacity of 33% larger, is an arbitrary decision at best.

The Summary of Impacts and Mitigation measures in the Executive Summary states that the effect on the "Geothermal Resource Lease" of the smaller power plant alternative,

> "...would constitute a breach of the existing power agreement between the applicant and SCE and could result in termination of the project".

6-7 Isn't this very similar to the no action alternative? The DEIS should evaluate an alternative that varies the amount of geothermal fluid pumped with the fluctuations of the ambient air temperature. This alternative would be a realistic choice and would provide many of the possible benefits to the Hydrothermal Resource as the "Smaller Power Plant Alternative. Mitigations such as consideration of the use of "super insulated" pipelines may further reduce this volume of fluid pumped from the ground.

6-7 These analyses may reveal that less fluid than proposed is actually needed. We don't know either way based on what is contained in the DEIS.

6-8 Page 2-15, "Gathering System" describes the layout and construction techniques used in pipeline layout. Nowhere in this description does it say that there will be "underground piping". This is in conflict with Figure 2-1 which indicates that segments of the pipeline will be "underground piping", as compared to being "below grade" in an open trench. The difference between these two will have significant detrimental or beneficial effects on migratory mule deer. This is also true of the description of the injection system described on page 2-21.

TABLE 2-4 HYDROLOGIC MONITORING PLAN

6-9 Colton and Casa Diablo springs should be monitored more often for temperature changes than the proposed once a month. Since these springs are so close to the production/injection field they will provide an early warning of pressure or temperature impacts migrating away from the powerplant. Therefore, temperature measurements should occur on a daily basis. 6-10 Similarly, Observation Well 65-32 should be checked for water level, temperature, chemistry, and isotopic analysis continuously throughout the life of the project, not just for the first year of operation. After all, we would assume that the proponent would continue to operate their power plant beyond the first year, and it seems reasonable that the level of monitoring should not taper off.

ALTERNATIVE LOCATION 2.2

6-11 Here again the DEIS states,

> "...it may be necessary to pump approximately 10 to 20% more geothermal fluid (up to a total 6,000 gpm) in order to compensate for temperature losses in the longer gathering lines and to generate more electricity to pump the fluid to and from the well fields."

The implication is that this greater volume of fluid will increase the potential of impact to the hydrothermal reservoir. Yet the DEIS provides absolutely no data to backup this vague contention. Without supporting data and technical analysis to back these contentions up, this statement is simply arbitrary and as such represents an alternative that is not fully developed.

6-12 Figure 2-6 illustrates this underdeveloped alternative concept quite well when compared to Figure 2-1 ("preferred alternative"). Compare the level of detail that each of these figures provides. Which portions of the pipeline in figure 2-6 are to be placed in "excavated trenches"? Where is section 2.1.7.9 that supposedly describes this pipeline construction detail?

6-13 It is unclear from examining figure 2-6 exactly which of the sections of fluid transmission lines for this alternative will be buried or subgraded to mitigate impacts on migratory mule deer. How can permitting agencies evaluate such potential impacts lacking such information?

If there were a generous use of techniques such as buried pipelines to reduce impacts to migratory deer, and if it were not necessary to pump so much more geothermal fluid to the alternate site location due to mitigations such as the use of "super insulated fluid transmission lines", then it is possible that this alternative could be mitigated enough to result in an environmentally preferable development alternative.

6-13 Apparently, as with the "preferred alternative", it is not proposed to bury any sections of pipelines to mitigate impacts to mule deer. All that is suggested is to subgrade those pipes in a trench. This is unsatisfactory. Pipelines should be completely buried at intervals of 300 feet to provide crossings for adult and juvenile deer.

6-14 Reinjection pipeline are routed through and adjacent to "Botanically Sensitive Areas" as identified in Figure 3 "Sensitive Habitats" of Appendix D. Why weren't these pipelines routed to the west side of the unnamed dirt road so that they would avoid these areas?

6-15 Page 3-36 Figure 3-5 Here is another example of the lack of detail in the DEIS for the "alternative site location". Why doesn't this map cover the areas occupied by all alternatives?

2.3 SMALLER POWER PLANT ALTERNATIVE

6-16 As we have said, the "smaller power plant alternative" seems to be in the DEIS merely to give the impression that a range of different actions has been considered. Its basis for being included in the DEIS is severely undermined in the very beginning of the document on page ES-23, where it is stated, and I quote,

> "The reduction in output to 7 MW would constitute a breach of the existing power agreement between the applicant and SCE and could result in termination of the project."

The solution for this dilemma is also found on the same page, to wit,

> "Approve the proposed project."

Now why consider an alternative that is doomed from the start? Another alternative suggested at the scoping meeting on July 8, 1988 was consideration of solar generated electricity to be produced by the proponent in a less sensitive location within Southern California Edison's grid. This alternative was not considered because, as is stated on page 2-1,

> "...the basic action under consideration by the BLM is not the generic generation of electricity, but the appropriate development of the federal geothermal lease."

Fair enough. Solar generated electricity is justifiably eliminated from consideration..., however, we submit that the consideration of a 7 MW plant, with its "Breach of Contract" dilemma, does not constitute an "appropriate development" of this geothermal lease. We feel that if it can be demonstrated that the smaller plant alternative is a realistic choice, then it should remain in the DEIS, however, as presented, it is an unrealistic choice, and should be eliminated as an alternative. ... Why was it considered? This superficial treatment of a non-viable alternative does not satisfy NEPA requirements.

ENVIRONMENTAL CONSEQUENCES

We object to the exclusion of the projects listed on page F-5 from the DEIS discussions on Cumulative Impacts. On the bottom of this page it states that treatment of these projects is not necessary due to the fact that they will not have the potential to consume significant or specific amounts of fresh water. Fresh water is but one resource value to be put at risk by the implementation of the PLES 1 project. We feel that this reasoning is extremely narrow minded due to the fact that the projects eliminated from consideration will combine with PLES 1 to potentially impact other resources from a
6-17 cumulative standpoint.

The primary effects on resources of concern would include potential degradation of water quality, fragmentation of wildlife habitat, and degradation of visual resources. The Town of Mammoth Lakes Golf Course and the Doe Ridge Golf Course in particular, are legitimate candidates due to their potentially close proximity in Long Valley to the proposed PLES 1 project. This serious deficiency has allowed the DEIS to sidestep the majority of potential cumulative impacts as it focuses on those potential projects of its choice. As such, we feel that this treatment of cumulative impacts exhibits a blatant disregard for the intent of NEPA.

AIR QUALITY

Air Quality, pg. 4-2 DEIS states,

"Disturbed areas would be revegetated, paved, or covered with gravel to limit long term dust generation".

6-18 This should be amended to indicate that this treatment will be applied to disturbed areas that are required for ingress and egress to maintain, operate or repair powerplant facilities.

ABANDONMENT AND RECLAMATION IMPACTS

Contained in this brief discussion is a cursory treatment of a scenario that could occur in the event of plant abandonment due to the project reaching the end of its useful life. It should be noted that
6-19 reclamation would be required under other circumstances such as forced shutdown as the result of pressure/temperature impacts occurring that were attributed to the operation of the PLES 1 plant. Reclamation under these circumstances may well result in stressful financial conditions for the powerplant owners.

The DEIS supplies no data to aid in identifying what the potential costs of such a reclamation effort would be. In this area
6-20 it is deficient as the costs would most likely be significant. To mitigate this the permitting agency should require the posting of an appropriately sized reclamation bond upon approval for construction, to be adjusted annually for inflation.

Possible plant abandonment as a result of resource exhaustion or
6-21 forced shutdown, and the prospect of inadequate (or nonexistent) rehabilitation bonding may result in significant adverse environmental impacts. These impacts would include:

a) long term visual impacts as the result of abandoned power plant facilities, roads pipelines and unrestored cut and fill disturbed areas, or incompletely restored disturbed areas.

6-21 b) Potential contamination of shallow fresh water aquifers with geothermal fluids as the result of fractured casings in abandoned injection and production wells. One old capped well at the existing Mammoth Pacific unit 1 failed in Sept.29, 1984.

c) Siltation of Mammoth or Hot Creeks due to erosion of unstabilized soils in previously disturbed areas.

d) Pollution of Mammoth or Hot Creeks due to runoff from contaminated soils.

The DEIS should identify the projected amount of a of a rehabilitation or a restoration effort, and make a proposal for an adequate sized bond to be provided by the plant operators. In consideration of the scope of such a rehabilitation effort the DEIS should evaluate such things as;

a) Complete removal of all physical components of the project including power plant, electrical substation, fluid transmission lines, well pad facilities, electrical transmission lines, and paving or concrete associated with spill retention basins and building and pipeline foundations.

b) Fill wells with concrete or other suitable material to seal and cap. This will be necessary in order to prevent geothermal fluids from one aquifer from migrating into the shallow freshwater aquifer. This could occur as a result of fractures or breaks in well casings due to major seismic events.

c) Regrade to a natural condition, all previously disturbed areas such as roads, well pads, plant site, cut slopes, trenches, and spill containment basins.

d) Revegetate all graded areas with native shrubs and grasses in order to reduce visual impacts and replace habitat and forage for wildlife. Similarly, all former pastureland should be restored to the satisfaction of the grazing permittee. Given the area's short growing season an the low fertility of native soils, the revegetation program must be initiated with some form of irrigation and followed up with a monitoring and maintenance program to insure survival of vegetation.

GEOLOGY, SOILS, AND EROSION

On page 4-12 and 4-13 of the DEIS, there is reference to geotechnical studies that indicate that "a fault may pass through the proposed power plant site". Mitigation (2) page 4-13 is actually a proposal to do a study, it is not a mitigation. It reads,

> "Require investigation to locate and, if found, to date the suspected fault. Move the power plant facilities and wellheads to avoid siting on active faults."

6-22 The conclusions of that study may result in significant alterations to the project design as represented in the DEIS. If significant earthquake faults are found, how will permitting agencies determine if an alteration in project design is significant? This information should be present in the DEIS pursuant to NEPA section 1502.22 "Incomplete or unavailable information".

6-22 In the absence of such information, an informed choice of alternatives is not possible, since unknown (but suspected) earthquake faults may affect the ability of proponents to locate project facilities in the areas illustrated in the figures of the DEIS.

We submit that to satisfy the intent of avoiding an adverse impact caused by an earthquake fault, this study should be done and be appended to this DEIS. The cost of such a study would not be exorbitant, given the scale of costs necessary to implement this powerplant facility. In fact, what appears to be the precise study in question is currently already underway.

In response to a "Freedom of Information Act Request" sent to Mark Ziegenbein BLM Bishop Ca. (Certified Mail, Return Receipt Requested #P466423409 10/13/88) we were told that, although proprietary, there are indeed investigations of this type currently underway in the Mammoth Pacific unit II and PLES unit I areas. (Ziegenbein, personal communication 10/19/88). They include both physical trenching studies, as well as Resistivity Surveys.

We conclude that this is clearly an example of incomplete information, and that the referenced study should be carried out as a part of the DEIS. This will enable permitting agencies to make a fully informed decision regarding power plant facilities siting so that they do not overlay earthquake faults in the Casa Diablo Area.

6-23 Mitigation (4) on page 4-13 suffers from the same ailment as (2) above. This is a promise to do a study to verify that high groundwater levels will not interfere with project construction. The results of the proposed studies may again result in moving project facilities to other locations.

This data will presumably inform someone (permitting agencies, the developer?) as to the level of groundwater at the power plant site that may in turn affect grading plans or facilities locations. Such information should be a part of the DEIS. Future changes in project design that may result when these studies are done may significantly alter one or more of the alternatives as presented in the DEIS. Given the high sensitivity for not impacting other resources (such as visual), we feel that shuffling around project facilities to avoid impacts revealed by these studies is also a sensitive issue. We do not believe that NEPA intends for permitting agencies to have such broad discretion to alter a project after an EIS has presumably been certified.

These are just two examples of "incomplete information". We belive that this lack of information in the DEIS has resulted in the inability of permitting agencies to make a fully informed decision. We do not see where the DEIS indicates that the costs to gather this information will be exorbitant. The suggestion that project layout can be adjusted later on is founded on questionable legal grounds.

WATER QUALITY AND HYDROLOGY

4.1.4.1.6 Cumulative Impacts.

6-24 It would be helpful in this section for the purposes of assessing cumulative impacts to water quality to identify the mixed water temperatures in Mammoth and Hot Creeks as they relate to the volumes of spilled fluids that could be released from MP 1, 2, 3, and PLES 1. This type of event could occur due to seismically induced pipeline ruptures which would presumably affect all powerplants if they affected one. Under these circumstances, it is probable that the mixed water temperature calculations found on pg 4-32 would be altered significantly. Under this scenario, we feel that this comprises another example of incomplete information, NEPA 1502.22.

6-25 DEIS page 4-32 bottom; where is Mitigation (10) for this impact? Mitigation (12) is actually a call for another study,

> "Bioassay would be required under the revised Plan for Baseline Data Collection.

A bioassay is not a mitigation for impacts to streams resulting from spills of geothermal fluids. It is a tool for evaluating the effects of those spills. We found an attempt at proposing an adequate mitigation for this impact on page 4-72,

> "If project operations caused mortality to fish in Mammoth Creek, Pacific Energy has agreed to fund restocking of the affected reach".

We made a clear point of the inadequacy of this type of mitigation in our scoping comments (see pages 16, 17) and refer to it by reference.

6-26 The feasibility of this mitigation is questionable. The DEIS fails to demonstrate that hatchery reared trout put in a stream that has been scoured of insect and invertebrate life will reproduce to re-establish the wild trout population that currently resides in the creeks in question.

Although a Bioassay is not a mitigation, it would identify the relationship between geothermal fluid and toxicity to aquatic

6-27 organisms. In our scoping comments 4/16/88 for the DEIS, we specifically requested such a Bioassay,

> "The DEIS should contain a bio-assay that identifies the tolerances of freshwater vertebrates and invertebrates to various temperatures and concentrations of geothermal fluid. this information would be very valuable in assessing potential adverse impacts to aquatic biota in the event an accidental spill of geothermal fluid reached Mammoth Creek. Of particular interest would be the insects that make up the food chain that supports the wild trout populations in Mammoth and Hot Creeks".

Why isn't this bioassay in the DEIS? In our scoping comments, (see page 15), we pointed out that Hot Creek is the most biologically productive wild trout stream in the state of California. Such productivity may be difficult, if not impossible to replace or

6-28 recreate. We protest this treatment of our concerns for the aquatic ecosystem of Mammoth and Hot Creeks as it relates to the DEIS and its deficiency in gathering information regarding the effect of spilled geothermal fluid on that ecosystem. Surely the proponents' claims that they can design a virtually "fail-safe" spill retention system and culvert shutoff valve cannot be accepted as reason enough to ignore this concern. We could find no technical appendices that provide evidence that such a shutoff valve exists, or has been tested in an environment that matches the winter and summer conditions existent at the project site.

6-29 The DEIS should identify a specific size of bond for the protection of these aquatic resources. The draft permit conditions for the Bonneville Pacific proposal specified $500,000 for such a bond, and we feel that although this is not large enough to offset total losses of Mammoth and Hot Creek, it is at least a start.

6-30 Page 4-34, Mitigation (7) is not a mitigation. As phrased, the ability of using reclaimed wastewater for revegetated areas is dependent upon "unknown" factors that govern "economic and technical feasibility". This referenced evaluation should be a part of the DEIS so that if irrigation with wastewater is feasible, it can be incorporated as a permit condition. As stated, this promise does not qualify as a mitigation, and merely serves to cast the project in a positive light.

6-31 Pages 4-47 to 4-51 describes what is being represented as a mitigation for adverse impacts to the Hydrothermal reservoir. Condition b, pg. 4-48 states,

> "A second monitoring well shall be drilled prior to the start of commercial production and subsequently maintained in conformance with the requirements of stipulation (a). The well shall be sited at a location to be determined by the Authorized Officer and the appropriate governmental agencies with land use jurisdiction".

Our contention has long been that the validity of monitoring data depends on pre-operational monitoring that is unskewed by commercial production and extraction of geothermal fluids. The DEIS is unclear how soon "prior to the start of commercial operation" this monitoring well will be put into place. This point is very important when viewed in light of the fact that proposed "trigger points" for production curtailments are nothing more than ranges of temperatures and pressures that are to be measured over time. If the time frame for measuring these swings is coincidental with the start-up of commercial production, then it may well be that pressure/temperature fluctuations that are the direct result of plant operations will be built in to the so-called "baseline data". PLES proponents have had ample time during the course of these proceedings to implement a monitoring well

6-32 This lack of specific parameters for implementing modification in project operations results in the granting of limitless discretion powers to the permitting authority. This situation undermines the feasibility of proposed mitigations regarding adjustments of injection and production schemes, as well as curtailment or cessation of plant operations. Such mitigation measures appear lengthy on the surface, but upon closer inspection, are quite vague in content. We reiterate the concerns that we brought forward on this topic in our scoping comments for the DEIS,

> "Another component of the monitoring program should include a detailed legal description of what would occur in the event pressure-temperature impacts were detected. This description/evaluation should be provided by legal counsel retained by the preparers of the DEIS, that would answer some questions likely to be asked surrounding this issue. As an example, curtailment or cessation of operations has been suggested as a mitigation regarding such impacts.

6-32 What is the trigger point (in terms of change in pressure or temperature) at which plant shutdown and/or curtailment will occur? Who will be consulted in determining that curtailment is necessary? What is the "chain of command" that will have the authority to implement curtailment? How will federal permitting agencies avoid litigation in the event that there is a dispute over who has caused an impact that surfaces at Hot Creek or the Hatchery?"

The DEIS has ignored these concerns, and these questions remain unanswered. The closest the DEIS has come in being specific on this matter is represented on page 4-53,

> "Monitoring results from MP I and PLES I production wells would be analyzed to detect changes in pressure, temperature, and/or chemistry outside the range established as normal based on previous experience".

6-33 Those words are far from specific, propose no criteria for initiating mitigations, and represent a significant, and legally questionable loophole. In this case, the DEIS has not demonstrated feasibility of its proposed mitigations. They sound good on paper, but in the real world, we believe them to be unworkable. Furthermore, all of these mitigations are structured in such a way as to detect effects on hydrothermal features after the effects have occurred. In and of themselves, they only serve to detect changes, but cannot be shown to

6-34a be effective in preventing adverse impacts to the hydrothermal system. Mitigations should go far beyond merely detecting changes, rather, they are defined by NEPA section 1508.20 as,

> "a) Avoiding the impact altogether by not taking a certain action or parts of an action".

Curtailment of plant operations occurs after the fact, it does not avoid the impact. The only mitigation that the DEIS contains to avoid impacts to the hydrothermal reservoir is the No-Action alternative.

> "b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation".

The only mitigation that may accomplish this is to choose the "smaller plant alternative", even if it would result in "breach of the existing power agreement between the applicant and SCE". NEPA is unconcerned with power purchase agreements of the project proponent. NEPA is concerned with impacts to the environment.

> "c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment".

Appendix C BGI report, upon which the discussions of hydrology are based contains a curious disclaimer on page 31,

> "Potential impacts of geothermal power production on surface thermal fluid resources (springs and other manifestations) near the Casa Diablo Area are difficult to predict precisely without a more thorough understanding of the geothermal reservoir. Additional drilling testing and analysis of the region would assist in evaluating potential adverse effects on springs".

This language sounds as if it were written by someone's legal counsel. In order to have confidence in the proponents ability to "rectify, repair or restore the affected environment" of thermal features, it follows that the BGI report should contain language more
6-34b like, "...given existing knowledge of the geothermal reservoir, it is easy to predict precisely...".

> "d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action".

See discussion above.

> "e) Compensating for the impact by replacing or providing substitute resources or environments".

We feel that the natural environment of the hot springs and fumeroles in the Hot Creek Gorge, or other thermal features in the Long Valley Caldera, are unable to be "replaced with substitute environments". Page 4-54 DEIS fails to describe any such mitigation proposals, its focus is clearly aimed at the Owens Tui Chub habitat contained in the Hot Creek headwaters, and the thermal component of the Hot Creek Fish Hatchery. Both are valuable resources that could be affected by thermal impacts, but they are clearly not the only thermal features with which we are concerned.

That being said, the discussion of the Mitigation Measures described for "step 6", page 4-55 DEIS is cursory at best, and as such does not comply with the intent of NEPA. Such a mitigation plan may
6-35 take on the scope of a completely new project in terms of design, agreements between holders of private property rights, permitting agencies, and governmental jurisdictions. Its feasibility is unproven, and we believe that further analysis would demonstrate the potential for various environmental impacts.

We believe that the hydrologic monitoring program in its entirety and including all proposal as identified in the DEIS, will not satisfy the intent of NEPA regarding the need for mitigations to protect the Hydrothermal Resource. Its primary focus is "detection", and its reinjection scenarios are mere hypothetical solutions cast against an appendix whose authors are only willing to go so far as to say that it is "difficult to predict" the effects of commercial production on the
6-36 fluid reservoir.

The monitoring plan's "progressive nature" only serves to illustrate that resource managers will follow impacts around the Long Valley Caldera as they drill their different monitoring wells. Accessibility and permission to drill monitoring wells in the areas indicated have not been demonstrated.
Finally it is arguable whether proposed wells will detect changes against a background that is skewed by commercial production.

In conclusion, it is the concern for potential adverse impacts on the Hydrothermal Resource which led the Mono County Board of Supervisors to adopt Minute Order 88-119 as they denied the use permit request for the Mammoth Pacific Unit II Geothermal Plant,

> "Despite the discussion of cumulative impacts in the project EIR, which may be technically adequate for the purposes of CEQA, no further geothermal development should be allowed in the Casa Diablo area, whether on lands under County, Town, or Federal jurisdiction, until a comprehensive study has been done of the impacts of this project, all other approved or proposed geothermal projects and all other approved or proposed projects of any other type which may affect the geology, hydrothermal characteristics, and general hydrology of the area".

This minute order was drafted with the full knowledge and benefit of an extensive public record that included testimony by experts in the field of hydrology.

It was also drafted with full knowledge and benefit of the stipulations contained in Conditional Use Permit No OIE-86-02 which contains a section titled "Hydrology and Water Quality". The conditions contained in this section of the draft use permit pertain to monitoring the hydrothermal resource, and are quite similar to those contained on page 4-43 to 4-54 of this DEIS.

Finally, this minute order fully intended to include the PLES project in its reference to "no further geothermal development" on private lands or lands under "Federal jurisdiction" pending the outcome of this "comprehensive study" which would identify the cumulative hydrological impacts of all these potential projects combined. We believe that the BLM should, in deference to this decision of the Mono Board of Supervisors, make an identical finding, and join in cooperation with other jurisdictional and resource agencies in the implementation of this study. Additionally this study should include other critical resources in Long Valley, such as mule deer.

6-37 In conclusion we wish to incorporate by reference into these comments IBLA Appeal #11667 filed by the Sierra Club, California Trout, and the Mono Wildlife Council. It was in the face of this appeal that the BLM requested that the Interior Board of Land Appeals remand the appeal back to the BLM for preparation of this EIS.

In this appeal, the point is clearly made that monitoring of itself does not constitute mitigation. In our written comments, we address this issue pursuant to NEPA section 1508.20 and we strongly encourage permitting agencies to evaluate that discussion very carefully.

The basic premise in the monitoring plan that a hydrologic impact can be reversed is based on projections contained in Appendix C of the DEIS. Consultants retained by the California Department of Fish and Game are drawing far different conclusions than those contained in Appendix C.

One thing is clear, both studies are hypotheses, neither can offer conclusive proof. This serves to illustrate that the "feasibility" of proposed schemes in the monitoring program of the DEIS is unproven.

TERRESTRIAL WILDLIFE

6-38 The PLES project as proposed in the DEIS is not in compliance with the existing Deer Herd Management Plans for the Sherwin Grade, Buttermilk, and Casa Diablo Deer Herds. These plans were jointly approved and adopted by the BLM, Ca. DFG, and the USFS. The BLM in particular as one of the lead agencies, should include a section in the DEIS that reviews the components of those plans as they relate to the conflict between project implementation and the management goals for the deer herds that use the Casa Diablo area, one of which was to protect migratory habitats.

An Appendix to the DEIS, a Deer Study by Timothy Taylor, contains figure 3, which illustrates a "major migration trail" passing very near the project site, and a "minor migration trail" that appears to pass through the project site. On page 36 of his study he references the geothermal proposals for the Casa Diablo area among other proposals for the area and states,

> "This study has revealed that deer from the Casa Diablo herd use these areas as migration and summer habitats".

The other Deer Study, written by Thomas Kucera, states on page 22,

> "From the standpoint of deer migration and summer use, the locations of presently proposed facilities (Figure 12), are less preferable than the initially proposed site (Figure 9 in Kucera 1987).

Mr. Kucera is referring to the "Preferred Site Location" as illustrated and described in the original EA/EIR. Why was this alternative eliminated from consideration in the DEIS? This alternative represents a viable but unexamined alternative, particularly from the standpoint of deer migration and summer range needs. The result is that this omission seriously undermines the adequacy of this document, particularly from the standpoint of impacts to mule deer.

6-39a The DEIS states on page 4-66,

> "The proposed project includes requiring the below-grade installation or screening of segments of the pipeline as appropriate which would effectively mitigate impacts".

Where in the DEIS is there any quantitative value placed on the words "as appropriate"?

6-39b In order for the effectiveness of this mitigation to be determined, specific proposals for the use or screening or subgrading must be given. Is "below grade" the same as "subgrade"? If so, will there be the use of "buried" pipeline? What is not described is which sections of pipelines are to be subgrade, below grade, or buried in all of the action alternatives.

6-39c For instance, Figure 2-6 gives no indication of where or if these techniques will be used for the Alternative Site Facility Location. The mitigation listed for this impact under the Alternative Location impacts is to locate the power plant in the "preferred" location. This is a prime example of how the DEIS handles its treatment of alternatives throughout. In this case, the mitigation should focus on the resource as affected by the alternative in question, not simply refer back to the preferred location to solve the problem. This type of treatment of alternatives is another serious deficiency of the DEIS.

6-40 The DEIS states on page 4-66,

> "Noise and human activity...may cause migratory deer to avoid the area but would not adversely affect...deer populations

This appears to be a contradictory statement. If deer must "avoid the area" then it follows that some effect must occur.

The DEIS follows that,

> "Similarly, it is unclear to what extent deer are affected and no specific result can be anticipated with respect to deer populations and noise levels".

This statement is unacceptably vague. If the extent of impacts to deer from noise is "unclear" then this lack of information mandates the preparation of a worst case scenario.

The same page draws an unrealistic analogy between the abilities of deer to jump fences. An example is cited of deer jumping fences eight feet tall to to reach "well watered vegetation". It is implied that it is reasonable to expect that deer using the PLES project site will then be able to jump fluid transmission lines. The DEIS should note that these animals may be pregnant does, at a low nutritional ebb after 6 months on a poor winter range and in the middle of a stressful migration. The DEIS should provide data to back up the contention that fluid transmission lines will not provide an obstacle to deer migrating through the project area on the way to their summer range.

6-41

Page 4-69 states that deer populations are currently stable in the region. Although population numbers may be stable, a more accurate characterization of the situation would be that the population may be on a temporary plateau while on a predominantly downward trend. Surely the DEIS is not making the claim that current developments and land uses occupying winter ranges, migration corridors, and summer ranges, have not contributed to declines in deer population numbers. If so it is in conflict with the contents of one of its appendices, "Casa Diablo Deer Study" by Taylor. This study states on page 1,

6-42

> "However, a decline of mule deer in the west has been a major concern of many state conservation agencies. A general statewide decline in California's deer herds has been occurring since the mid 1950's".

The author of the Deer Study, Final Report, 1987, Thomas Kucera, wrote a personal letter to the Mono Board of Supervisors on March 1, 1988. That letter reads,

March 1, 1988

Dear Supervisors,

"I have been reading with some dismay reports in the Review -Herald regarding the apparent headlong rush to approve a complex of geothermal development in the Casa Diablo area of Mono County. Having done some of the wildlife work used in the environmental documents of several of the projects, and having done other wildlife research in the area for several years, I am somewhat familiar with the area and some of the issues.

In my reports on wildlife concerns of the various projects, the conclusions and recommendations invariably included the comment that, while the specific project being considered may not by itself be of major concern regarding wildlife, the fact that several projects are being discussed in a small area requires a more comprehensive analysis of the cumulative impacts of all projects. Further, NEPA and CEQA require that such analyses be performed. Thus when faced with a suite of proposed environmental changes, it is not only wise, but required by state and federal law, to consider the suite as a whole. It is bad public policy, and counter to law, to ignore the forest for the trees.

I have tried to make the same point in personal testimony to the Board. I hope you will consider this rapid rush to industrialize part of Mono County in a larger and more comprehensive fashion, giving special importance to those qualities of the County that make it attractive and that, if managed wisely, will keep it attractive indefinitely".

Sincerely,
Thomas Kucera
2909 Regent #2
Berkeley, CA. 94704

(emphasis is author's)

Mr. Kucera is clearly advising that the cumulative impacts of all geothermal development in the Casa Diablo area must be carefully considered. He emphasizes that even though a project by itself may not be of major concern, the concurrence of a number of projects "requires a more comprehensive analysis of the cumulative impacts of all projects".

DEIS page 4-69, cumulative impacts,

"Cumulative impacts to local deer herds are potentially significant".

We believe that this acknowledgment, succinctly stated, is in many ways the focus of the issue concerning mule deer. If all project developers can correctly state that their projects, considered on its own, will not significantly impact the resource, then how is it that a cumulative impact can result? The answer is that the whole is great than the sum of its parts. When the incremental stresses to pregnant does, habitat losses, and subtle interferences to migration routes are all added up, a significant adverse effect is the result.

We acknowledge and agree with this finding in the DEIS, that the PLES will contribute to a significant cumulative impact on mule deer populations in the Casa Diablo area. Unfortunately, mitigations suggested for this impact are too general in content, and as such do not propose specific solutions to the problem. Although we endorse the concept of the mitigation listed on page 4-70, we suggest some changes in its current form.

Off site mitigation measures (such as critical habitat acquisition) should be employed proportional to the acres impacted by the project. This is not quite the same as the acres "disturbed" by a project, due to the fact that certain project facilities, while
6-43 creating little actual ground disturbances (such as above ground fluid transmission pipelines) may impact deer movements over the acreage through which they cross. More importantly, acquisition of winter range will not offset adverse impacts that occur in the migration corridors. Therefore, acquisition efforts as a mitigation should occur in habitat types that are the same as those impacted.

We have yet to see any movement by the proponent in the direction of acquisition of critical mule deer habitat (such as migration corridors or winter range). Instead, the responsibility of acquisition is laid at the doorstep of conservation organizations or government agencies. (see page 4-70 DEIS) This suggestion is misguided at best, and avoids the issue.

6-43 We object to this attitude for it is the proponent whose development agenda will impact this deer resource, and therefore it is the proponent who should provide the mitigation. Acquisition of habitat with the intent of preservation, or improvements such as watering stations should be implemented by the developers.

The Taylor Deer Study also speaks to the need to consider impacts from a cumulative standpoint on page 36,

> "Therefore, in order to insure the welfare of the Casa Diablo herd it is imperative to evaluate the effects of land use projects on an individual and a cumulative basis".

Although an attempt has been made in this DEIS to evaluate the cumulative impact to wildlife in the Casa Diablo area, we believe that it has not gone the distance. As we mentioned under our discussions concerning Hydrology, it will be necessary to conduct a comprehensive analysis of all existing and reasonably foreseeable proposals that will occur in the migratory corridors of the Casa Diablo, Buttermilk, and Sherwin Grade Deer Herds. Only in this way will it be possible to accurately determine the true tolerance for deer to biological stresses that will be introduced as each of these projects is implemented.

An important point to remember is that Pacific Energy Company has corporate ties to approximately 80% of the proposed or existing geothermal development in the Long Valley area. As such, they will clearly have a significant role to play in any impacts that will accumulate as each successive project is constructed. In light of this fact, Pacific Energy Company has an obligation under NEPA and CEQA regulations to contract for an EIS to be prepared that fully assesses the scope of its actions from a cumulative standpoint. We feel that this DEIS has avoided this issue in its treatment of cumulative impacts in all resources of concern, not just wildlife.

The discussion of terrestrial wildlife could benefit from the addition of specific mitigation proposals regarding mule deer. The use of buried pipelines should be specifically identified on the site facility illustrations. Similarly, deer crossing ramps should be discussed as a mitigation measure, again, giving specific locations of where such ramps would be used. Design of fencing should be detailed.

6-44 Page 4-68, DEIS paragraph 2 implies that the impacts to deer from the alternative plant location may be greater due to the wider area of disturbance. This may be true. However, the suggested mitigation to locate the power plant at the proposed site skirts the issue. The DEIS in "rigorously exploring" this alternative should make some effort to identify ways that this action alternative could be mitigated with respect to mule deer impacts.

AQUATIC RESOURCES

6-45 Page 4-72, Mitigation (12), This is not a mitigation, only a promise to collect data or do a further study, see discussion under Water Quality and Hydrology.

6-46 Page 4-73, No action Impacts, under "Mitigation" replace with the words, "Require Mammoth Pacific I to install emergency spill containment structure as detailed in the PLES DEIS".

CULTURAL RESOURCES

6-47 Page 4-77, add the words,

> "A qualified archeologist shall be retained by the developer and be present on-site at all times during construction activities such as excavation and grading, should previously unknown objects of cultural..etc. The archeologist shall have the power to halt construction, if in his/her judgement, significant new specimens meriting further investigation are discovered".

If this is not the case, it is doubtful that construction personnel will have the knowledge or expertise to recognize such specimens if they are discovered. Page 4-79, same as above.

RECREATIONAL RESOURCES

6-48 As we pointed out in our scoping comments (pages 1, 13, 14) the DEIS should make an attempt to quantify the issue of adverse impacts to the area's recreational resource. The conflict between the possible proliferation of geothermal powerplants at Casa Diablo and recreational values of open space that the area enjoys is a source of considerable controversy among citizens and business owners in the neighboring communities. We discussed this issue at length in our scoping comments on page 22. The potential to impact the Hot Creek Gorge through impacts to the hydrothermal reservoir would be of serious consequence to the members of local communities. The DEIS should quantify how an erosion of the 95,000 RVD's enjoyed at the Hot Creek Gorge relates to the economic base of the communities (due to its "less valuable" status as a geologic interpretive site, were it to be impacted).

3-48 The brief discussion on page 4-83 of the DEIS is insufficient coverage of this topic. Visitors to the Eastern Sierra enjoy many recreational activities, not just the Hot Creek Gorge Geologic Site and Fish Hatchery.

6-49 DEIS page 4-84, the suggestion that impacts to the aquatic environment can be mitigated as a result of the proponent agreeing to "restock the affected fisheries" is short sighted, simplistic, and fails to substantially lessen the potential for impacting a wild trout stream. Please see our discussion of this topic under Water Quality and Hydrology, as well as our scoping comments for the DEIS page 19.

This DEIS is deficient in its description of the potential impact to these recreational resources, and it offers no data to indicate the substantial fiscal losses that community businesses would incur if any
6-50 of these impacts were to occur. Contrast this cursory treatment with the identified Environmental Consequences to be felt in the area of Economics. This topic of "construction and taxes" Economic impacts receives substantial quantitative treatment, unlike recreational economic resources. It is yet another example of the pro-development bias of the DEIS, a bias which casts a dark shadow over the question of the legal adequacy of this document pursuant to NEPA regulations.

Once again, we must point out that the promise to do a future Bioassay study (page 4-84) to determine the effects of geothermal fluid on aquatic biota is not a mitigation. Mitigations, as we described under Water Quality and Hydrology, are actions that will eliminate or substantially lesson an adverse affect.

Page 4-84, "Impact" middle of the page, the DEIS fails to note that "sight-seeing" is a major form of recreation that occurs on the
6-51 Inyo National Forest, and presumably also on that part of the forest that surrounds the project site. See our scoping comments page 13.

VISUAL RESOURCES

The extent of the visual analysis seems to be based on the assumption that viewers will be wearing blinders. The Sensitive vantage point used to generate Figure 4-1 is just that, a single point. Not only is it a single point, but it is also the lowest point along Hwy. 395 from which to view the project site. As a result, the
6-52 impression given in figure 4-1 is very misleading. For instance, the overpass of Hwy. 395 at the intersection of Hwy 203 offers a much more exposed vantage point. In addition, people engaged in recreational activities on foot on the thousands of acres of surrounding forest service lands will have an unobstructed view of the project site. (see our scoping comments page 12)

The DEIS makes contradictory statements regarding the USFS VQO for the site and whether or not the PLES project will be in compliance with that VQO. On page 4-95 under Cumulative Impacts,

> "In views from Highway 395 and Route 203, these power plants and their ancillary facilities would not likely be noticeable to the casual observer".

The criteria, for the VQO of "retention" which is the VQO is to
6-53 maintain the natural appearance of the area, so that surface disturbances are not noticed by the casual observer. This passage in the DEIS is saying, in an indirect way, that the retention VQO will be met. Yet the DEIS states on page 4-91 that as a result of implementation of listed mitigations, that the VQO would be met "over a period of 10 to 15 years". The implication is that, until "10 or 15 years" has passed, the VQO will not be met. So which is it, compliance or noncompliance? It appears to us that until the landscaping can grow to substantial size, a significant visual impact will result during the interim period of "10 to 15 years".

It is interesting to note that the mitigations listed on page 4-91 DEIS, are almost verbatim as those listed on page 4-46 of the original EA/EIR. The only difference is that the new set lists "Native trees would be transplanted...". How many trees, how tall, where would they be planted?, are all unanswered. The point to be made is that the original EA/EIR concludes at the end of its list of mitigations,

> "...even with mitigations the plant would be noticed by casual observers and the project would therefore be inconsistent with the VMO of "Retention". However, when fully mitigated the plant could meet "Partial Retention" objectives".

The conclusions of these two documents, based on fundamentally the same data, are completely opposite. Although transplanting of larger tress may increase the effectiveness of vegetative screening, such techniques have only been attempted recently. It remains to be seen whether these trees have a high rate of survival after undergoing a winter season. Even though there exists a "Landscape and Revegetation Plan", Appendix B for this DEIS, this appendix has not resulted in the creation of any new mitigations for visual impacts. (compare lists on pages 4-91 DEIS, and 4-45 EA/EIR) In light of this, how can the two documents reach such different conclusions while being based on the same evidence?

It should be noted here that in denying the Mammoth Pacific unit II Geothermal project, the Mono County Board of Supervisors were considering a basically identical project, proposed to be situated behind this PLES project, which had access to all of the same visual mitigations as defined in this DEIS. Even in light of all the ideas and visual mitigations that the proponent could develop, the Supervisors, in denial, adopted the following findings, 88-118,

> "Geothermal development at the proposed location of this project will create unacceptable visual impacts, which may adversely affect recreation and tourism and which will change the natural character of the environment in the area of the project. While the Mono County General Plan may encourage environmentally sound geothermal development, this board is not required to and does not accede to this request to permit geothermal operations in the highly visible location near U.S. Highway 395 and the intersection of Hot Springs road and the extension of State Route 203 where project construction and operation would occur".

Also adopted was finding 88-121,

> "The Draft EIR described the cumulative visual effect of the project in combination with the existing Mammoth Pacific I project and the proposed PLES I as significant. The response to comments in the final EIR stated: "The impact would be significant, even after mitigation". This Board agrees and cannot therefore approve the project".

In considering whether or not the proposed PLES project will result in significant visual impacts, the Lead Agencies should weigh and consider the decisions made by the Board of Supervisors.

We would now like to comment on the list of so-called "mitigations" for visual impacts on page 4-91 DEIS.
For ease of reference, we will refer to them as mitigations 1 through 8 as listed in consecutive order on the page.

6-54 1) Avoiding mature trees "whenever possible" is a vague and unclear statement. What is the criteria to be applied when such judgements are being made?

6-55 2) "Partial or complete" revegetation of disturbed area "as soon as practical" is another example of the same situation. Which areas will be ignored if "partial" revegetation is implemented? What are the guidelines that will identify what is "practical" as far as timing is concerned? Unless the DEIS provides some specifics on these questions, such words should be eliminated from the mitigation

6-56 4) Will exterior surfaces be visually unobtrusive from the south and west or will they not? The "extent compatible" should be identified in the DEIS.

6-57 5) How much exterior lighting will be necessary? Scattered ambient light levels emanating from the project site should be quantified.

6-58 7) Is there any specific proposal for the size, numbers or densities per area of land regarding the idea of planting trees for screening? These data should be present in the DEIS.

6-59 8) This statement gives the impression that the locations of pipelines is somewhat flexible. If pipelines are to be placed to take advantage of natural vegetation or topography, how will that placement correspond with with the pipeline locations as illustrated currently in the DEIS? Furthermore, as is the case in most of the other mitigations on this page, what is meant by the word "possible"?

In summary, the general and vague nature of the mitigations listed for visual impacts does not allow decision makers to accurately assess the effectiveness of those mitigations. These mitigation suggestions are open-ended and noncommittal in terms of how, where, when, or how much is going to be done to substantially lesson the impact. As written, there is insufficient data and incomplete information (NEPA 1502.22) available to allow an informed decision to be made regarding the significance of visual impacts. We therefore find the conclusion of the DEIS that visual impacts can be mitigated to a level of insignificance to be arbitrary and capricious.

LAND USE PLANNING

There are two land use planning efforts underway in Mono County that the DEIS does not mention, and that would be in conflict with the proposed land use at Casa Diablo. These involve efforts to establish a National Recreation Area, and the Mammoth Trout Park. We brought forward this issue on page 36 of our scoping comments, yet as is the case with many of the concerns raised in that letter, no attention has been paid to this issue in the DEIS.

6-60 As we have stated in our scoping comments, the component of National Forest Lands that is in riparian habitat is less than 4% of all available land. This habitat is vitally important to the large recreational use that the forest enjoys. The Mammoth Trout Park is an emerging concept that puts a recreational focus on the fisheries resources (which of course depend on the riparian habitats) of the Mammoth Lakes Area, with Hot Creek and Mammoth Creeks as its focal point.

6-60 We believe that if geothermal development is allowed to expand in the Casa Diablo area, irreversible degradation of the ecosystems of these creeks will result. The DEIS has offered no feasible mitigations for rehabilitating that ecosystem in the event that its "fail-safe" spill retention system doesn't work. We perceive this as a Land Use and Planning conflict, and feel that it merits discussion in the DEIS.

6-61 The creation of a National Recreation Area in the Mono/Inyo county area is a concept that is gaining attention and momentum among area planners, and government agencies, both town, county and federal. As we have stated, the resources values that provide the basis for our recreational use are in direct conflict with this type of land use, especially when it occurs in such sensitive view corridors, adjacent to critical deer habitats, and in the immediate drainage of one of the premiere trout streams in California. Management goals for resources in a National Recreation Area would give emphasis to preservation of existing levels of amenities, through the use of strict adherence to such things as Visual Management Objectives and Deer Herd Management Plans.

These are two examples of land uses that are currently being planned which will encompass the Casa Diablo area, which may have potential conflicts with the proposed PLES Geothermal project, and which should be discussed in the DEIS.

ECONOMICS

6-62 Page 4-101, mitigation (10), In our comments regarding water quality and hydrology, we pointed out that such a mitigation scheme would take on the complexity of a completely new project proposal. Depending on the makeup of such a proposal, which as presented is undeterminable, numerous environmental impacts could surface as a result of attempted implementation of this mitigation. The language in this mitigation defers until later the establishment of this critical data.

There is insufficient detail to evaluate the effectiveness of this mitigation, and it is therefore inappropriate for a permit to be granted in advance of further delineation of this plan. Ability to offset impacts at the hatchery depends on the success of this plan, it should be available for readers to study as a part of the DEIS. The prediction of the DEIS that this mitigation would allow timely implementation of effective measures is not based on any data contained in either the DEIS or its Appendices, and as such, is purely speculative.

6-63 We do not believe that it can be demonstrated that an environmentally acceptable mitigation for this potential impact can be developed, and we call upon the DEIS to prove us wrong. In consideration of the lack of data and cursory mitigation proposed on page 4-101 of the DEIS, it should be stated that the economic resources of the Hot Creek Gorge and Fish Hatchery are destined to remain at risk, should a hydrothermal impact occur.

6-64 The Economics section of the DEIS should mention the administrative and legal costs that permitting agencies may incur as a result of reasonably anticipated challenges, appeals, or litigation arising from disputes between agencies or organizations and project proponents as a result of disagreements over interpretation of what constitutes a significant impact to the environment as caused by PLES I. Clearly such entities as the BLM, GBUAPCD and Mono County must have incurred such costs as a result of such actions that have already occurred.

COMMUNITY SERVICES

6-65 Page 4-106, The DEIS appears to suggest that risks associated with the long response time to the site can be lessened through the implementation of a "Fire Protection and Prevention Plan". Although a plan will increase awareness of the hazards, it is not a substitute for readily available equipment and trucks.

A mitigation for the problem of the approximately 15 minute response time would be for the PLES facility to maintain firefighting engines and equipment on site, rather than relying on such entities as The Long Valley Fire Protection District or the Town of Mammoth Lakes to respond. Any fire that spread off-site on to adjacent forest lands presents a threat, and potential impact, to the resources values associated with those lands as they exist today in their unburned condition. Some of those resource values include wildlife habitat, watershed qualities, scenic quality, timber resource, and sensitive plant communities.

As the number of geothermal projects could be projected to increase at Casa Diablo, the risk for fire is also concentrated. We suggest that this mitigation measure be added to the DEIS.

GEOTHERMAL RESOURCE LEASE

6-66 Page 4-116, It is suggested here that the no action alternative would result in a Breach of Contract between the lessee and the Federal Government. More accurately stated, this contract requires utilization of the Geothermal Lease in an manner which avoids environmental impact. The adverse environmental impacts resulting from action alternatives associated with PLES I would prohibit the fulfilling of such a contract.

This concludes our comments on the PLES DEIS.

ELLEN HARDEBECK
CONTROL OFFICER

GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT

157 SHORT ST., SUITE #6 - BISHOP, CA 93514
(619) 872-8211

RECEIVED BISHOP RESOURCE AREA NOV 08 '88

November 7, 1988

Mr. Jim Morrison
Area Manager
B.L.M.
787 N. Main Street, Suite P
Bishop, CA 93514

Dear Mr. Morrison:

Enclosed are copies of all comments received by Great Basin Unified Air Pollution Control District on the Draft EIS/Supplemental EIR on the PLES-I Geothermal Project. I also have attached a transcript of the public hearing held in Mammoth Lakes on October 21, 1988.

I have sent a copy of all these comments and the transcript to Sandra Guldman of ESA.

Sincerely,

Ellen Hardebeck

Ellen Hardebeck
APCO

EH/dl

Enclosures

cc: Sandra Guldman

PUBLIC HEARING ON PLES 1 GEOTHERMAL PROJECT
DRAFT EIR SUPPLEMENT

October 21, 1988 - Mammoth Lakes, CA

The welcoming remarks and introductions of the Great Basin Unified APCD staff were given by Debra Lawhon before the tape recording was started. In addition she mentioned that the hearing was solely to take testimony, either oral or written, on the Draft EIR Supplement. Since this second hearing concerned only that document, there would be no presentation by the project proponents, and no information given on the project itself.

Debra Lawhon: What I'd like to have you do is when you come up to speak, or if you are speaking by the overhead projector, try to speak up and first give your name so that when later on we transcribe these recordings we'll be able to identify who's speaking. So if we can give the person's name when we first get started, if later on you happen to say something later on in the meetings, please give your name a second time -- if you speak a second time. That's about all I have to say so the first person to speak is Timothy Durbin, his agency is, he's actually working with California Department of Fish & Game and the S.S. Papadopulus and Associates.

Timothy Durbin: I am Timothy Durbin and my firm has been retained by Cal Fish & Game to do a couple of things. First of all to help them prepare comments on the EIR and to do independent analyses of the impacts of the projects on the geothermal resources of the area. As a bit of introduction and to make a little bit of statement regarding my credentials to talk on this subject; I've been with this Papadopulus and Associates for about four years. Prior to that I was head of the U.S. Geological Survey, Water Resources Activities in California and that position involved directing the work in 14 offices throughout California. One of the projects that was being conducted under my direction at that time was the -- there would be work that is on going still by the USGS in the Mammoth Lakes area; the work that Chris Farrar and Stewart Roistosser [spelling?] and others have been doing at time was being done under my direction. Prior to holding the position as District Chief for the USGS for California, I had a similar position in the state of Nevada. There, there was a very large geothermal program that was being conducted in Nevada by the USGS, and that program consisted of two parts. One part was a research part in which we were developing and evaluating various techniques for the evaluation of geothermal resources, so we were trying to develop sort of the basic tools that hydrologists use to examine and to evaluate geothermal systems. The other part of the work was to do specific evaluations of various KGRA's in Nevada and that work was done principally for the US Bureau of Land Management as part of their process of setting value on lands that potentially would be leased to developers. Our firm has extensive experience in geothermal matters, in ground water; myself and other principals of the firm have developed computer programs for modeling ground water systems that are used throughout the world by hydrologists and we are currently doing work for the U.S. Environmental Protection Agency for some very specific model development things. So that's a little background of who I am, what I am bringing to some of the remarks that I'm going to make.

Timothy Durbin (CONTINUED):

First of all, I think I'm going to say up front that there -- what I'm going to say at the end and in where I'm going to get to at the end of my comments is the basic conclusion that the planned geothermal development including the PLES but also the other projects that are proposed for the Long Valley area will cause a significant adverse environmental impact. The second conclusion that I'm going to come to is that the EIR as it now stands is totally inadequate with regard to attempting to make any kind of assessment of what the
7-1 impacts of this project and other projects will have on the geothermal system and the environmental element such as the hot springs and hot creek that are dependent upon this geothermal system.

Now, to start there are some basic concepts that are going to apply to my comments and I want to run through those and the slide that I have up states what those are. And the first one is the notion of the "Water Budget". And a water budget is just simply an accounting much like you might do an accounting of your checkbook or of your bank account. It says that the "Inflow" minus the "outflow" equals the "storage change". Now if you put that in terms of your bank account if you have more money being deposited on a regular basis into your bank account than you are withdrawing then the amount of money in your bank account goes up. Likewise if you withdraw more than you put in, the amount of money in your account goes down. And the same thing applies to water in the ground water system -- if you put in more water than you are taking out the water levels rise and if take out more than you put in, water levels decline. This same concept applies to heat. That you can, if you put in more heat than you take out the stored heat within the geothermal system goes up and that's manifested in increased temperatures; likewise, if you take out more heat than is being put in then the stored heat goes down and the temperatures within the geothermal system on the average go down.

Now, let's consider the pre-development condition. Prior to any development in the geothermal system, you basically have a system in which there's a large bank account-- we might talk if we are going to talk of in terms of dollars, many thousands of dollars -- ten thousand dollars -- and we have heat coming into the geothermal system and we have an equal amount of heat going out. So we have a system in which the bank account stays constant because as we put in heat, heat is coming out. Now the heat that comes in is coming from the deep magma sources that basically occur in the center of the Long Valley Caldera at a very great depth. And that's where the heat is coming from. That heat that is coming in then, all the heat that comes in ultimately gets discharged. And that heat is getting discharged in basically two ways. One we have what is called convective heat discharge from the system and this is the heat that is being carried out of the geothermal system by the hot water that is discharging from the various springs and is accumulating in Hot Creek and discharging out of the valley. So that's one source of heat discharge. The other source of heat discharge is conductive heat flow and this is heat flow that results from simply the movement of heat through the soils, and the heat from the hot ground water that is in the subsurface. Heat goes up through the soils above the ground water table and finally comes to the land surface and is disbursed into the atmosphere. The place in the valley where this

Timothy Durbin (CONTINUED):

occurs is in the area down by Crowley Lake in the meadow areas that are on the west side of the lake -- there is a large area in which there is a very significant conductive heat flow.

Now, Post-Development Conditions. The basic concept of the heat budget applies to the understanding of the situation. Under the Post-Development condition we start to put a withdrawal of heat on the geothermal system so we are taking heat out. Now, the amount of heat that was coming in naturally before is basically the same. And we have to go back to sort of the bank account thing under Pre-development Conditions maybe we have a hundred dollars coming in and a hundred dollars coming out and when we get to the Development situation we turn to a situation where we are taking out on the order of a thousand dollars, to put it in those sorts of terms, a thousand dollars out of our account and, however, through the re-injection wells some of that is put back so that the developments are all taking heat out of the ground water system converting part of into electricity and putting the remainder back into the geothermal system. That amount that goes back in might in our bank account terms, might represent a hundred dollars and so there is a net "Out" of nine hundred dollars so that with development, what it does is start to deplete the heat that is stored in the geothermal system and if we use; I think at one time I made a statement that maybe we could call it $10,000 was stored, we start to at $900 a year or something like that, start to take out that much net extraction of heat and what happens is that the heat stored in the system goes down and temperatures go down. That description follows from, again, basic consideration of the heat budget which in turn is based or just a way of stating the law of conservation of energy and an important aspect is that that conceptual basis depends, does no way depend upon the any sort of conceptual model that you have about what the geolcgy is like out there.

Okay, so what happens? Start to remove heat from the geothermal system and this can be thought of directly analogous to the condition of a mine, say an open pit mine in which we are excavating mineral ore. And we start to take material out and a hole is left behind. And when you take heat out of a geothermal system you leave a thermal hole in the geothermal system and which again is very much equivalent to the hole that is left behind in open pit mining. Now, from some just some very basic calculations and with knowledge of how much heat all the projects taken together are going to extract from the geothermal system that it's a fairly straight forward thing to come up with a value that these pits that will be created in the system are gonna have a volume equal to something of the order of a cubic mile -- which is a very large volume. If we assume that perhaps the actual depth of these pits is maybe only 500 feet or so the area that would be affected would have a surface area of 7 square miles. Only from consideration of how much, well, the only way you can get heat out of the geothermal system is to reduce the temperature of a certain volume of a system. The developers, the project proponents, have stated that they have certain plans to extract a certain amount of heat from the geothermal system. This is the volume of water, or the volume of the geothermal system that has to be cooled in this

Timothy Durbin (CONTINUED):

particular estimate it was considered this volume was going to be cooled an average of 100 degrees C everywhere. This is the volume that has to be cooled in order to produce the amount of energy. Now one of the things that in the EIR that is the subject of this meetin and in other EIR's that have been prepared on these projects, there are calculations that have been done that make some statement about the volume or the area that will be affected by the injection wells. Now, a question now is -- well, first of all those volumes are significantly smaller than these volumes that are stated here. And the question is why are they different? To answer that you have to g back to sort of the, again our bank account thing. And I stated earlier that the development of geothermal system involved taking money out of the bank account and putting some back in. And that on the order of $900 is being taken out and a $100 is being put back in The calculations that are done within the EIR deal only with the re-injection part of it. And so they ignore, totally ignore this other $900 that is being taken out. In no way look at the heat that's bee extracted, they only look at some of the issues regarding what is pu back. And the situation goes further in that while they've done some calculations in the EIR those calculations are really not relevant t the overall issue of how much of the geothermal system is going to b affected by development. It's almost as if they have answered a totally different question. The calculations that they do for their what they call the bulk model, are totally unrelated to how much of the volume of the system is going to be affected. Again it's like if someone asked, or if I were to ask you what is the county seat of Mono County and you answered 24. Well, 24 is possibly the answer to what is the sum of 12 and 12. But it's unrelated to the issue of what is the county seat of Mono County. And in the same way the calculations, while technically correct and they answer a question - it is not the question of what the impact on the system will be.

What happens to these thermal pits? Well one of the things that will happen to the thermal pits is that thermal pits of various sizes will be, will form around the various injection and production wells for the various projects, and over time these spread out and in some cases the various pits will merge together. But after the 30 years of production just one cubic mile of system will be affected. Now those pits will not just stay at the, in the areas of injection and production wells; what will happen they will start to migrate within the regional ground water system. And the direction of ground water flow in that system is well documented and that direction is from the west to the east. So that these pits as they are formed will move towards the east and towards the vicinity of the Hot Creek and the springs that feed Hot Creek. Now the rate of migration is very slow and it may take on the order of hundreds of years before these pits reach the area -- but eventually will and that's a foregone conclusion and there's no way of avoiding the fact that eventually these pits will migrate to the areas of thermal discharge for the geothermal system and in the areas where springs occur those pits will cause a period during which temperatures of the springs are suppressed and in the areas where the heat is being conducted by, to the land surface and then into the atmosphere the rate of "heat flow at the land surface will be reduced. The Hot Creek is the first

Timothy Durbin (CONTINUED):

thing that is in the path of these migrating pits and so that the first and most pronounced affect will be felt on the springs that are discharging into Hot Creek.

What these several pits might be thought of as, can be thought of conceptually in a lot of different ways. One way is to think of the, well first of all the thermal pits simply mean there is less heat in the system. And the thermal pits might be, could be thought of in terms of as a pollutant and there's a certain mass of pollutant that the project will introduce into the geothermal system and that pollutant will stay in the system until it sort of washed out over perhaps centuries through the spring discharges and through the conductive heat flow. And during the period that the pollutant is being discharged you might think that's the period of time in which the springs will "be contaminated". They will be contaminated in the sense that they will have cooler temperatures in them. And again from a conceptual standpoint the analogy, is I think, between a pollutant and the reduced temperatures are quite appropriate in that it conveys the sense that the reduced temperatures are an adverse affect that will occur on the geothermal system.

7-2 Earlier, or at the very beginning of my presentation I said that the EIR/EIS was inadequate in the way that it tried to analyze things. I stated that the bulk mode calculations answer a question that isn't really a relevant question to the problem at hand. And so then what is needed to properly understand the impacts of the [development] on the system? And the only real way this can be accomplished is to put together a model that represents all of the essential processes that are going on in the geothermal system. And these processes are those that cause the formation of the thermal pits. They are the processes that affect what happens around the production wells both hydraulically (sic.) and thermally and the processes that affect things that are happening around the injection wells and also the processes that affect the migration of the pits through the geothermal system. The techniques for doing this are quite well developed and it is just a matter of doing it and in fact as an independent exercise that I am doing this kind of modeling for California Department of Fish & Game. Without it, in this kind of work, being the basis of the EIR/EIS there really is no way of being very explicit about the timing in which impacts will occur. Now, from the earlier considerations of the heat budget we know that the impacts will occur and we know that the total mass, if you will, of the impacts -- we know what those will be. What we don't know, but can answer with a complete model of the geothermal system is how that total mass of heat deficit or pollutant, whatever term you want to apply it; how the impacts of that are distributed among the spring discharges in the, and the conducted heat flows. We know what the sum of the impacts on those two are but we don't know how much of the impact goes to the springs and how much goes to the conducted heat flow. My belief at this time is that if this modeling is done that it will be discovered that there will be that most of the impact will go to the spring discharges.

The modeling that has been done in the EIR/EIS is completely

Timothy Durbin (CONTINUED):

inadequate and is no basis on which to make any decisions regarding what the impacts of the development will be on the geothermal system and the environmental elements that depend on that system.

Some conclusions regarding impacts:

1) These thermal pits are going to be created and we can state very positively how large those pits will be. We can state that the pits will eventually migrate to the discharge areas. There has been a lot of controversy generated around some issues of what is the proper geo-hydrologic-hydrologic conceptual model to apply this system. The first two conclusions are independent of what conceptual model you apply to this system. You may recall that the basic debate is over whether we have basically we have a system in which we have isolated up-welling of heat or we have lateral flow of heat. I think that, well, first of all the conclusions are independent. But I think that the truth of the matter is that the system is mostly a lateral flow system to where we have local areas where water is moving upward, the hot water is moving upward into the shallower system.

2) Another conclusion is that the temperature and heat flux in the areas of thermal discharge will be reduced and they will be reduced in a very significant way. I have done some tentative calculations that suggest that Hot Creek will eventually experience a period lasting somewhat of a hundred years, in which on the average over that period, temperatures within Hot Creek will be reduced perhaps as much as 25 degrees C.

In the EIR/EIS there was one paragraph which asked the basic question of why would anybody invest in this, in these various projects if things are as bad as they appear to be. And that's sort of a question that I have been pondering because I can't understand
7-3 how it is that the project proponents cannot be aware of the basic facts of life and that with some very simple calculations using simply a heat budget you have to come to the conclusion that this geothermal system cannot support all the existing and proposed projects. Environmental constraints aside, I thing that realistically the system can support the existing plant that is out there plus another one of perhaps the same size. Recently I happened to run across somebody whose company at one time in the past was considering investing in some of the projects that are proposed for this area. And I mentioned to this person, Mike Lee, that the area was -- if all the projects were developed -- that it would be a gross over-development; perhaps in the order of a factor of 3 to 5 times as much power than the system can really support. And this person said their company basically came to the same conclusion and decided to stay completely away from what was going on here. The only thing that I can figure out that there is some way to make money on failed projects, or for projects that only last for 5 or 10 years. There's no way that this system is going to support on the order of 50 MW of power production for 30 years. These projects are going to fail long before that happens. And that ends my comments. Now I have xerox copies of the various slides that -- I should have them already, so thank you.

Debra Lawhon: Thank you, you timed that pretty well, 29 minutes and 50 seconds.

I notice we've had 2 or 3 people walk in after we had started and if I could just request you to come up and sign in, then we will know who attended the hearing.

Unidentified man: Can we sign in after the meeting?

Debra Lawhon: That's fine. The other thing then is -- if any of you want to speak then you can let me know so that I give you a time and get your name.

[None of the late arrivals indicated an interest in giving testimony.]

The next person in the group here is Tom Heller who's with the Forest Service in Mammoth.

Tom Heller: My name is Tom Heller, I am with the Forest Service here in Mammoth Lakes. And basically just a couple of concerns, maybe things that were just omitted or things that maybe could be included in the draft document. In a couple of places there is a list of different kinds of activities that occur in the Mammoth area on, both on the draft in the summary as well as in Part 3 page 53. I'd like to see

7-4 the addition of the word "sight-seeing" included in the list of activities that occur.

In Part 2, page 49 there's talk about the recreation resource; it discusses mitigating measures for lots of geothermal features at Hot Creek -- in the Hot Creek area and one of the things that may need to be addressed, we feel would be the, if the plant does dry up the geothermal site that is down there, but the plant does prove to be

7-5 profitable we would like to see some kind of a mechanism by which the plant's responsible for developing an alternate geological interpretive area as well as contribute to the removal of facilities that are currently down there.

7-6 The third portion of the document, page 53, there's talk about the fish hatchery existing at the location because of geothermally heated springs used in their rearing ponds and I guess the comment would be that maybe there needs to be a little bit more discussion about the fact that the fish hatchery is <u>solely</u> there because of the geothermal quality of the water, and should that change what kind of mitigation measures are planned to satisfy the State Fish and Game and to maintain a viable fish hatchery?

7-7 Part 3, page 54, there's a discussion on Hot Creek Gorge and it's felt that that should include that it's a major attraction and that the attraction is that the people enjoy visiting or viewing the geothermal spring as well as soaking in the hot creek.

7-8 Part 4, page 83, under Recreation Resources - The Impacts, there's a loss of a geothermal hot springs or the loss of the geothermal hot springs in the gorge would result in the loss of a unique interpretive site and the loss of this experience and that's

Tom Heller (CONTINUED):

7-8 something that's not really listed on the [document] or the effects of the impact. The loss of the feature would reduce the administrative work as far as the Forest Service is concerned managing the site, but as I mentioned before we would have to move the facilities, we would have to rehab the site and we'd like to see it mentioned in that area that the company would be responsible or would cooperate with the development of an alternate site as well as removal of the existing facilities.

7-9 Appendix B, under Visual Resources Part 4, page 91, there is nothing mentioned in that Appendix as far as a planting plan. I would like to see something mentioned as far as what kind of species, what sort of spacing, relationship to facilities as well as irrigation system - what would be proposed. There's nothing in there. I didn't notice anything on lighting plans, what kind of lighting. What would be expected to be seen during night time hours at the plant in all of the different locations that are proposed? If there's a poor rate of survival as far as plants are concerned, what kind of mitigation will be involved in trying to make sure there's successful planting? And there's a discussion on the fact that there's a relatively young fault in the area, but there's really nothing. It mentions that there needs to be some kind of an evaluation made, but there's no time table involved in discussing how active that fault is. And this is in the area of the proposed preferred alternative.

7-10 And lastly, in order to avoid the artesian water fumaroles, ground water could be pumped. It's mentioned in Part 4 on page 14. What effect that will that have on the vegetation that remains in the local area if you draw down, possibly draw down the ground water table, what would happen to the remaining plants that are there? That's all I've got.

Debra Lawhon: Thank you. Okay, our next speaker will be Curtis Milliron, California Department of Fish & Game.

Curtis Milliron: Well, the Department has been accused recently of unwarranted opposition to geothermal in general -- the Long Valley KGRA. Why are we so opposed to such benign projects that do so much good? And, we feel the projects are not benign, obviously, from the comments of Tim Durbin, and there's good reason to feel that way. There's a lot at stake, the Long Valley. My Supervisor, Phil Pister, uses an analogy or makes the comment quite frequently that this is a real important area here and we have more visitors to Inyo National Forest than to Yellowstone, Glacier and Grand Teton put together on an annual basis. That's pretty significant and so we better be careful how we treat this area that's only going to be more significant as the years go by.

We've got the hatchery, probably the most productive and important hatchery in the State of California, is right here as Hot Creek Hatchery has a product of over 20 million dollars annually. That's in trout eggs that are supplied to other state facilities, other states. But mostly in fry for all the back country and a lot of sub catchable and catchable trout. Supports Crowley Lake and that's a heck of a resource to lose.

The Department has already made the comment in previous public meetings that the county and people that make the decisions around here decide that geothermal is a lot more important than the fish hatchery and we're going to re-evaluate our priorities as well. That's not a threat, that's just simply a statement that says "hey you guys, now what's really important to you? Do we need a little bit more energy or do we need the fish hatchery?"

Now why is the fish hatchery really in jeopardy? Now it seems like we're only talking a few degrees here and there and so forth, but it's more than that. That hatchery is very complex and it's been operating for 50 years now and it's set up right now to take the best advantage possible of the existing situation -- the existing spring temperatures that are provided. And we use them as they come from the ground, there's nothing changed. So, the coolest water available on the hatchery is used right now for the Hot Creek Stream brood stock and other brood stock fish. It's critical that these brood stock fish are kept at a temperature below 56 degrees F. And that is a critical temperature, it's stated in Federal and State Trout Culture Documents. And what happens when you go above that temperature is that the sperm in the egg viability drops off very quickly and this is not just something that happens to be conveniently there as -- we're right there, we're at that temperature, and we can experience a problem with really just one degree change. The Hot Creek strain that utilizes -- that brood stock that utilize that lowest water temperature spring source are a unique strain. They have been developed at Hot Creek, they have been genetically altered for the last 30 years to take advantage of a -- to alter the spawning times of the fish so that when they are growing they develop -- they come off, the planted trout are ready to plant at a different time of year when the other trout come off so that we have a more complete planting schedule which is complete throughout the year so we don't have major gaps. We just don't have fish to provide for all the recreational demand in the area.

7-11 There has been some mention in this document that these temperatures, or the temperatures at these springs is quite variable and that was based on hatchery information, data provided to the people who wrote the document by the hatchery manager. But that data is really not very good data. That data was taken over the past 10 or 15 years by many different hatchery personnel with many different types of thermometers in many different areas within each spring source. There was no effort, and there was no need, to be consistently accurate on how that temperature was taken. It wasn't necessary, it was just "let's just go see how things are going -- what are we going to do here, what are we going to do there?" And that's how the hatchery is operated. But now that there's an issue there has been a greater effort to determine how accurate or how consistent, how variable those temperatures are at the various spring sources in the hatchery. And what we're finding out is they are very consistent. They don't vary much at all. And so this is something that is not reflected in the document. Instead the argument is made there that

7-11 the temperatures vary considerably, therefore, how could there be a impact of 1 or 2 degrees? How could an impact of 1 or 2 degrees make a difference? Well, these systems, these springs don't vary that much. They vary something less than 1 degree. So it could make a difference and it would make a difference.

Of course, right below the hatchery is Hot Creek, it's a -- I don't think I need to speak too much on that -- it's a well known blue ribbon trout stream. It's one of the best in the country. It's not very long, it's only a couple of miles long of really primo trout fishing areas. As Tim explained there could be an impact of some 2 degrees C. Now that's a real preliminary, cursory calculation and it's subject to change. As Tim also mentioned he's also in the process of doing a more thorough evaluation of this resource out here so we should be able to narrow that down a little better. But what does that mean to Hot Creek? If we lower the temperature, we've got another stream. We've got a lot of streams, there's not very many Hot Creeks. We're not going to replace Hot Creek easily. We can replace other streams, there are plenty of them. So we've just now taken a blue ribbon trout stream and converted it to a Sierra stream and that's not acceptable.

There's, of course, the Gorge and as mentioned why do people go to the Gorge? And we're talking about 95,000 visitor-use days just to go to the Gorge. And that's to go sit and soak in warm water in a beautiful area and to see a Yellowstone-like environment. That's not easily replaced. And it's certainly not a replacement, or not a viable mitigation to go rip out what's already there and put a bunch of pipes in and let it bubble up and so we've got something that 7-12 steams. That is not a viable mitigation. I'm sure that 95,000 people or most of them would agree with that. So if we lose a major thermal element, if we lower the temperature of that spring source that supplies that neat geothermal interpretative area, we've lost major component of tourism to this county. That's got to be a lot more impact than what has been addressed.

There's also another issue that has been very much -- let me go back just a minute. As far as this document, it's very inadequate in addressing this thermal impact to the Hot Creek Gorge Area. It mentioned something about, well, if there's a change in pressure, which we don't think will occur, maybe it won't, then we'll put an injection well upstream and we'll boost the pressure. But they don't talk about a loss of temperature to this system -- and yet that is certainly going to happen as I stated earlier. And I don't see how you can, even if you tried to use the same idea -- how could you take water from upstream and put it downstream? Well, you're still taking water that's already been affected.

And finally, another major area of impact -- of course there's a terrestrial wildlife impact as well and Ron Thomas is here if he wants to speak on it, he's certainly more qualified to speak on that subject. But the final area I want to talk on is the thermal springs. For example, the Casa Diablo Geyser. I don't know if everyone knows this, but there used to be a geyser and it used to

Curtis Milliron (CONTINUED):

flow, somewhat variable flows, but it used to geyser at times and it had a flow and it's located right next to the existing power plant. Well it's not variable any more, it doesn't flow at all. There's nothing there. So the plants, the animals, and the habitat types that were dependent upon that geyser, that system, that microhabitat, are gone. Now we don't know if there was anything really unique there or not. We don't know if there were uniquely adapted invertebrates, algae, things that most of us consider as insignificant. But we don't know how significant they are, and we'll never know because they're not there any more. So that's a potential extinction that we don't even know if it happened or not. And that's the kind of thing we can expect with more development -- that Michael Sorrey pointed this out very strongly that there are many examples of geothermal fields where impacts to local thermal springs occur, there no examples where they don't occur. And in fact, on this system there is an example it has occurred. We've lost the Casa Diablo Geyser flow. It hasn't flowed. There has been no discharge in [the] spring source there for, since April of 1987, I think is the date. But the point there is that we've lost something we don't even know what it was -- we stand to lose a lot more of that. The Department has written comments and there are certainly a lot more points that we brought up in those written comments and those will be available sooner or later. I think that's the final point I'd like to make is that some people have questioned us already why is the Department of Fish & Game hiring a consultant. We've got the BLM and Forest Service -- they've hired consultants. The proponents have hired consultants, in fact it's one consultant. Everybody is using one consultant -- it's the same consultant, it's BGI. Personally, I don't know how you feel but if I was feeling pretty well but went for an annual check up to my doctor and the doctor says "you're in pretty good shape, but you know you've got an appendix in there and you've got some tonsils and maybe a little extra intestine. I think we'll go ahead and remove that but you probably won't feel too much." I would get a second opinion and that's what we're doing. We feel that we have something to lose here, we don't have the expertise to really analyze the potential impacts due to exploitation of this geothermal resource so we went out and we hired the Papadopulus consultant. That's all I have to say.

Debra Lawhon: Thank you. Okay, the next person who's asked to speak is Carla Neasel, she's speaking as an individual.

Carla Neasel: My name is Carla Neasel and I'm not affiliated with any organization. I just want to address a couple of ways in which I feel like this document fails to fulfill NEPA requirements as well as ignores some crucial qualities of this area.

7-13 The three alternatives in addition to the new action one are either too similar or too poorly developed to fulfill NEPA requirements of full exploration of all alternatives. For example the alternative of moving the power plant to a less visible area, the document states that piping the water from the wells to the plant would result in significant heat loss through the pipe walls and therefore would necessitate an increase in the amount of water pumped from the supply

which would then increase the impact on the groundwater resource.
7-13 But no consideration is given to mitigation of that problem. For
instance, insulating the pipes.

The document also states that by moving the power plant to a more
forested area to reduce visual impacts, wildlife in those areas would
7-14 be adversely impacted. But again the report fails to develop ways to
offset those impacts such as burying pipes or otherwise allowing for
wildlife movement in those areas. Another alternative, building a
smaller power plant, the document states that the environmental
impacts would basically be the same, therefore it's not truly an
7-15 alternative. Also the capacity of the smaller power plant would be
about 7 MW which is a violation of the contract -- I believe the
permittee holds for about a 10 MW station.

Finally the preferred alternative does provide for monitoring of
surface water temperatures to determine if the extraction of
geothermal groundwater is lowering the temperatures of the hot
7-16 springs, such as Hot Creek, but it does not provide for mitigation
should lowering of temperatures occur. The proposed mitigation of
re-injecting semi-cool water back into the ground is not a proven
method either of replenishing the supply or of maintaining surface
water temperatures at their natural levels.

NEPA also requires that unless it is too costly all relevant
information should be included in the EIS, but the following are some
examples of pertinent information which is not included in the
document. It does not contain the findings of preliminary studies on
7-17 significant earthquake faults in the proposed power plant area and
further studies should be done. It does not include any sort of bio
assay to determine the effects of geothermal fluids flowing back on
7-18 fish, other wildlife and plants in the area. And finally the other
options which were proposed in earlier public meetings such as
utilizing previously existing solar energy plants or perhaps building
7-19 another solar energy plant in a different and less sensitive area
were not explored as alternatives.

Due to the many deficiencies of this document it's very possible that concerned members of public resource agencies or conservation organizations may feel compelled to seek relief through the appeals process. It would probably be a better use of time and resources to withdraw this faulty EIS and prepare a revised draft. Such a thoroughly revised and prepared EIS would certainly find that the Long Valley Caldera area is a highly inappropriate location for geothermal development. Given logistical problems, fish, wildlife and botanical considerations as well as the presence of unique recreational and wildland values.

I just want to speak as to why people live in this area. People come to live here because of the uninterrupted vistas and the natural wonders as well as the tremendous recreational possibilities. Industrializing the area destroys the very qualities so many thousands of people come here to seek either as permanent residents or as revenue-bringing visitors. Alternative sources of energy are

Carla Neasel (CONTINUED):

needed but not at the expense of wildlands and esthetic qualities that we all need to survive.

Debra Lawhon: Thank you. Our last speaker is Frank Stewart of the Sierra Club.

Frank Stewart: This should be fairly close to what I am going to say. [He then handed-in written testimony.] My name is Frank Stewart and I'm here today on behalf of the Toiyabe Chapter of the Sierra Club, as well as the Northern California Nevada Regional Conservation Committee. I would like to thank you for the opportunity to express our views.

Some of the comments that I am going to make, kind of parallel the prior speaker but I think I'm going to make them anyway. And also, I'd like to point out that I structured my comments in reference to NEPA and the accuracy of this document as an EIS. And I feel that obviously parallels can be drawn to the requirements of CEQA and the EIR supplement.

[See attached copy of the statement from Frank Stewart.]

Debra Lawhon: That concludes the number of people who have already asked for presentation time. Is there anyone else who would like to say something for the record? If there is no further comment then, this meeting is adjourned. Thank you all for coming.

PACIFIC ENERGY

A SUBSIDIARY OF PACIFIC ENTERPRISES

6055 East Washington Boulevard, Commerce, California 90040

Telecopier (213) 725-8772

Telephone (213) 725-1139

November 4, 1988

Mr. James Morrison
Area Manager
Bureau of Land Management
Bishop Resource Area
787 N. Main Street, Suite P
Bishop, California 93514

Reference: PLES I Geothermal Development Project; Draft Environmental Impact Statement/Environmental Impact Report Supplement

Dear Mr. Morrison:

Please find enclosed, Pacific Energy's comments on the Draft Environmental Impact Statement/Environmental Impact Report Supplement prepared for the proposed PLES I Geothermal Development Project. Please contact our office if you should have questions regarding any of our comments.

Thank you for your continued assistance.

Respectfully,

for Michael J. Walker
Manager of Operations - Geothermal

TRT:MJW:me

Enclosures

cc: C. Harvey
D. Liddell
File 3005.4.3.10

T1104881.603

PACIFIC ENERGY COMMENTS ON THE PLES I GEOTHERMAL PROJECT DRAFT EIS/EIR SUPPLEMENT

The following comments are provided on the Draft Environmental Impact Statement/Environmental Impact Report Supplement (Draft EIS/EIR Supplement) prepared for the proposed PLES I Geothermal Project.

Page/Paragraph		Comment
ES-2/¶ 2, and 1-5/¶ 2	8-1	The federal lease (CA-11667) on which the PLES I Project is proposed is 1,510 acres, not 630 acres, as indicated.
2-28/¶ 1	8-2	Since the Draft EIS/EIR Supplement was distributed, Pacific Energy has initiated a demonstration transplanting of mature Jeffrey pines using the tree spade technique. This demonstration has shown that, using this technique, trees in excess of 30 feet in height, even taller than the estimated 20-foot trees suggested in the environmental document, can be transplanted within the proposed project area. Thus, significantly greater immediate vegetative screening of the proposed facilities can be expected than is discussed in the document.
3-14/¶ 1	8-3	The Mesquite Group, Inc. analysis actually indicated that all wells have appeared to have risen relative to the benchmark, and that the subsidence is localized between the Taylor-Bryant fault on the north and the eastern graben boundary fault on the south, which suggests a tectonic relationship.
3-25/¶ 4	8-4	A zero total spring flow from the Casa Diablo Geyser has frequently been observed over the course of historic observations; thus, a range of 0.0 to 1.4 cfs is more accurate.
3-27/¶ 3	8-5	Additional temperature data for the hatchery springs and pools have also been collected by the USGS since 1984 (Farrar, 1988). Continuous temperature data have been taken for the H-2,3 pool (not the spring vents). These data indicate about a one degree Fahrenheit fluctuation annually. This data is consistent with the CDFG data provided in Appendix C of the Draft EIS/EIR Supplement. Furthermore, H-2,3 is the coldest spring group, being essentially the temperature of the cold groundwater, with little or no geothermal component. Fluctuations are mostly reflective of ambient temperature conditions and annual precipitation recharge. The USGS also has collected periodic measurements of the AB spring temperature at random over the last two years, and collected continuous AB spring temperature data since June 1988. Again, these data are consistent with the CDFG data. Pacific Energy has requested a third-party consultant (Mesquite Group, Inc.) to compare the recent USGS data with the historical CDFG data. No direct comparisons are possible because the days of measurement do not coincide; however, paired data taken within a few days of each other were selected for comparison. This tabular comparison is attached to these comments. As can be seen from the attached table, most measurements are within ±0.4°F (±0.2°C) of each other, with the most extreme difference being ±1.1°F (±0.6°C). This is remarkably good agreement, given all the likely problems of instrumentation variance and differences in measurement

8-5 locus, personnel, and timing. This comparison provides a degree of validation to the more comprehensive historical CDFG data, dating back to 1976.

3-28/¶ 2 It is incorrect to state that the H-2, 3 spring group may be more susceptible to a reduction of the thermal component as its temperature is currently about 51°F, the same as the coldwater springs, and thus has essentially no thermal component. See also comment to page 3-48/¶ 3.

3-28/¶ 3 Figure 1-12 (Appendix C) indicates the temperature of the H-1 spring is 53°F, not 54°F, and that the range is from 52.5°F to 56°F, not 51°F to 54°F.

3-29/¶ 2 There are actually 12 wells drilled within the caldera to depths greater than 2,000 feet. The Sandia well drilled into the west moat and the 2 wells drilled by the Town of Mammoth Lakes were all "cold" (less than 170°F), which directly conflicts with the lateral flow model theory.

3-31/¶ 2 Both temperature and chemistry data from well SF 65-32 are similar to other Casa Diablo wells.

3-43/¶ 3 8-6 Pacific Energy has funded an expanded continuation of the mule deer migration and summer-range survey through 1988. The interim report of the continued survey for the spring migration period is entirely consistent and corroborates the work undertaken in 1987, in that a dispersed pattern of deer activity in, and movement through, the survey area by approximately the same number of deer was noted, and no well-defined migration trails were observed.

3-48/¶ 3 8-7 The third sentence in the paragraph states that a 2°F decrease in the temperature range [ostensibly in the broodstock spawning facilities] would delay spawning until spring and would result in the practical elimination of the Coleman and Hot Creek strains from the hatchery's statewide trout planting program. This is an entirely inappropriate statement which suggests a potential impact that is not feasible given the physical hydrologic environment. The document clearly states that the temperature ranges in the springs supplying the broodstock complexes range from 52.5°F to 56°F for the H-1 spring group and 50.8°F to 54.2°F for the H-2,3 spring group. However, the cold groundwater in the immediate area, as measured by springs in the area with no thermal component such as Laurel Springs, are consistently measured at a temperature of about 51.8°F ±0.5°F. As such, in the extremely unlikely event that the entire thermal component of the springs supplying the spawning facilities were to be lost, the temperature range of these springs could not fall below the temperature of nonthermal springs in the area which in the case of the H-2,3 spring group is already within its recorded temperature range, and for the H-1 spring group could be reduced, at most, approximately 1°F. Thus, it is impossible for the stated impact to the spawning broodstock to occur!

3-50/¶ 2 8-8 In 1987 a group of Native Americans from the Bishop Council, including those most concerned with preserving traditional values, were provided a tour of the proposed project site and thermal features in the Casa Diablo Hot Springs area. The Native Americans were accompanied by the Inyo National Forest, Forest Archaeologist, who was also concerned that proposed project operations may impact some undocumented and

8-8 previously unidentified site considered sacred by the Native Americans. No thermal springs, fumaroles, nor thermally altered areas in the project site were identified to be of cultural significance to the Native Americans.

3-54/¶ 3

8-9 An evaluation of the timber conditions on the PLES I site was conducted by the Inyo National Forest, Mammoth Ranger District, in March 1988. The Forest Service concluded that the merchantable sawtimber available on the site is sparse and of poor quality, and because the young growth was targeted for transplanting around the project site, the Forest Service determined that the timber should be valued as fuel wood rather than as merchantable timber and estimated the volume to be approximately 3.6 cord.

4-2/¶ 5

8-10 The assessment indicates that dust control measures proposed for the project would reduce particulate emissions to acceptable levels. In addition, the principal traffic to and from the project site will be along existing paved roads or along an existing unpaved road which will be paved to the power plant site. Only short, infrequently used, access roads between well sites will be unpaved. As such, we question the need to require a potentially unenforceable mitigation such as a five mph speed limit.

4-12/¶ 4

8-11 While it is correct to state that SEA, Incorporated has determined that a fault may pass through the plant site, it is incorrect to state that ground rupture "could cause ruptured geothermal and isobutane lines, collapse of structures, and human injury" without clarifying that this could occur only if these facilities were located directly over the fault rupture itself. The principal purpose of the trenching recommended by SEA, Incorporated is to precisely locate and classify the fault trace (if any) so that final engineering design can, if necessary, accomodate, relocate, or redesign facilities within the current plant boundary which may now be proposed to cross the fault trace. SEA, Incorporated has formally stated that they believe there is nothing that would prevent construction of the power plant at the preferred site location (Johnson, 1988).

4-13/¶ 5

Again, SEA, Incorporated has stated that they see no reason why the power plant cannot be constructed within the currently proposed power plant site. If the proposed borings encounter shallow cold or thermal groundwaters, then minor relocations of proposed power plant facilities can be made within the confines of the power plant site can be made. It is not at all correct to indicate that the plant site may have to be moved to avoid the shallow groundwater. These are final design details which are properly and routinely resolved after construction permits are issued.

4-14/¶ 3

8-12 The document discusses observed subsidence in the project area and the potential for induced subsidence from geothermal operations. Pacific Energy retained a third-party consultant to review and evaluate the subsidence issue in the Casa Diablo Hot Springs area (Mesquite Group Inc., January 1988). The report of that assessment concluded that the observed subsidence is a result of natural tectonic activity and that the volcanic rocks in the area have structural integrity which do not lend themselves to the compaction subsidence associated with fluid withdrawal. The Mesquite report is provided as an attachment to these comments.

4-26/¶ 1

8-13

We recommend the document provide some guidance with regard to cumulative impacts from noise and suggest the following rewording of the mitigation:

> "Discussion of mitigation measures to deal with the cumulative impact from traffic noise resulting from other proposed projects is best reserved to environmental assessments for those projects which generate substantial traffic and to regional planning documents such as the Noise Element to the County General Plan and the Forest Management Plan."

4-30/¶ 2

8-14

We believe the appropriate mitigation to prevent this spill event from ever occurring is to implement and maintain the emergency spill containment plan and facilities proposed. The suggested mitigation to perform a bioassay of the geothermal fluid is not directly applicable.

4-42/¶ 3

8-15a

While the Draft EIS/EIR Supplement dismisses the results of the "Papadopolus" modeling by redoing the calculations (as indicated above), it does not reject "Papadopolus" nearly as strongly as it should. We believe the major deficiencies of "Papadopolus" should be spelled out explicitly. These deficiencies have been identified and are provided an the attached table.

4-42/¶ 4

8-15b

The numbers provided in the Table are not the same as those provided in Appendix C. The correct values are:

Area	10yrs	20 yrs	30 yrs
Casa Diablo	-5.6°C	-10.7°C	-15.4°C
Hatchery	-0.5°C	- 1.9°C	- 2.6°C
Gorge	0.0°C	- 1.0°C	- 2.0°C

4-43/¶ 2

8-16

PE believes that the statements made in this paragraph are slightly misleading, in that it is not that difficult to predict the potential for geothermal reservoir changes in different areas of the Long Valley Caldera. Three independent, commonly used reservoir modeling techniques have been employed to predict "extreme case" reservoir temperature and pressure changes which could occur in different areas as a result of the PLES I Project. As described, the use of conservative reservoir values in the modeling means that the actual changes will be substantially less than those predicted. Maximum temperature and pressure changes of -15.4°C and +2.2 psi were predicted in the Casa Diablo reservoir and -2.6°C and +0.55 psi in the Hot Creek Hatchery reservoir after 30 years of PLES I Project operation. As noted, a pressure change of +2.2 psi in the Casa Diablo reservoir is insignificant, although the "extreme case" prediction of a 15.6°C temperature decline in the Casa Diablo production reservoir would probably decrease the ability of the power plant to operate efficiently.

Although the model calculations described above and in Appendix C indicate that, even assuming hydraulic communication exists, the potential for significant subsurface changes to extend the three to five miles to Hot Creek Hatchery and Hot Creek Gorge is very low. What is more difficult to precisely predict is the effect that these small predicted temperature and pressure changes in the geothermal reservoir will have on surface thermal features at the Hot Creek Hatchery and certain other areas distant from the Casa Diablo geothermal area. Special

8-16 circumstances exist at each of these thermal areas, such as those at the hatchery springs, where it is estimated that approximately 2% to 3% of the flow is thermal water. The temperature of the thermal fluid component of these springs is unknown; but it is estimated that a loss of the entire thermal component could result in a lowering of average spring temperature of 2° to 3°C (Sorey, M.L., 1976). No effects have been measured at Hot Creek Gorge or hatchery springs to date, and none would be anticipated on the basis of the reservoir measurements made to date at Casa Diablo.

Based upon the minor changes in reservoir temperature and pressure predicted to occur under these "extreme case" examples, and the nature of the hydrothermal connection to the surface, especially in the case of the Hot Creek Hatchery, it is extremely unlikely that any significant impacts would occur to these distant thermal features of concern.

4-47/¶ 2-3

The text of this paragraph presents a very sketchy and incomplete overview of the hydrothermal monitoring and mitigation programs proposed as part of the project description. Because an accurate understanding of the purpose, design and implementation of these programs is critical to determining how they will be effective, we suggest you replace these paragraphs with the following.

> "This "mitigation process" was designed to reduce to insignificance the possibility of impacts to any of the sensitive hydrothermal features by implementing a program of monitoring the hydrothermal system at numerous points to detect any potentially adverse changes so that mitigation measures could be implemented before those changes reach the sensitive hydrothermal features. This hydrothermal system monitoring program would establish additional baseline data, detect changes caused by project operations before they could affect hydrothermal features of concern, provide information to select and implement appropriate mitigations to prevent hydrothermal changes from migrating away from the production field toward the sensitive hydrothermal features and monitor the effectiveness of the implemented mitigation. The data to be collected by the operator are listed in the Plan for Baseline Data Collection discussed in Chapter 2.

8-17

> "The proposed monitoring program is progressive; that is, the results of initial monitoring may result in the establishment of additional monitoring, and possibly the drilling of additional monitoring wells. It was designed to provide documentation of any progressive movement of hydrothermal system changes away from the Casa Diablo project area toward the Hot Creek Hatchery and other areas of concern. Finally, it was intended to provide the information necessary to select, implement and monitor those mitigation measures appropriate to prevent any detected adverse hydrothermal system changes from reaching the thermal features of concern.

"The proposed hydrothermal mitigation program consists of several techniques which are commonly used in geothermal and oil and gas wellfield operations to manage pressure changes within the reservoir. Geothermal wellfield operations basically consist of the production and injection of large quantities of water so that the heat in the reservoir can be extracted. To produce water from a geothermal well, the pressure in the well is reduced so that the water flows from the geothermal reservoir into the well, and then to the surface. Injection wells reverse this process; increasing the pressure in the injection well forces the water into the injection reservoir, slightly increasing the reservoir pressure in the injection zone.

"Many decisions are made in the process of the development of a geothermal wellfield, such as the location and depth of the production and injection wells; the quantity of water produced or injected; or the number of production and injection wells, all of which affect the specific flow paths of the water in the subsurface geothermal production and injection zones. For example, as previously indicated, since the proposed injection area is to the east of the proposed production area, the injection wells will create a zone of slightly increased reservoir pressure between the area of slightly decreased reservoir pressure in the production

8-17 zone and the hydrothermal features of concern, such as the Hot Creek Hatchery springs. Because water flows in response to pressure changes, by changing the way in which the project produces and injects the geothermal fluid it is possible to modify the way in which the geothermal water flows in the reservoir and, thus, mitigate changes which are detected in the geothermal reservoir which may migrate towards the hydrothermal features of concern. By implementing one or more of the proposed geothermal mitigation measures, the operator, as directed by the authorized officer, should be able to prevent the detected adverse hydrothermal system changes from reaching the thermal features of concern.

"Finally, as a mitigation measure which would be implemented only in the unlikely circumstance that the monitoring and wellfield mitigation measure program failed to prevent the migration of adverse reservoir changes, the hydrothermal mitigation process required that the operator provide an alternative source of thermal water to the affected Hot Creek Hatchery headsprings. This alternative source of water was to be conveyed to the Hot Creek Hatchery headsprings in a manner that did not introduce other fish into the headsprings, and was to be maintained for as long as an alternative source of thermal water was needed to maintain temperatures at levels existing prior to the onset of impact from project operations.

8-17

> "Impact: This hydrothermal mitigation process is quite comprehensive and, as summarized, is designed to reduce to insignificance the possibility of impacts to hydrothermal features of concern. However, several potential insufficiencies have been identified. First, although the California Department of Fish and Game (CDFG) is responsible for the continued operation of the Hot Creek Hatchery, they were not included as one of the "consulting agencies"; the same was true of the U.S. Forest Service with respect to the Hot Creek Gorge springs. The LVHAC monitoring program has now been revised and updated, effective May, 1988. The proposed process ignores the potential for an increase in hydrothermal flow and, therefore, temperature, at the Hot Creek Hatchery springs. The process is also silent on the means by which the authorized officer will determine when to implement any of the additional monitoring or mitigation measures; no method to establish "trigger points" is identified. Finally, the program did not address any issues regarding the timing of the implementation of the mitigation measures designed to correct and prevent any adverse impacts to the thermal features of concern. In order to correct these potential insufficiencies, the following replacement mitigation is suggested."

4-47/¶ 5 The process is more correctly described as a "monitoring and remedial action program designed to prevent, or mitigate, potential hydrothermal impact to the Owens tui chub critical habitat, Hot Creek Hatchery, and Hot Creek Gorge springs."

4-47/¶ 6 8-18 The current version of the LVHAC monitoring program is dated May, 1988.

4-48/¶ 1 This proposed mitigation measure deviates from that contained in the project description by requiring the drilling and completion of a "second" monitoring well (in addition to the already completed SF 65-32 monitoring well) prior to the start of commercial operations. There is absolutely no justification for completion of this well prior to commercial production presented anywhere in this environmental document, nor is there any valid technical argument to support its completion other than under the originally proposed criteria! This condition should be deleted and replaced with that presented on page 4-44, paragraph 2.

8-19 Pacific Energy has previously committed to drilling one observation well prior to commercial production. This well, SF 65-32, was drilled and completed in December 1987, at a location (±1,300 ft east of SF 35-32) and according to procedures previously agreed to by the BLM and the LVHAC. Pressure, temperature and chemical data clearly indicate that this well is in communication with the Casa Diablo production reservoir. Thus far, a "stabilized" pressure drawdown of less that two psi is observed at the well when the MP I project is operating at maximum capacity. This is obviously an inconsequential effect with respect to the warm springs at the fish hatchery some three miles to the east, as even this document recognizes (page 4-39). No changes in temperature or chemistry have been observed.

Pacific Energy has also previously committed to drilling a second observation well near Colton Spring, if it is determined that there is a need for supplemental monitoring data based on the information developed from the first well. This was clearly intended to be a progressive process whereby potentially detrimental changes in or near the geothermal field (i.e., at the first well, SF 65-32) would trigger the drilling of the second well, about a third of the way to the hatchery, in order to determine if the change was propagating in that direction.

It should be noted that a monitoring well at Colton Spring would still be within the Casa Diablo graben. Thus, with either model of the hydrothermal system, i.e., Lateral Flow or Fracture Upwelling, clearly measurable changes could occur at Colton as the result of normal changes in the geothermal field. However, only if the Lateral Flow model is correct, could such changes eventually propagate to the hatchery two miles further east.

The definitive observation well with respect to identifying a true threat to the hatchery springs was previously envisioned as being located about midway between Colton Spring and the hatchery head springs. Pacific Energy has also committed to drilling this third observation well if significant changes are observed in the Colton Spring area well. Thus, if there is a progressive (but predicted diminishing) change from the geothermal field to SF 65-32, then to the second observation well and then to the third observation well, cause and effect can rightly be
8-19 presumed. Note that simply drilling the third well is insufficient, as changes due to the proposed Mammoth/Chance Project operations or natural phenomena cannot be distinguished from those due to the Casa Diablo geothermal projects without the intervening two observation wells to define a progressive effect.

The proposed change in the monitoring process now deviates from the previously agreed upon plan by requiring that the second observation well (i.e., near Colton Spring) be drilled "prior to the start of commercial production". In our opinion, there is no technical justification for requiring that this well be drilled prior to observing a substantial change in the first observation well. While the magnitude of what constitutes a "substantial change" can be subject to argument, no responsible technical expert is likely to argue that the currently observed, less than two psi operating pressure drawdown at the first observation well is substantial. This is especially true when it can be demonstrated that the pressure in the production wells and the observation well returns to its initial static condition (within the limits of measurement accuracy) in a very short time after shut-down (e.g., one to two hours in the producers, one to two days in SF 65-32). This means that the surrounding reservoir is not being depleted by present operations and that, at some small distance from the field, the hydrothermal system is undisturbed relative to its natural condition.

The Draft EIS/EIR Supplement itself states (pg. 4-39) that "any response, positive or negative, less than 10 psi in the producing area of Casa Diablo is not considered significant". Thus, the rationale for requiring a second observation well to be completed prior to commercial operations simply does not exist at the present time. Proposing to require the second observation well prior to detecting significant change in the first is an approach which we believe has no technical merit.

4-48/¶ 3

This condition sets "trigger points" for the implementation of mitigation principally on the basis of pre-production data and conditions, rather than on variations from predicted changes to the commencement of production. It is not reasonable to expect that imposition of the PLES I Project will not cause "any variation outside their normal ranges based on data collected prior to production at PLES I". MP I operations currently result in a very small, but definable, less than two psi pressure drawdown at SF 65-32. With the imposition of PLES I operations, a new semi-steady state is expected to be established. Additional operating pressure drawdown at SF 65-32, roughly proportional to the additional fluid withdrawals due to PLES I operations is to be expected. If MP II operations are also added, current models of the reservoir predict about a 10 psi operating pressure drawdown at SF 65-32. The fact that it deviates from the "normal range" established by measurement prior to PLES I production is not a reason in itself for triggering mitigation actions.

What needs to be determined is whether a 10 psi decrease in pressure at Casa Diablo can reasonably be expected to have any impact at the fish hatchery three miles away. It is our opinion that such a change will be inconsequential, with the 10 psi drawdown dissipating rapidly with distance away from the field. Furthermore, we believe that most technical experts familiar with the Long Valley hydrothermal system would agree with us that a 10 psi drawdown is not significant, as do the authors of the Draft EIS/EIR Supplement (pg. 4-39).

8-20 At the point in time, some two years hence, that such an operating pressure drawdown may be experienced, the available data base will be much more extensive. In addition to the baseline data available pursuant to the LVHAC monitoring programs, the results from drilling, testing and initial operation of the wells associated with PLES I (and MP II) will be available. The ability to numerically model the reservoir performance will be greatly refined by this time. It should then be much more meaningful for the various technical experts to advise the controlling regulatory bodies as to the significance of any observed changes at Casa Diablo. We expect that a ±10 psi drawdown will still be considered inconsequential. On the other hand, a ±20 psi drawdown, which substantially exceeds expectations and continues to decline, could indicate that the available recharge is unable to keep up with the increased withdrawals. This might well be judged to warrant drilling the second observation well and implementation of mitigation measures such as modifying the injection distribution in order to maintain pressure. Likewise, a potentially detrimental change in produced fluid chemistry or declining resource temperature of more than a few degrees could also be legitimate causes of concern, particularly because no such changes are currently expected.

The point is that the requirement for additional monitoring wells and mitigation measures is best left with the responsible regulating body who will be advised by technical experts (internal and external) on the basis of <u>actual</u> observations and data available at the time. To require, at this time, that any deviation from the current "normal range" trigger additional mitigation is not technically defensible. This is especially true when we already predict and expect small changes to occur due to additional development, which are currently judged to be inconsequential.

4-52/¶ 3 **8-21** Replace or revise in accordance with previous comments on 4-48/¶ 1.

4-53/¶ 3 **8-22** Revise in accordance with previous comments on 4-48/¶ 3.

4-56/¶ 4 There is absolutely no justification for the drilling of this injection zone monitoring well presented in this document, so we can only presume that this newly proposed mitigation measure is mainly predicated upon the numerical pressure response modeling done for this Draft EIS/EIR Supplement. This model predicts that reservoir pressure will increase a small amount (i.e., 2.2 psi at SF 65-32, and 0.55 psi at the hatchery) on the east side of the field, thereby causing a minor increase in the hydrothermal component flow near the hatchery. This, in turn could potentially cause a minor temperature increase in the hatchery springs.

However, such a pressure increase in the injection zone at the Casa Diablo can already be monitored directly with the data from the annual pressure fall-off surveys conducted in the injectors. Thus far, no increase in injection reservoir pressure is indicated. Furthermore, injector wellhead pressures and downhole pressure in one injector are now being continuously monitored during injection. Any anomalous
8-23 increase in operating injection pressure can thus trigger a shutdown at any time of the year to measure the fall-off to static reservoir pressure. This will insure that no pressure increase in the injection reservoir will go undetected.

Thus, there is really no need for an injection reservoir observation well to detect an increase in pressure. Furthermore, the Draft EIS/EIR Supplement itself states (pg. 4-54) that:

> "It should be noted that it is considered exceedingly remote that pressure in the hydrothermal reservoir would rise, resulting in increased temperatures. The predicted very small pressure increase occurs because the model assumes complete hydrologic communication between the production and injection reservoirs. In reality, it is unlikely that there is such communication. Therefore, although no detectable impact is expected, of the two possibilities, a decrease in the thermal component is the more likely."

While we don't necessarily agree that there is no communication between the production and injection reservoirs, we do agree that there is no current direct evidence of communication. Pressure in the production reservoir is actually being maintained at present by additional hydrothermal influx, (i.e., recharge from below or laterally) not by injection. What is observed is actually a less than two psi decrease in operating pressure at SF 65-32 in the production reservoir, not a two psi increase as predicted by the EIS/EIR modeling due to injection.

From the foregoing it should be clear that monitoring pressure in the injection reservoir with a new observation well is unnecessary. Not only is a pressure increase due to injection exceedingly unlikely, but pressure will be monitored directly from the injectors themselves during each shutdown.

More recently, a concern about temperature decline at the hatchery and Hot Creek gorge caused by injection cooling at Casa Diablo has been raised by the S.S. Papadopulos & Associates, Inc. report commissioned by the California Dept. of Fish and Game. This is a different process with an effect opposite that produced by the pressure response modeling which caused the initial concern about monitoring the injection zone.

The Draft EIS/EIR Supplement considers the "Papadopulos" possibility and dismisses it as a non-problem by: (1) doing bulk-model calculations (pg. 4-40) which show that the cool temperature front due to injection will move out only a short distance from the field (i.e., less than 1,300 feet) during the project life; and (2) repeating the Papadopulos heat balance modeling approach (pg. 4-42) while correcting a few (of many) of the fundamental assumption errors in Papadopulos' modeling, with the result being no cooling at the hatchery or Hot Creek gorge due to Casa Diablo operations.

8-23

"Papadopulos" postulates that this cooled injection zone will eventually migrate with the regional flow to the hatchery area. Migration calculations in the Draft EIS/EIR Supplement (pg. 4-41) also indicate that the cooled injection zone could reach the hatchery area in about 100 years, if the zone maintained its integrity. However, it was noted that the cooled zone could not really migrate intact, but rather would tend to sink deeper into the reservoir, (pg. 4-41), and would be reheated by the hot reservoir rock as it moves from west to east. The reheating potential was not calculated in the Draft EIS/EIR Supplement, but a simple heat balance calculation shows that the 80°C water in the cooled zone will be reheated by the rock to 130.6°C (or 1.6°C less than the current Mammoth/Chance reservoir temperature of 132.2°C) by the time it reaches the hatchery area. Only one percent of the heat in this rock is required to achieve this. The basic input values for the calculation are the same as those used in the bulk model calculation, and further assume piston-like displacement of the cooled zone water (i.e., no benefit of mixing with hotter waters upstream or downstream) and an average rock temperature of 141°C between Casa Diablo (150°C) and the hatchery (132°C) area. Because the hydrothermal component is about three percent of the total spring flow at the hatchery, the spring temperatures would actually then decline only 0.04°C on average. Given the range of normal variation, such a decline would be undetectable for all practical purposes.

As a result of the foregoing it should be clear that cooling of the springs at the hatchery due to Casa Diablo injection is not a problem. Thus, again, there should be no need to directly monitor the temperature in the injection zone with a monitoring well.

Likewise, chemical changes in the injection zone fluids are not a problem. The binary power cycle at Casa Diablo is a non-consumptive closed cycle. The injected waters are chemically identical to the produced waters and can obviously be monitored directly with surface sampling.

In summary, the only potential for detrimental change in the injection zone is a very unlikely pressure increase. This can be monitored directly with periodic pressure fall-off surveys in the injectors themselves. As a consequence, we do not believe there is any justifiable technical

8-23 reason at this time for a separate well to monitor the injection zone. However, if for any reason the drilling of an injection zone monitoring well becomes desirable, other proposed conditions give the authorized officer authority to require the drilling of an injection zone monitoring well.

4-66/¶ 5

8-24 This paragraph seems to be referring to mitigation of visual impacts rather than those associated with deer. With regard to mitigation of potential impacts on mule deer migration, Pacific Energy has: (1) adopted former BLM stipulation No. 12 (Draft EIS/EIR Supplement, page 2-6), which states that noise intensive activities during deer migration periods may be limited; and (2) agreed to construct pipeline crossing ramp(s) for mule deer which would be constructed, as may be required by the BLM authorized officer. An engineering detail of the proposed mule deer crossing ramp design was earlier provided to the BLM (Detail "L" on Drawing No. C-0416-1-E-108, PLES I Facilities, Details and Specifications) and is provided as an attachment to these comments.

4-66/¶ 6

8-25 This mitigation measure should read:

> "No mitigation measure other than those proposed by the applicant is recommended."

4-91/¶ 11

8-26 As discussed in earlier comments, the ability to transplant even larger mature Jeffrey pines, in excess of 30 feet in height, taller than earlier anticipated, provides the opportunity of meeting the Forest Service VMO for retention in the project area almost immediately, or at least in a much shorter time frame, by vegetative screening of the proposed facilities.

4-102/¶ 7

8-27 The following economic impact associated with the smaller power plant should be added:

> "Economic benefits to the federal government from royalty revenues; and to the local economy from property taxes, County of origin revenues, local employment, local spending and sales taxes would be proportionally less for the smaller power plant than for the proposed project.

5-3/¶ 3

8-28 The following individuals should be added to the list of individuals in private organizations contacted:

- Environmental Management Associates, Inc.

  Dwight L. Carey, D.Env.

- Pacific Energy

  Claude Harvey, Vice President

- Pacific Enterprises

  Donald C. Liddell, Special Counsel

Appendix F
F-1/¶ 6

8-29

The statement that PURPA and the CPUC require electrical utilities to purchase electricity from small power producers at "a higher price than the utilities would pay a large conventional fuel electrical producer" is inaccurate. Instead, the act and the implementing agency require a utility to buy electricity at the price the utility "avoids" by not having to build its own generating capacity.

Appendix F
F-2/¶ 3

8-30

With regard to the potential for additional geothermal development in the project area it is important to note that, to date, only the isolated Casa Diablo Hot Springs area has been proven to have commercial geothermal potential. Further, both the Inyo Domes Unit operator, Unocal, and the Long Valley East Unit operator, Santa Fe Geothermal, have both gone on record announcing that they have no plans for development in the project area in the foreseeable future.

Appendix F
Figure 1

8-31

This figure identifies existing development in the project area and shows a developed area (Area D) as the site of the MP I geothermal project. This is in error, and the large developed area shown is actually undeveloped private land owned by the Los Angeles Department of Water and Power (LADWP) and is not associated with the MP I project. The MP I project is actually within an area immediately east (identified as proposed project area No. 6). The relatively small (approximately 170-acre) MP I project area is also the site of the proposed MP II and MP III projects. Finally, the larger area surrounding the LADWP property and the MP projects is the Pacific Energy federal lease in which the PLES I project area is proposed.

Appendix F
F-5/¶ 3

8-32

This paragraph discusses several public projects proposed within, or near the Town of Mammoth Lakes. We recommend redrafting the paragraph as follows:

> "Town of Mammoth Lakes Projects: Three public agency-sponsored projects are proposed for development within, or near, the Town of Mammoth Lakes, including the: (1) Town of Mammoth Lakes Golf Course; (2) Mammoth Water District Water Project; and (3) Economic Development Corporation plans for an Industrial Center at Old Mammoth School.

Appendix F
F-5/¶ 4

8-33

We understand the decision to dismiss from consideration the issue of cumulative hydrologic impacts from the projects identified. However, we believe this decision may not be clear from the information provided in the Draft EIS/EIR Supplement. As such, we recommend adding the following clarifying language to the paragraph:

> "The following projects were evaluated in the cumulative impact assessment in this document; however, for the reason identified for each project, it was determined to be inappropriate to analyze the potential cumulative hydrologic impacts from these projects with respect to the proposed PLES I project."

COMPARISON - USGS VS. CDF&G

WATER TEMPERATURES (°F)

HOT CREEK HATCHERY SPRINGS

AB Group			H-2,3 Group		
USGS	CFD&G	Δ T	USGS	CFD&G	Δ T
60.8 (6/21/84)	60.7 (6/25/84)	0.1	52.0 (6/21/84)	51.7 (6/25/84)	0.3
60.6 (4/28/85)	60.0 (4/17/85)	0.6	51.4 (4/28/85)	51.3 (4/17/85)	0.1
59.9 (4/8/86)	59.8 (4/14/86)	0.1	51.8 (4/8/86)	50.9 (4/14/86)	0.3
-	-	-	51.6 (7/19/86)	51.4 (7/15/86)	0.2
-	-	-	52.0 (8/29/86)	51.8 (8/1/86)	0.2
62.6 (10/16/86)	62.3 (11/5/86)	0.3	52.2 (10/16/86)	51.7 (11/5/86)	0.5
-	-	-	52.7 (11/18/86)	51.7 (11/5/86)	1.0
61.0 (4/21/87)	61.2 (5/4/87)	0.2	51.4 (4/21/87)	51.4 (5/4/87)	0
61.5 (5/27/87)	61.8 (6/4/87)	0.3	51.4 (5/27/87)	51.8 (6/4/87)	0.4
-	-	-	51.4 (6/18/87)	50.8 (6/23/87)	0.6
-	-	-	51.8 (7/28/87)	51.6 (7/27/87)	0.2
63.1 (7/31/87)	62.0 (7/27/87)	1.1	52.2 (7/31/87)	51.6 (7/27/87)	0.6

CD Group			H-1 Group		
USGS	CFD&G	Δ T	USGS	CFD&G	Δ T
57.9 (4/28/85)	57.4 (4/17/85)	0.5	55.2 (4/28/85)	54.2 (4/17/85)	1.0

(Source: Mesquite Group Inc., 1988)

Mesquite Group, Inc.

P.O. Box 1283
136 W. Whiting Avenue
Fullerton, California 92632
(714) 738-8224

January 27, 1988

Mr. Donald C. Liddell
Senior Counsel
Pacific Lighting Energy Systems
6055 E. Washington Blvd.
Commerce, CA 90040

Subject: Review and Evaluation of Subsidence in the Casa Diablo Area, Long Valley Caldera, Mono County, California

Dear Don:

Pursuant to your request last month, we have now completed the subject subsidence review and evaluation. A short report documenting this effort is enclosed.

Briefly, our conclusion is that the observed subsidence in the Casa Diablo area is in no way related to the geothermal operations. The subsiding area actually constitutes the Casa Diablo Graben and is, in our opinion, a normal tectonic event which has characterized the area for thousands of years. Furthermore, the current subsidence is centered 1,500 feet south of the geothermal plant, and its onset was more than two years after plant start-up.

The only detectable subsidence within the geothermal field area occurred between mid-1986 and mid-1987 near the plant site, and is less than 0.02 feet. This amount of movement is minor in comparison to other elevation changes observed in the Long Valley Caldera in in recent times. Even if subsidence continues at this rate in the field area, it will be a widespread phenomena which clearly poses no threat to facilities or the environment.

The available data and evaluation leading to this conclusion are detailed in the enclosed report. Please call if you have questions or wish further elaboration.

Sincerely,

Don

Don A. Campbell

DAC:mjo
Enclosure
cc: Dr. M.L. Sorey, USGS
Mr. Terry Thomas, EMA

Mesquite Group, Inc.

P.O. Box 1283
136 W. Whiting Avenue
Fullerton, California 92632
(714) 738-8224

REVIEW AND EVALUATION OF SUBSIDENCE IN THE CASA DIABLO AREA, LONG VALLEY CALDERA, MONO COUNTY, CALIFORNIA

Introduction

Dr. J.S. Savage of the U.S. Geological Survey (USGS) stated in the July-September 1987, Long Valley Caldera Monitoring Report that "the most prominent signal is the subsidence over the 1 km section that crosses the Casa Diablo geothermal field. That subsidence, which appears in both plots, amounts to about 15 mm/yr near the center of the field". Savage presented several figures (included as Appendix A) intended to support this interpretation. These data were referred to in the covering page of the report with the statement "the local subsidence associated with the Casa Diablo geothermal field that began following the onset of routine power production from the geothermal power plant in 1984". Note that Savage's original statement did not correlate subsidence to production, only to location.

Concern about possible complications arising from subsidence associated with field operations caused Pacific Lighting Energy Systems (PLES) to request that Mesquite Group, Inc. (Mesquite) review and evaluate all the available subsidence data. Mesquite initiated the required data compilation by requesting Dr. Savage's raw leveling data (1982-1987), Gram-Phillips'/Ben Holt's original well location/elevation survey data (1982 and 1984), and Western Air Photo's 1987 topographic survey data. The discussion below summarizes the available data base and Mesquite's evaluation thereof.

Leveling Data

The National Geodetic Survey (NGS - formerly the Coast and Geodetic Survey) installs elevation bench marks along lines throughout the United States. Periodically, the NGS precisely determines the location and elevation of these bench marks, an operation called "leveling". The Long Valley leveling line extends from Tom's Place in the south to Lee Vining in the north. The line usually follows the route of Old Highway 395 (i.e., Hot Springs Road). At present, bench marks are spaced approximately 700 feet apart across the resurgent dome in the Casa Diablo area.

The data that Dr. Savage transmitted to Mesquite included the physical location of the bench marks in Long Valley and the results of previous leveling surveys that were performed in 1932, 1957, 1975, 1980, 1982, 1983, 1984, 1985, 1986, and 1987. The increased frequency of measurement begun in 1980 reflects the USGS's expansion of their Long Valley Volcanic Hazards Monitoring Program. During this time the number of bench marks was greatly increased across the resurgent dome.

Mesquite reviewed the data and selected the 1984 survey as a baseline. This survey was performed before commercial production operations began and contained all of the newer bench marks. The elevation of each bench mark in subsequent annual surveys was compared to the elevation in 1984 and the relative difference was calculated. The annual elevation change relative to 1984 is plotted in Figure 1 for the Casa Diablo area. In general, the resurgent dome (including Casa Diablo) has risen over 0.5 feet since 1984. However, between the last two surveys (1986 and 1987), the rise appears to have stabilized regionally, and a 4,000 foot wide section of the dome actually subsided a maximum of approximately 0.06 feet. This subsidence is greatest at the Casa Az bench mark, which is located near the intersection of Old 395 and Route 203 (Plate 1). At the Z123 bench mark, across the road (Old 395) from the Mammoth-Pacific I (MP I) power plant, the measured subsidence amounts to less than 0.02 feet. Geographically the subsidence extends from near the Mammoth Creek crossing of Old 395 on the south to the Southern California Edison (SCE) Substation on the north.

Well Survey Data

Well surveys, which include location coordinates and ground elevations, are usually finalized immediately after a well is drilled. The original MP I well surveys and accompanying field notes were obtained from the Gram/Phillips Associates, Inc. (local surveyors) and the Ben Holt Company (the MP I Project contractor). These data were mostly from 1982, before the MP I wells were drilled, and thus the actual ground elevations at the new wells may be slightly different than the surveys due to site grading. However, surveys were also done at this time for two of the already existing wells in the area, i.e., Union-Mammoth 1 and Endogenous 1, and these surveys should be exact. In addition, 1984 survey data, after drilling, were provided for two of the new MP I wells, MBP 3 and IW 1.

The reported ground levels for each well were first adjusted relative to the NGS reference point (BM Z123) elevation in the year of the survey (Plate 1). This was necessary because Gramm/Phillips had assumed the 1980 elevation of BM Z123 to be a constant reference for their surveys, while the NGS date showed movement from year to year. These adjusted elevations were then compared with the elevations shown on the 1987 air photo topographic map prepared by Western Air Photo (which was referenced to the correct 1987 NGS elevation for BM Z123). The total change in well elevation between the original survey (1982 or 1984) and 1987 was then calculated as shown on Table 1. Each well's movement relative to the bench mark was also determined by subtracting the movement of the bench mark (Z123) in this period and this is plotted in Figure 2. Similar calculations for the other NGS bench marks in the area are also shown on Table 1 and plotted in Figure 2.

not rise as fast as the other resurgent dome bench marks. Between 1986 and 1987, the resurgent dome uplift generally stabilized and slight subsidence (maximum of 0.06 feet) occurred in the Casa Diablo area. The subsidence area is a 4,000 foot wide zone centered near the junction of Old 395 and 203. At the MP I Plant, the elevation decreased only 0.02 feet.

The lack of precise annual surveys of well elevation comparable to the NGS surveys prevents a detailed analysis of surface movement in the field area. However, a gross comparison of the original well surveys (1982 or 1984) and one in the fall of 1987 is possible. Taken literally, the data indicate that the geothermal field (both injection and production areas) has moved up nearly twice as much as the general regional uplift between 1982 and 1987 (+1.0 feet vs +0.5 feet), as shown on Table 1 and Figure 2. There are no 1986 well survey data available to indicate whether the recent minor subsidence consistent with the NGS leveling line movement has occurred. Nevertheless, it is clear that no subsidence of any consequence has occurred within the field area, and that an overall a rise of 0.5 to 1.0 feet dominates elevation changes in the area since 1982.

Geologically, the recent subsidence observed along the NGS leveling line appears to be related to tectonic movement of the Casa Diablo Graben. The subsidence only occurs east of the Taylor-Bryant Fault and west of the eastern Casa Diablo Graben Boundary Fault. Such tectonic movement is seen throughout eastern California and Nevada where the grabens (i.e., down-dropped fault blocks) move down in relation to the adjacent horsts (i.e., raised fault blocks). In fact, the Casa Diablo Graben is an easily mapped feature that extends for over three miles in a very young volcanic terrain. This indicates that the graben has experienced active down dropping for at least the past 60,000 years. Subsurface correlation between the three MP I injection wells clearly shows that the Casa Diablo Graben has moved approximately 400 feet downward in relation to the eastern horst during recent geologic time.

It should also be pointed out that the types of rock found in the Casa Diablo area do not readily lend themselves to subsidence which is not tectonically induced. Classical subsidence associated with fluid production occurs above sand/shale reservoirs as individual grains of rock compact in response to reductions in pore fluid pressure. Dr. M.L. Sorey has recently suggested that a similar compaction phenomena might result from rock contraction associated with cooling due to injection. However, the volcanic rocks involved at Casa Diablo generally have structural integrity which minimizes or precludes compaction. Porosity is almost exclusively vertical fractures, which may close in response to pressure decline or open in response to cooling, but such movements do not have significant vertical components. Furthermore, there has been no change in average reservoir pressure in the production area or the injection area which could induce movement. Contraction due to cooling of the injection interval rock remains a theoretical possibility, but there is no indication of movement in the injection area which is not consistent with the regional tectonic movements.

TABLE 1

WELL ELEVATION CHANGES

Well or Benchmark	Original Survey Elevation (ft ASL)	Original Survey Year	1987 Elevation (ft ASL)	Total Elevation Difference (ft)	Movement Relative to BM Z123 (ft)
Endog. #1	7334.05	1982	7335.0	0.95	0.4
Union Mammoth #1	7305.98	1982	7306.8	0.82	0.3
MBP #3	7310.25	1984	7311.3	1.05	0.5
IW #1	7294.96	1984	7295.8	0.84	0.3
EGE 6	7333.10	1983	7333.55	0.45	-0.1
Z 123[a]	7290.10	1982	7290.63	0.53	0.0
EGE 7	7272.81	1983	7273.19	0.38	-0.2
CASA AZ[b]	7249.74	1982	7250.19	0.45	-0.1
DBR 11	7250.89	1984	7251.37	0.48	-0.1

(a) Bench mark across Old 395 from the MP I plant.

(b) Bench mark at the intersection of Old 395 and 203.

The movements suggested by the well survey data range from +0.3 to +0.5 feet more than the 0.53 foot upward movement of BM Z123 between 1982 and 1987. This implies that the wells have risen nearly a foot, or twice the regional uplift. This is not really believable in Mesquite's opinion. More likely, the wells have moved similarly to the bench mark and there is some systematic difference between surveys. Such a difference is not surprising, in that the well surveys were not conducted with the precision of the NGS survey. Western Air, in fact, only claims an accuracy of ±0.3 feet. Nonetheless, the consistency of the data is such that the wells are clearly indicated to have risen in the 1982 to 1987 period, and no subsidence is evident.

Discussion

The NGS elevation data shows that the Casa Diablo area has generally risen an average of 0.5 feet since 1984. This elevation gain is associated with the upwarp of the resurgent dome resulting from hypothesized deep magma injection, and is known to have begun well before the geothermal project start-up in late 1984. Between mid-1985 and mid-1986, the bench marks along Old 395 from near the SCE substation to Mammoth Creek (Figure 1) did

Conclusion

The 1986-87 subsidence observed in the Casa Diablo area has actually been relatively minor when compared to elevation changes elsewhere in the Long Valley Caldera during the period of historic observation. In Mesquite's opinion, the subsidence of the Casa Diablo Graben is merely a resumption of tectonic down-dropping which has characterized the area for thousands of years. The fact that geothermal operations are being conducted in the graben has no correlatable relation to the observed subsidence.

The overall evidence for this conclusion may be summarized as follows:

1) The apparent onset of recent subsidence was actually more that two years after operations began at MP I.

2) The subsidence is centered 1,500 feet south of the MP I power plant and extends for over 4,000 feet along Old 395. The geothermal operations are located on the far northern flank of the subsidence area and could not reasonably be expected to impact the area in a manner that caused subsidence to be projected southward.

3) Well survey data indicates that the production and injection areas have moved upward in concert with the NGS leveling line. This data does not show any subsidence associated with either production or injection.

4) Geological evidence indicates that the recent observed subsidence is related to normal tectonism of the Casa Diablo Graben.

5) There has been no average reservoir pressure decrease in the production area or increase in the injection area which could induce movement. Cooling of the injection area is a theoretical possibility, but this area has predominantly moved up.

6) The volcanic rocks involved generally have structural integrity and do not lend themselves to compaction which results in subsidence.

FIGURE 1

ELEVATION CHANGES

JUNE 1984 TO YEAR INDICATED

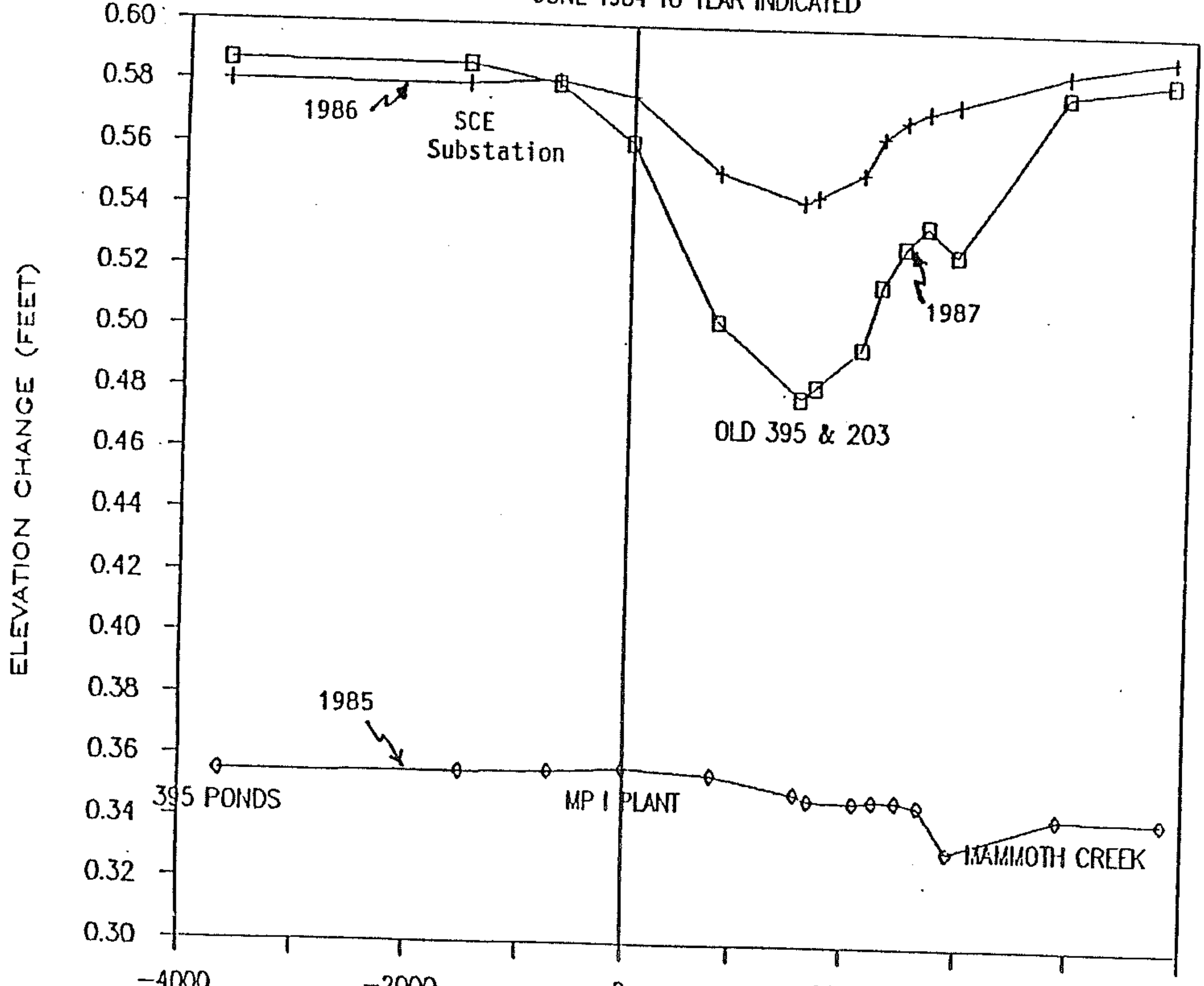
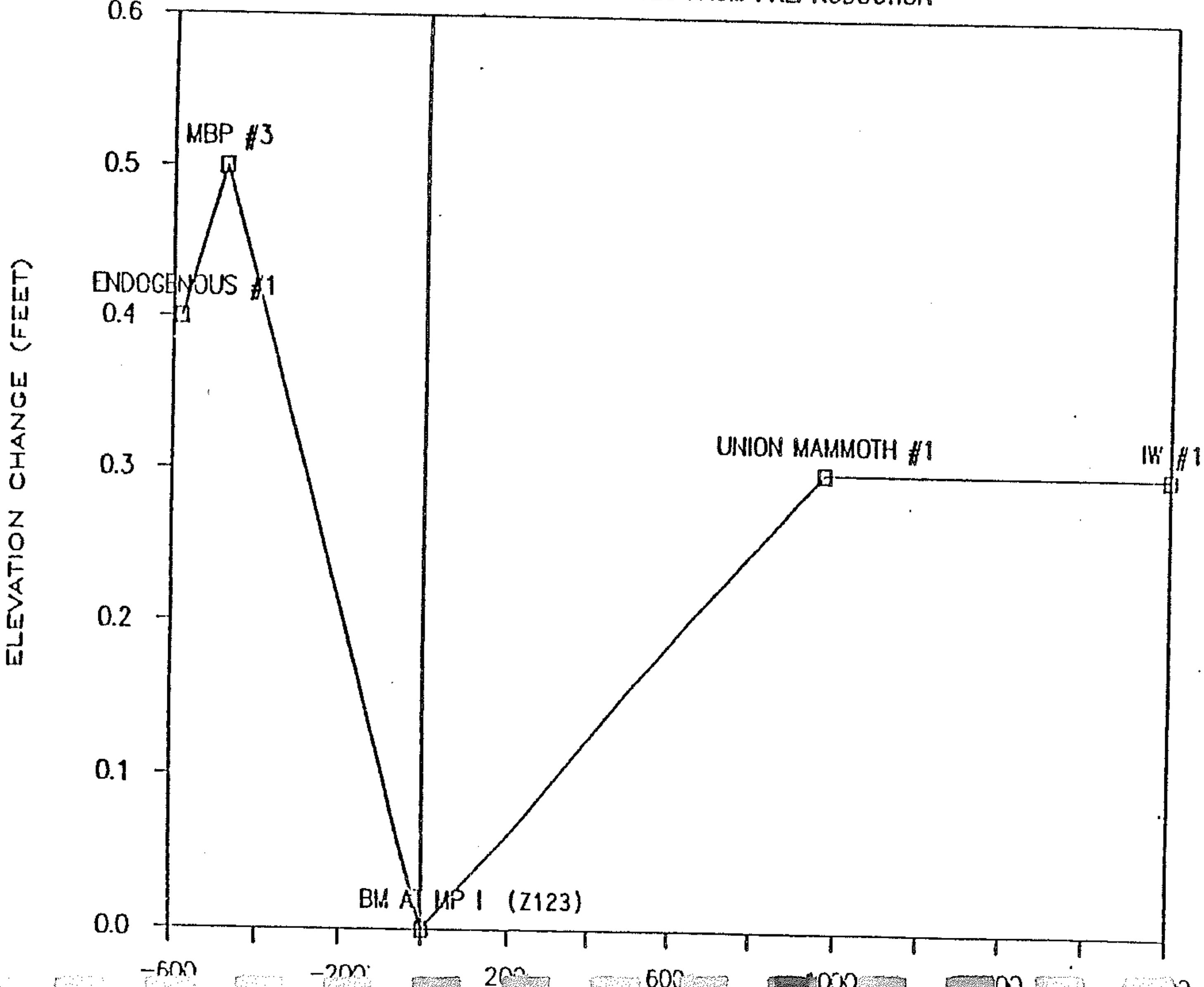


FIGURE 2

MP I WELL ELEVATION CHANGES

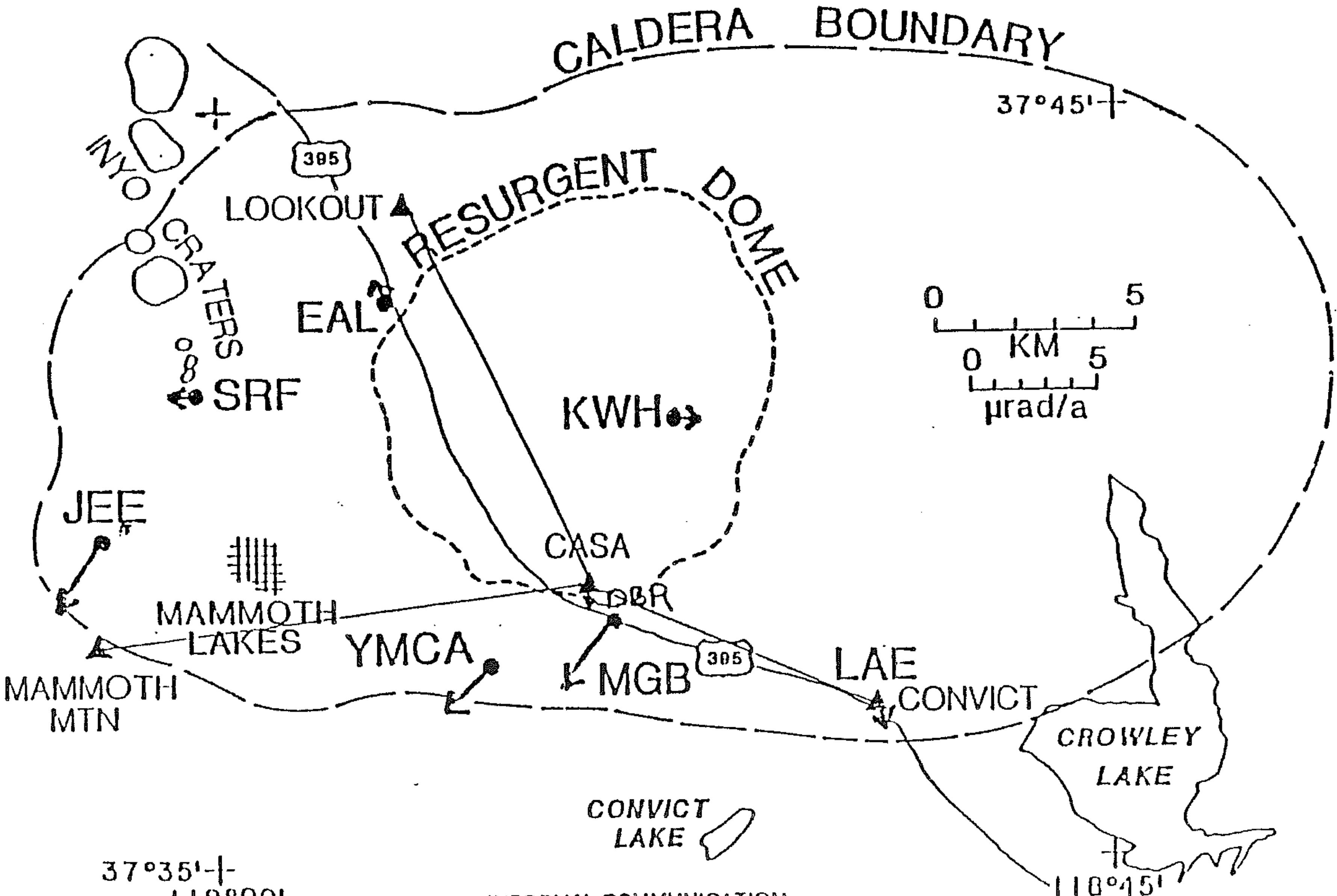
RELATIVE TO BM Z 123 FROM PREPRODUCTION



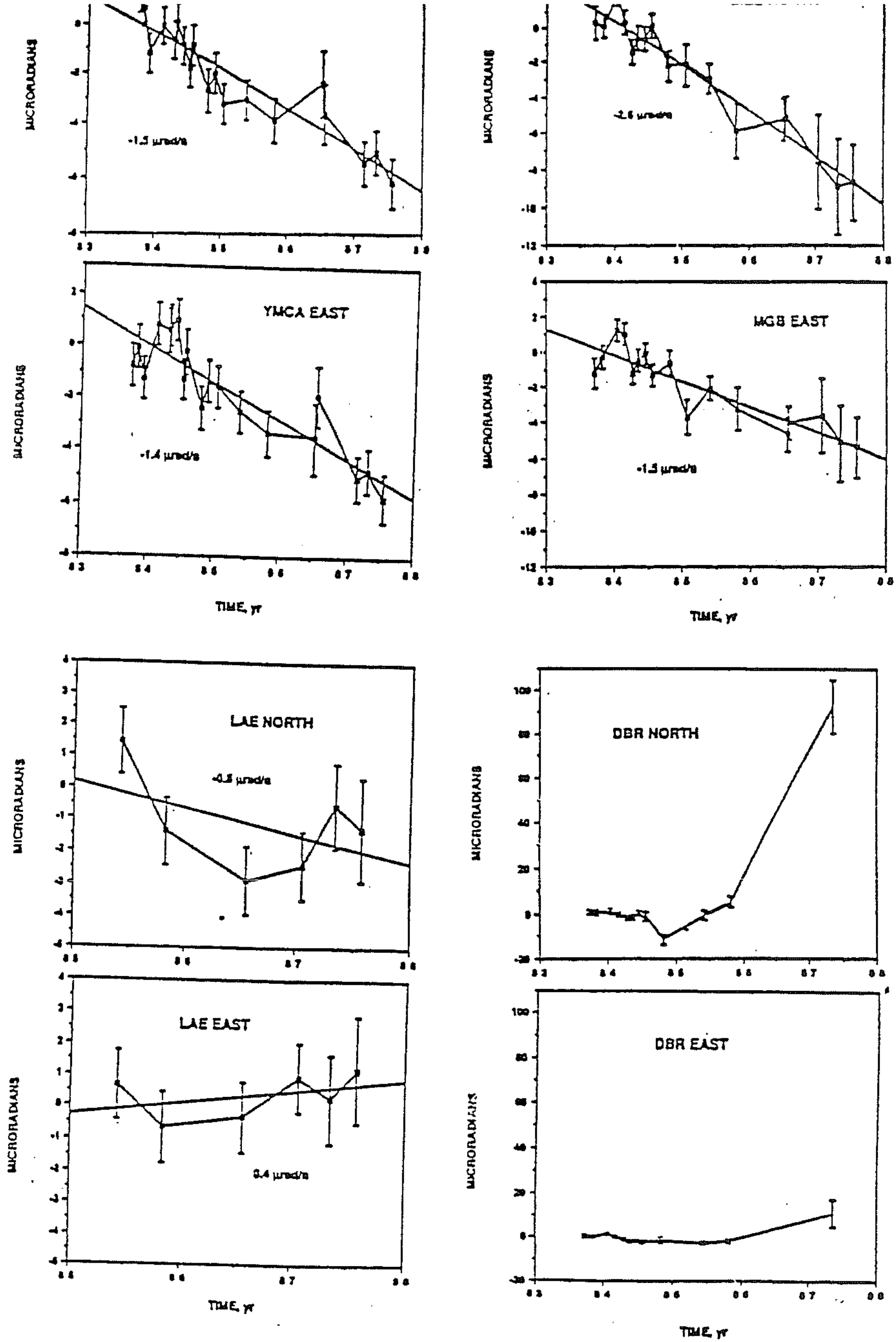
APPENDIX A

FIGURES FROM THE USGS LONG VALLEY MONITORING REPORT, JULY-SEPTEMBER 1987, J.S. SAVAGE

FIGURE G10: Map showing infra-red geodimeter lines and L-shaped level figures. Arrows indicate the direction and magnitude (see scale in urad) of cumulative tilts measured at each array for the interval 83.7 (Sept. 1983) to 87.6 (Aug 1987).



INFORMAL COMMUNICATION
NOT TO BE CITED FOR PUBLICATION



INFORMAL COMMUNICATION
NOT TO BE CITED FOR PUBLICATION

FIGURE G-12 cont'd

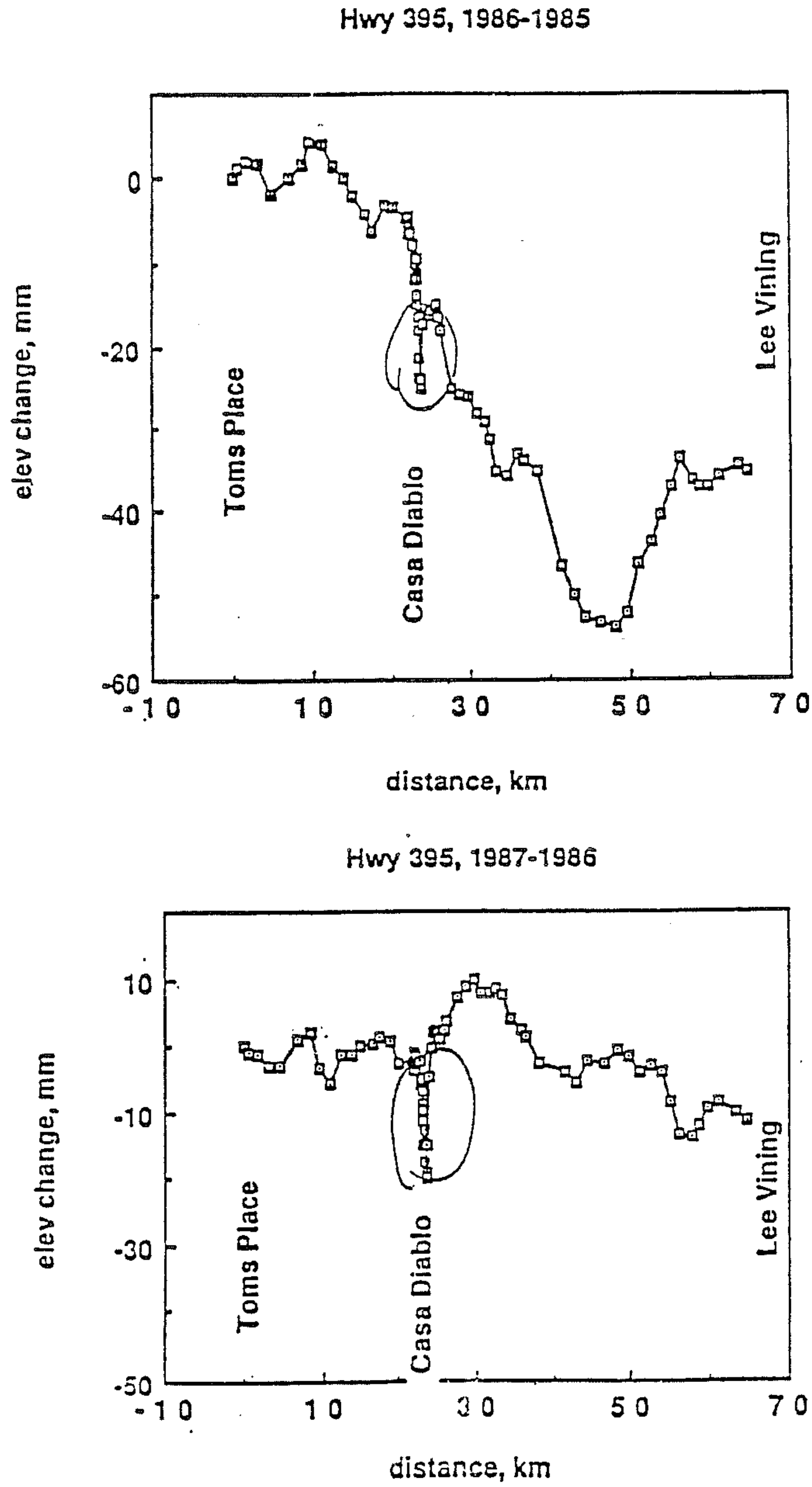


FIGURE L1: Differences in benchmark elevation along Highway 395 for the years 1986-1985 (top) and 1987-1986 (bottom). Distance along Hwy 395 measured from Tom's Place.

INFORMAL COMMUNICATION

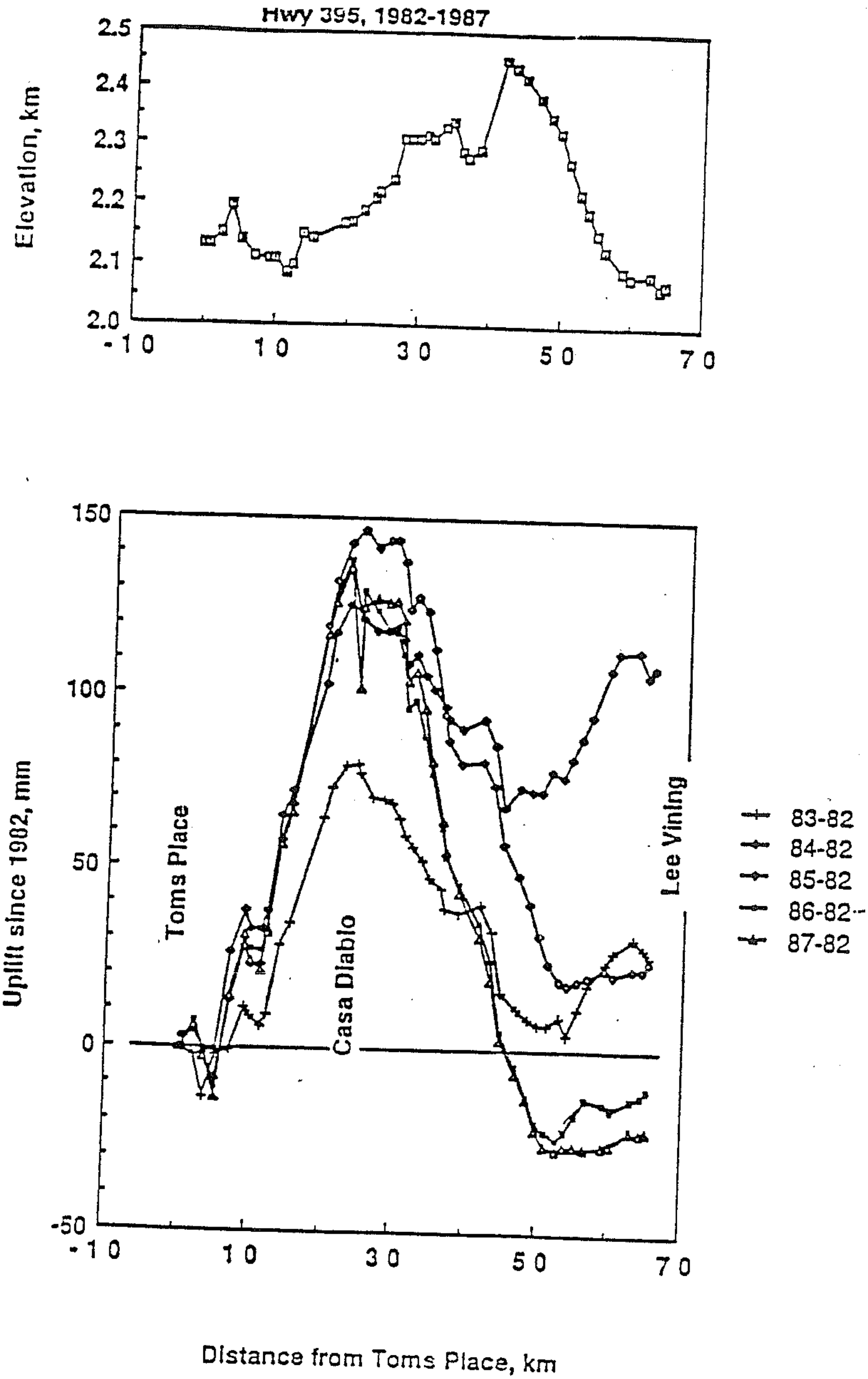
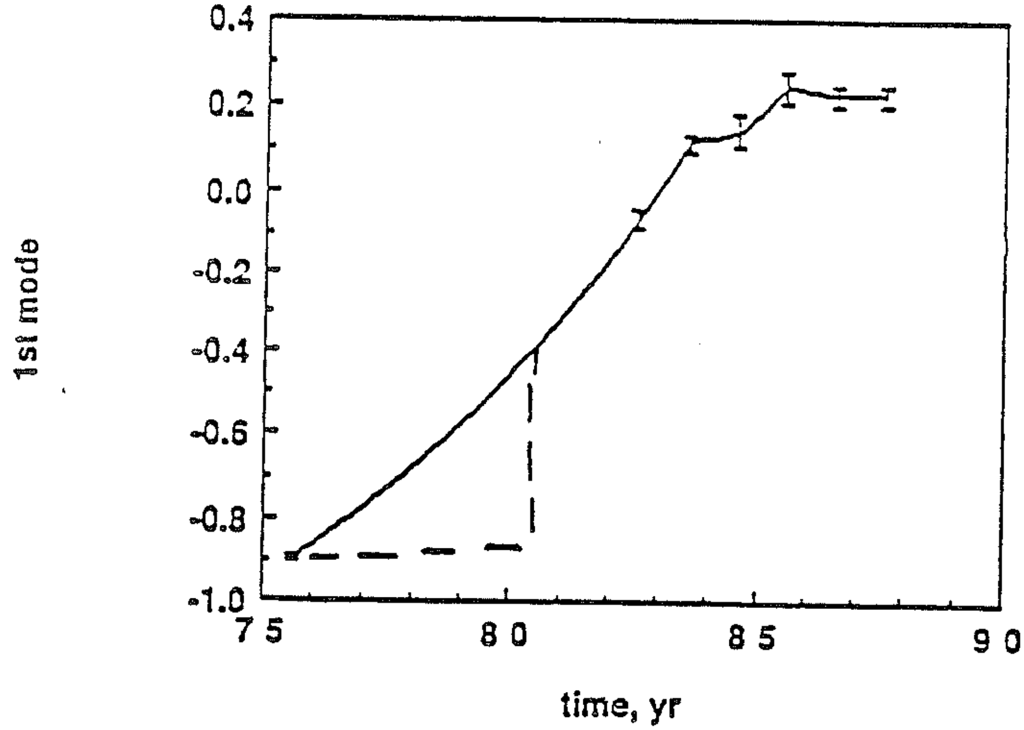


FIGURE L2: Differences in benchmark elevation along Highway 395 for the years 1982-1987 (top) and 1983 through 1987 with respect to 1982 (bottom).

L2



Hwy 395, 1975-1987

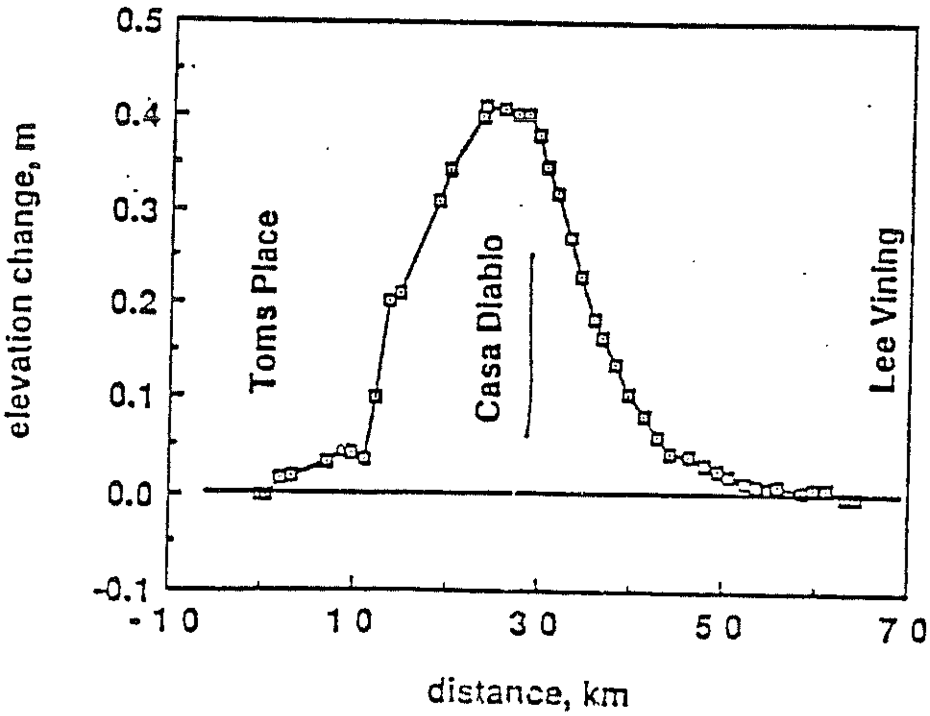


FIGURE L3: Results of principal mode analysis of levelling data along Hwy 395 for 1975 through 1987. The dashed line in the temporal variation (top) represents the possibility that the onset of resurgent dome uplift coincided with the May 1980 Mammoth Lakes earthquake sequence.

PAPADOPOLUS REPORT DEFICIENCIES

	Papadopulos Assumption	Correct Assumption
1.	Heat-in-Place, = 1 x 10^{17} Cal (actually uses slightly higher and lower numbers in models)	At least 10 times this much per Sorey, 1988 - Most published numbers are even higher
2.	Recharge is limited to outflow of hot springs and conductive losses in Crowley meadows (Uses 5 x 10^7 Cal/sec in model)	Equilibrium is not required, as meteoric recharge varies and system may actually be heating-up due to intrusive magma - Sorey, 1976 says hot springs alone discharge 6.9 x 10^7 Cal/sec - uncredited discharges include: (1) conductive losses to widespread shallow groundwater flows which mask surface heat flow; (2) downward "cooled legs" of the geothermal convection cells; and (3) subsurface flows out of the caldera towards Bishop - Fails to account for increased recharge potential if pressure is decreased by production in the shallow hydrothermal reservoir - Inconsistent with observations in major geothermal fields around the world where withdrawals far exceed the identified pre-development discharges
3.	Porosity is 35%	Much too high for fractured rhyolites (5% to 10% is better estimate)
4.	Recharge is distributed uniformly between Casa Diablo and Hatchery area	Lateral flow concept requires all flow to go through Casa Diablo (model only applies if lateral flow exists)
5.	Entire reservoir in model is 200°C at beginning	Actual temperature ranges from 175°C at Casa Diablo to 130°C at Mammoth/Chance (near Hatchery)
6.	Casa Diablo reservoir temperature decreases 150°C in 20 years	Power generation would cease with ±30°C decrease (in about 4 years) - MP I alone should have already caused a 6°C decline if model is correct
7.	Implies a 34°C temperature decline at Hatchery Springs	Even if model is correct "as is" (which it isn't), a 34°C decline in hydrothermal reservoir temperature only translates to a 1°C decrease in spring temperatures because hydrothermal component is only 2-3% of spring flow
8.	Claims monitoring will not detect adverse impacts until irreversible changes have occurred	Drastic changes such as those predicted by model would be detected at Casa Diablo itself almost immediately - Fails to recognize ability to control pressure distributions and/or temperature by re-orienting production/injection patterns - Fails to recognize conductive reheating potential of massive volume of hot rock between Casa Diablo and Hatchery area.

S1104881.603

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

October 21, 1988

Area Manager
Bishop Resource Area
787 North Main Street, Suite P
Bishop, California 93514

Dear Sir:

In accordance with the National Environmental Policy Act, we have reviewed the Draft Environmental Impact Statement (EIS) for the "PLES I Geothermal Development Project, Mono County, California" which you provided to us. We are responding on behalf of the U.S. Public Health Service.

We wish to emphasize the need for compliance with the requirements of the Occupational Safety and Health Administration for worker safety both during the construction phase and in the actual power plant operation. In our review of the proposed Geothermal Development Project, we found potential hazards to public health posed by this project, in general, to be well defined and mitigated. However, we believe that additional attention should be devoted to the potential health threat due to the quality of indoor air in the power plant.

9-1

Although neither the geothermal fluid nor the isobutane working fluid, to be used in the shell-and-tube heat exchangers, would be exposed to ambient air under the proposed engineering design, we believe the area within the power plant should be monitored for levels of Hydrogen Sulfide, hydrocarbons, and radon gas. Radon can be found in high concentrations in soils and rocks containing granite, uranium, shale, phosphate, and pitchblende. While radon levels would not be of concern in outdoor air in the area of the wells and power plant, the area inside the power plant could be subjected to increased levels of radon. You may choose to have the geothermal fluid tested for radon levels to negate the necessity for testing for radon levels in the air inside the power plant.

9-2

Please insure that we are included on your mailing list for the FEIS for this project as well as other documents which are developed in accordance with the National Environmental Policy Act.

Sincerely yours,

David E. Clapp, Ph.D., P.E., CIH
Environmental Health Scientist
Special Programs Group
Center for Environmental Health
and Injury Control

THE TOWN of MAMMOTH LAKES CALIFORNIA

PLANNING DEPARTMENT

P.O. Box 1609, Mammoth Lakes, California 93546
619-934-8983

October 6, 1988

Area Manager,
Bishop Resource Area
787 N. Main Street, Suite P.
Bishop, Ca. 93514

Dear Mr. Morrison,

Thank you for allowing the Town of Mammoth Lakes the opportunity to comment on the Draft EIS for the PLES I geothermal plant. As you know, we were concerned over potentially significant adverse impacts of the plant and we commend your decision to prepare an EIS.

Our comments on the DEIS are:

10-1 1. The alternate location considered by the DEIS provides significantly better visual screening than the primary location. The Town feels that this location is preferable. However, we do believe that additional mitigation is required including burial of fluid transmission pipelines to reduce conflicts with mule deer migration.

10-2 2. If this project is approved, there should be a time period established to monitor the effects of the two operating plants before any more plants are considered in the vicinity. The Town feels that a five year span between power plant installation would be appropriate.

10-3 3. Because this plant will reduce habitat within the mule deer migration corridor, the applicant should be required to purchase other developable property within the migration corridor or winter range and donate it to the BLM or Forest Service for protection of critical habitat.

10-4 4. The procedures for monitoring the impacts to the geothermal reservoir should be modified to assure more independence. We would like to see wider participation in the Long Valley Hydrological Advisory Committee and we feel that the data should be collected by an independent party responsible directly to the BLM or the HAC, not the applicant.

10-5 5. Page 1-9, section 1.4.1.4 Visual Resources. The concern of the Town is not just on the detrimental effects on tourism. We are also concerned with how a deterioration in the visual environment affects residents. This should be addressed as well.

10-6 6. Page 3-36, Figure 3-5. This map should be extended to the west to cover the lands which could be affected by the alternate plant location.

10-7 7. Page 4-34, section 4.1.4.2.1 Proposed Project Impacts. If the cold water well lowers local groundwater levels, would that have an impact on the ephemeral ponds to the west? If so, how could that be mitigated? This question should be addressed in the final EIS.

10-8 8. Page 4-68, Deer Migration Mitigation Alternative Location. This section does not discuss options such as burying fluid transmission lines. Burial should be discussed and if it is a successful mitigation, it should be required.

10-9 9. Section 4.3.6, Proposed Project Impacts. The only analysis is from the point where 395 crosses Mammoth Creek. While this is a sensitive vantage point, using it as the sole viewpoint oversimplifies the visual impacts. The project location is much more exposed from the vicinity of the intersection of 203 and 395. Mitigation such as tree transplanting would have less immediate effect, would require more trees, and would take longer to achieve the visual quality objectives than the analysis indicates. Further, while transplanting appears to offer an exceptionally effective means of providing screening, it has been attempted only recently and on a limited scale in the project vicinity There has not been sufficient time to determine survivability of the transplanted trees.

10-10 10. Page 4-104, mitigation. The Mammoth Unified School District eliminated developer impact fees about six months ago so this measure no longer is applicable.

10-11 11. If the proposed mitigation measures for the alternate plant location are inadequate to prevent significant adverse impacts to the mule deer herds, we would no longer feel that that site is preferable.

10-12 12. If the project is to be approved, all proposed mitigation measures should be required.

Sincerely,

Gary Flynn,
Mayor

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF TRANSPORTATION
500 SOUTH MAIN STREET
P.O. BOX 847
BISHOP, CA 93514

October 14, 1988

File: Mno-395-R25.75
SCH #86122913

Bishop Resource Area
787 No. Main St., Suite P
Bishop, CA 93514

Attn: Area Manager

EIS/EIRS for PLES 1 Geothermal Project, SCH #86122913

11-1 We have reviewed the above-referenced document and find that it addresses our concern adequately.

Very truly yours,

Andrew J. Zeilman, Chief
Transportation Planning Branch

AJZ:ac

OCT 17 '88

United States Department of the Interior

FISH AND WILDLIFE SERVICE
SACRAMENTO ENDANGERED SPECIES OFFICE
2800 Cottage Way, Room E-1823
Sacramento, California 95825

OCT 21 1988

In Reply Refer To:
EML/1-1-88-I-44

MEMORANDUM

To: Area Manager, Bishop Resource Area, Bureau of Land Management, 787 N. Main Street, Suite P, Bishop, California 93514

From: Acting Field Supervisor, Endangered Species, Fish and Wildlife Service, Sacramento, California

Subject: Draft Environmental Impact Statement/Environmental Impact Report for the Proposed PLES I Geothermal Project, Mono County, California

This memorandum responds to your September, 1988, request for comments on the subject document. Our comments are limited in scope and address only the potential impacts the project may have on the endangered Owens tui chub. We previously consulted with the Bureau, pursuant to Section 7 of the Endangered Species Act, on this project, and also provided comments in response to the notice of preparation of a draft Environmental Impact Statement. (See our July 22, 1988, memorandum in which we outlined the conditions under which reinitiation of formal consultation should be considered.)

The California Department of Fish and Game recently forwarded us a copy of the technical input it received from its consulting hydrologist regarding potential impacts to the Hot Creek headsprings. (See enclosed copy of the October 7, 1988, letter from S. S. Papadopulos & Associates to the Department of Fish and Game.) The Department's technical consultant concluded: (1) geothermal development will create thermal pits within the geothermal system surrounding the Casa Diablo area, (2) that these geothermal pits will ultimately migrate to areas of natural
12-1 thermal discharge, and (3) that the temperatures or heat flux of the natural discharges will be reduced.

We request that you address these comments and conclusions in the final Environmental Impact Statement, and that you determine whether the criteria in 50 CFR 402.16(b) have been met relative to the reinitiation of formal consultation because of the presentation of new information.

Please contact Ed Lorentzen or me at (916) 978-4866 if you have any questions regarding our comments.

David L. Harlow

Enclosure

cc: Chief, Endangered Species, Portland, OR (FWE-SE; Attn: Ralph Swanson)
Field Supervisor, Laguna Niguel Field Office, Laguna Niguel, CA (Attn: Patricia Rice)
California State Director, Bureau of Land Management, 2800 Cottage Way, Room E-2841, Sacramento, CA 95825
Regional Forester, Pacific-Southwest Region U.S. Forest Service, 630 Sansome Street, San Francisco, CA 94111
Director, California Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814 (Attn: Larry Eng)
Fisheries Manager, California Department of Fish and Game, 407 W. Line Street, Bishop, CA 93514 (Attn: E.P. Pister)

S. S. PAPADOPULOS & ASSOCIATES, INC.
CONSULTING GROUND-WATER HYDROLOGISTS

S. S. PAPADOPULOS
S. P. LARSON
C. B. ANDREWS
T. J. DURBIN

October 7, 1988

Mr. Curtis Milliron
California Department of Fish and Game
407 W. Line Street
Bishop, California 93514

Dear Curtis:

I have reviewed the draft Environmental Impact Statement on the PLES I geothermal project in the Mammoth Lakes area, and I have the following general and specific comments:

General Comments

Important environmental issues regarding the proposed project are (1) the individual impacts of the PLES I project on spring discharges and (2) the cumulative impacts of the PLES I project together with other projects on those discharges. The principal springs at issue include the springs in the Hot Creek gorge area and the springs in the fish hatchery area. The PLES I project and other existing and proposed projects will have a significant

12-2 adverse impact on the thermal component of spring discharges, but an adequate evaluation has not been made of the impacts.

The projects will "mine" heat from the natural geothermal system in order to produce electrical power. The cumulative rate of heat production, or rate of mining, for the existing and

WESTERN OFFICE: 260 RUSSELL BOULEVARD, SUITE B, DAVIS, CALIFORNIA 95616 (916) 756-0922
CORPORATE OFFICE: 12250 ROCKVILLE PIKE, SUITE 290, ROCKVILLE, MARYLAND 20852 (301) 468-5760

proposed projects will be about 1.5×10^8 calories per second. Over the planned 30-year life of the projects, a total of 1.4×10^{17} calories of heat will be removed. This will result in the cooling of part of the geothermal system. In the affected areas, the temperature within the geothermal system will be reduced by as much as 100°C. The affected volume of the geothermal system will be 2.6 $\times 10^9$ cubic meters. If the assumption is made that the system is 150 meters or 500 feet in thickness, the affected surface area will be 170 square kilometers or 7 square miles. Therefore, the mining of heat will create thermal "pits" within the geothermal system that have a depth of 500 ft and a cumulative surface area of 7 square miles. These pits are analogous to the excavations of open-pit mines. However, in the case of geothermal development, heat is excavated instead of mineral ore.

The cumulative volume of the thermal pits is independent of whether the source of the mined heat is stored heat or replenished heat. As a more general statement, it is also independent of the conceptual model that applies to the geothermal system. This can be understood from the following analogy: Imagine a barrel that has been filled with water to overflowing from a garden hose. Now, consider the first of two situations. The tap is still on, and water is overflowing from the barrel. Then, a bucket is dipped into the barrel, and a bucket-full of water is removed.

However, these thermal pits will not remain stationary. They will be swept from the project area, toward the southeast, to the vicinity of Hot Creek gorge and the fish hatchery springs. The pits will migrate because they will move with the water that flows within the geothermal system. Data are not available to determine the rate of migration. However, based upon reasonable assumptions regarding the possible ranges of the determining factors, the pits probably will migrate at a rate between 50 to 500 meters per year. These rates translate into travel times of 80 and 8 years. Regardless of the rate of migration, however, the pits eventually will reach the Hot Creek gorge and the fish hatchery springs.

The mining of heat from the geothermal system will create a heat deficit in that system. That deficit ultimately will be manifested in part as decreased temperatures in the thermal component of the spring discharges. The heat deficit might be thought of as a "pollutant" within the natural geothermal system. The mining of heat by the projects will introduce the pollutants into the system. After project operations have been terminated, the pollutants will remain within the system, until they are discharged from the geothermal system in the areas of natural thermal discharge, where the discharges include the convective heat flow from springs and conductive heat flow to the land surface.

However, these thermal pits will not remain stationary. They will be swept from the project area, toward the southeast, to the vicinity of Hot Creek gorge and the fish hatchery springs. The pits will migrate because they will move with the water that flows within the geothermal system. Data are not available to determine the rate of migration. However, based upon reasonable assumptions regarding the possible ranges of the determining factors, the pits probably will migrate at a rate between 50 to 500 meters per year. These rates translate into travel times of 80 and 8 years. Regardless of the rate of migration, however, the pits eventually will reach the Hot Creek gorge and the fish hatchery springs.

The mining of heat from the geothermal system will create a heat deficit in that system. That deficit ultimately will be manifested in part as decreased temperatures in the thermal component of the spring discharges. The heat deficit might be thought of as a "pollutant" within the natural geothermal system. The mining of heat by the projects will introduce the pollutants into the system. After project operations have been terminated, the pollutants will remain within the system, until they are discharged from the geothermal system in the areas of natural thermal discharge, where the discharges include the convective heat flow from springs and conductive heat flow to the land surface.

The draft EIR neither acknowledges this ultimate outcome nor attempts to analyze it in any meaningful manner. Crude models have been developed in order to predict the impacts of geothermal development on Hot Creek gorge and the fish hatchery springs. However, these models do not represent the essential elements of the geothermal system with regard to the response of the system to development. The most important element is that the development and migration of the thermal pits is a transport phenomenon, and at least the migration of the pits must be treated explicitly as such in any model that is proposed as a tool for predicting the impact of geothermal development. A second element is that the relevant transport processes occur within a particular hydrogeologic environment, and the model must incorporate information about the local properties of the hydrogeologic system. The existing models that were used in the preparation of the EIR incorporate neither of these essential elements.

The EIR is flawed both in the methods that are used and in the conclusions that are reached, and it should be rejected as a statement of the impact of development on the geothermal system. From consideration of just the most basic physical laws of the conservation of mass and the conservation of energy, the only possible conclusions regarding the impacts are (1) that geothermal

Mr. Curtis Milliron
October 7, 1988
Page Six

development will create thermal pits within the geothermal system, (2) that pits will ultimately migrate to areas of natural thermal discharge, and (3) that the temperatures or heat flux of the natural discharges will be reduced. These conclusions hold regardless of the conceptual model that is applied to the geothermal system. The issues represented by these conclusions are not addressed in the EIR.

Specific Comments

Page 4-36. Paragraph 2.

12-3 The design of a viable monitoring program demands that the phenomenon to be monitored be properly considered. Owing to reinjection, significant pressure changes will not occur within the regional geothermal system. However, reinjection of colder water will create the thermal pits that were described above. Once the pits are created, they cannot be removed in any practical manner. The pits will migrate within the regional geothermal system. Then, especially if the rate of migration is slow, all that a monitoring program will do is to track the inevitable migration of the pits to the areas of natural thermal discharge.

Page 3-40. Paragraph 3.

12-4 Considering the cumulative impact of the PLES I project together with other existing and proposed projects, the projects will produce thermal pits with a surface area of 7 square miles. This value is calculated by assuming a rock-water heat capacity of 5.5×10^5 calories per cubic meter, a thickness of 150 meters, a temperature differential of 100°C, and a cumulative production over 30 years of 1.4×10^{17} calories. The conclusion is that the projects cumulatively will create very significant thermal pits within the natural geothermal system.

Page 4-41. Paragraph 1.

12-5 The migration of the thermal pits to Hot Creek gorge or to the fish hatchery springs does not require an "extremely abnormal" flow pattern. It simply requires the consideration of alternative flow patterns. Nevertheless, the important fact is that the thermal pits inevitably will migrate to the areas of natural thermal discharge. That outcome holds regardless of the conceptual model or flow patterns that apply to the actual system, and that outcome should not be in dispute.

Page 4-41. Paragraphs 3 and 4.

12-6 Little is known about the large-scale bulk permeability of the geothermal system. Accordingly, statements about fluid velocities are merely speculations. The actual velocities easily could be an order of magnitude higher than stated, and the travel times concomitantly could be an order of magnitude shorter. Regardless of the fluid velocity, the thermal pits will inevitably migrate to the areas of natural thermal discharge. Furthermore, impacts will always be impacts regardless of the time at which they occur.

Page 4-43. Paragraph 2.

12-7 The fact that impacts have not yet occurred is absolutely no evidence that impacts will not occur at some future time. The model calculations are no evidence that impacts will not occur, because the models do not represent the essential features of the geothermal system.

Models can be valuable tools for the assessment of the impacts of development on the geothermal system. However, models easily can be misused by accident or for other reasons. Models are nothing more than a formal statement of the modeler's assumptions regarding a specified system. If the modeler's underlying concepts of how the system behaves are incorrect or overly simplified, then the predictions that are made using the model will be incorrect. The art of model building is to identify the essential elements of the system and to incorporate those elements into the model. However, the models that were used in the development of the EIR are based on an overly simplified conceptualization of the system, do not incorporate the essential elements of the geothermal system, and are therefore not valid predictors of the response of the system to development.

Appendix C. Page 32. Paragraph 3.

The pressure-response and bulk models probably provide a reasonable gross assessment of the pressure effects within the geothermal system and of the initial development of the thermal "pits" within the vicinity of reinjection wells. The heat-balance model can only provide qualitative indications of the direction of
12-8 long-term regional impacts, and it cannot produce quantitative predictions of the magnitude of the impacts. The problem with the heat-balance model is that it does not sufficiently represent the essential features of the actual geothermal system. Additionally, certain parameter values of the model (such as the reservoir volume) are difficult to assign properly, and the quantative predictions are sensitive to the selected values. To assess the

Mr. Curtis Milliron
October 7, 1988
Page Ten

long-term regional impacts, a more physically based model would be required.

Appendix C. Page 45. Paragraph 2.

12-9 The block sizes that are used in the heat-balance model should be selected to encompass just the area over which temperature changes will occur. Likewise, the blocks should not include areas in which temperature changes do not occur. The block sizes used in the Papadopulos model assume that temperature declines will spread laterally over a width of about 1300 meters. The heat-balance model that is described in Appendix C implicitly assumes that temperature declines will spread laterally over a width of 3700 meters. However, calculations in Appendix C using the bulk model state that the thermal front would spread laterally 800 meters. Therefore, the heat-balance model that is described in Appendix C is inconsistent with the bulk model. However, the Papadopulos model is more consistent, but an even smaller reservoir volume might have been used in the Papadopulos model.

Appendix C. Page 46. Paragraph 1.

12-10 Given the actual magnitude of the resource and the environmental constraints on its development, the combination of the existing and proposed projects taken together represent an unreasonable expection regarding the magnitude of possible development. The projects taken individually and in aggregate represent a significant risk to the environment and perhaps a significant risk in terms of the economic viability of the projects.

Appendix C. Page 47. Paragraph 1.

2-11 The results obtained with the heat-balance model that is described in Appendix C do not indicate what actually might occur within the geothermal system. The arbitrary use of a reservoir volume that is much too large results in computed temperature declines that are much too small. As discussed above, the block widths should be equal to the width that will be effected by temperature declines. That width is significantly smaller than that used in the heat-budget model that is described in Appendix C. Accordingly, the simulation results are meaningless regarding the magnitude of impacts.

Summary Remarks

2-12 Much has been made in the EIR and elsewhere of the controversy regarding the conceptual model that applies to the geothermal system. However, that controversy has little relevance to the larger picture, because the general impacts of the projects will occur regardless of which of the "lateral flow" or "upwelling" models properly describes the actual system. Most of the remarks that have been made above are not based on any particular conceptual model. Regardless of which conceptual model applies, the project will impact the areas of natural thermal discharge. The only relevance of the conceptual model to a discussion of impacts is with regard to the temporal and spatial distributions of those impacts. Nevertheless, the total "mass" of the impact is independent of the conceptual model.

Sincerely,
S. S. PAPADOPULOS
AND ASSOCIATES, INC.

Timothy J. Durbin

Timothy J. Durbin
Vice President

UNITED STATES GEOLOGICAL SURVEY

JAN 26 1989

WATER RESOURCES DIVISION
P.O. BOX 1298
SANTA ROSA, CALIFORNIA

Area Manager
Bishop Resource Area
787 N. Main St.
Bishop, California, 93514

Nov. 8, 1988

Dear Area Manager:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement for PLES I Geothermal Project, September 1988. In general the document is well written and comprehensive, however I have noted a few errors of fact, a few points in need of clarification, and a few points of discussion that should be included.

Errors Noted:

13-1 1. Pages 2-33 and 2-34 are missing and pages 3-24 and 3-23 are found in their place. Of course this prevents anyone from commenting on what may be discussed on those pages.

13-2 2. Page 3-38, Fish Hatchery spring H-I is described as "the lowest temperature spring in the cold water source area to the west." This sentence is confusing because spring H-2,3 is colder than spring H-I.

13-3 3. Page 3-28, section E, second sentence, "seasonal spring temperatures have varied from 73° to 94° C during a 1983 to 1985 monitoring period at HC-1 and HC-2 springs." This sentence implies a seasonal 21° temperature variation for these springs. That is not correct. The flow rates of many springs diminish over time as mineral precipitation clogs the supply conduits. As the flow diminishes, the water temperature also diminishes due to greater conductive losses. However many springs in Hot Creek gorge remain vigorous for years and their temperatures vary by 1-2° C over the seasons at most. One spring in the gorge has been within 2° C of 92° C between 1983-1988.

13-4 4. Page 3-31, paragraph 1, last sentence states the elevation of the high temperature zone is approximately 400 ft. lower at Shady Rest than at Casa Diablo. The difference is only 100ft, 6700 ft. at Shady Rest and 6800 ft. at Casa Diablo.

Points in need of clarification:

13-5 1. Setmire, J.G., 1984 is referenced on pages 3-26 and 4-27, claiming his report showed the discharge of thermal water from the Casa Diablo wells during 1962 had no adverse impact to Mammoth Creek. His report was written 22 years later and was never intended to address this issue. His report makes no assessment of the impact from well discharges.

13-6 2. Page 3-26, paragraph 3, mentions 760 gpm from Casa Diablo wells was directed to the creeks. However, this was 760 gpm at the well head, much less flow would have reached Mammoth Creek due to infiltration and evaporation.

13-7 3. Page 3-32, last paragraph, isotopic analyses arediscussed. The point is made that large differences in isotopic ratios in different springs and wells can be interpreted under the "Lateral Flow Model" as caused by complicated processes of mixing, boiling, and different recharge areas. Then it is suggested that the "Upwelling/Fracture Flow Model" provides a less complicated explanation of the isotope data. Table 1-4, appendix C shows δ D in springs at Casa Diablo varies from -110.9 to -122 and δD in wells varies from -111 to -117 (not including the flashed sample from IW-2 on 1-7-84). The source of water for the springs at Casa Diablo is the same as for the wells at Casa Diablo regardless of which model, Upwelling or Lateral Flow, is correct. The fact that differences do exist between springs and wells at Casa Diablo shows isotopic ratios do vary due to evaporation, boiling, mixing, and other processes and that the differences do not require different source reservoirs as claimed in the Upwelling Model.

13-8 4. Page 4-34, paragraph 4.1.4.2.1, it is stated that "neither the alluvium nor a significant shallow fresh water resource is continuous downslope toward Chance Ranch...". This claim is not substantiated and actually there is a high likelihood that the shallow fresh water aquifer is continuous to the south and east of Casa Diablo toward Chance Ranch.

13-9 No analysis is given for the cumulative impact of supplying irrigation water for all the projects MP I, II, III, PLES-I, and Mammoth/Chance.

Needed additions:

13-10 1. Page 4-29 and 4-32, discusses temperature impact to Mammoth Creek if a pipeline ruptured. Scenarios are presented separately for pipeline breaks at the PLES-I and MP-I well fields, but no cumulative impact analysis is given for pipeline breaks at two or more project sites. All proposed project sites are located on or near faults and the area is known for its frequent seismic events. It is conceivable that fault displacement could cause pipeline breaks at more than one project site at the same time, therefore the cumulative impact should be addressed.

13-11 2. No assessment is provided for the impact to Mammoth Creek water quality from potential pipeline breaks. The discussion on page 4-29 is inadequate and uses the reference, Setmire (1984), incorrectly to suggest

13-11 no impact was detected to water quality in 1962. An analysis of water quality impact should be included considering the potential cumulative impact from several projects if the containment ponds overflow or fail. This analysis could follow what is given for the temperature impact but should include the cumulative impact of more than one project.

General comment:

13-12 Several numerical models have been used to predict future conditions under various production scenarios. The results of these predictive models provide a wide range of potential outcomes. Numerical models can not provide meaningful projections of future conditions when they are based on sketchy hypotheses. When considerable data are available numerical models can be more strictly constrained and may provide worthwhile predictions. The widely divergent predictions that are forecast by various modellers using various modelling approaches demonstrates a lack of data at the present to adequately constrain the models. All the models presented thus far are not well constrained and their relation to the real world is very tenuous at best. The results predicted by these models are equally unreliable and should be considered only as possible examples of what might happen if everything included in the models are correct.

However, numerical models are not required to adequately assess all the possible adverse impacts caused by developments. Reasonable cautionary measures can be a part of development and continuous monitoring of key points in the hydrologic system can insure early detection of potential problems and provide needed data to decide what modifications in development operations can reverse an adverse trend.

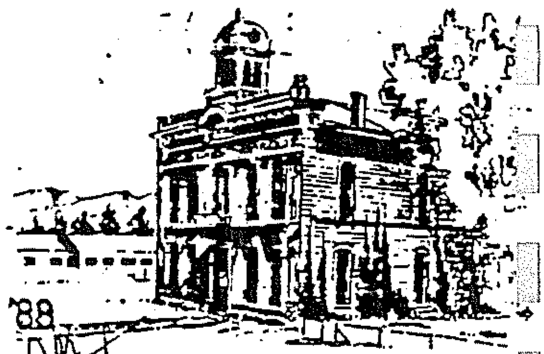
Sincerely,

Christopher D. Farrar

COUNTY of MONO

ENERGY MANAGEMENT DEPARTMENT

HCR 79, Box 221
Mammoth Lakes, CA 93546
(619) 934-6704, Ext. 403



NOV 25 '88

EL L. LYSTER
Director

November 23, 1988

Mr. James Morrison
Area Manager
Bureau of Land Management
Bishop Resource Area
787 North Main, Suite P
Bishop, California 93514

RE: RESERVOIR MONITORING REQUIREMENTS FOR THE PLES-I GEOTHERMAL PROJECT

DearJim:

On November 16, 1988, the Long Valley Hydrologic Advisory Committee, Hydrologic Monitoring Subcommittee met at the U.S.G.S. office in Menlo Park. The purpose of this meeting was to review and discuss results of the recent reservoir interference testing at the Mammoth-Pacific I Geothermal Project and to discuss the technical merits and need for requiring two additional monitoring wells (one in the injection zone and one in the vicinity of Colton Spring) prior to the start of commercial production of the PLES-I project, as recommended in the "PLES-I Draft Environmental Impact Statement". The members of the Hydrologic Monitoring Subcommittee which attended this meeting were as follows:

14-1

U.S. Geological Survey - Mike Sorey, Chris Farrar
California Division of Oil and Gas - Robert Habel
Mono County Energy Management Department - Dan Lyster, Bo Bodvarsson
Bureau of Land Management - Ken Chan

The Long Valley Hydrologic Advisory Committee (LVHAC) continues to strongly support the need for geothermal resource monitoring and endorses the "Proposed and Recommended Hydrologic Monitoring Plan for PLES-I 10MW(e) Binary Power Plant" as outlined in the Environmental Assessment and Environmental Impact Report for the PLES-I project. Accordingly, it was the unanimous decision of all subcommittee members that sufficient technical evaluation of the benefits and need for implementing the two additional monitoring wells prior to the start of production should be conducted before formally including these as mitigation measures in the context of permit requirements for the PLES-I project. This technical evaluation is expected to be completed in a timely manner and should not impede the permitting or project completion schedule.

The LVHAC recommends that BLM not require completion of an injection zone and/or Colton Spring monitoring well prior to PLES-I commercial production until the LVHAC has determined the scientific basis for, and benefits to be gained by such a permit requirement. It is the intention of the LVHAC to open the technical review process to all LVHAC members wishing to participate, including the California Department of Fish and Game and their consultants.

A formal recommendation from the LVHAC on this issue will be made to your agency subsequent to completion of the technical review and concurrence by LVHAC members. This process should help to establish optimum monitoring requirements based on sound technical and scientific judgement.

If you have any questions regarding this request, please contact me.

Sincerely,

Dan Lyster

Dan Lyster, Chairman
Long Valley Hydrologic Advisory Committee

DLL/sc

cc: Ken Chan - BLM Sacramento
LVHAC Members
Mono County Board of Supervisors

10.3 RESPONSE TO COMMENTS

10.3.1 GENERAL COMMENTS

Comments: 2-3, 2-63b, 2-88b, 6-1b

Response: Worst-case analyses have been conducted as a part of the EIS/EIR. In regards to the potential hydrologic impacts of the project, where it is acknowledged that the available data do not yet provide the ability to definitively determine whether the Lateral Flow Model or the Upwelling Fracture Flow Model is correct (see Section 4.1.4 and Appendix C) the "worst-case" Lateral Flow Model is assumed to be correct, and the hydrologic impact analysis is conducted based upon this assumption. As the EIS/SEIR states, "the predicted impacts would be lowered to insignificance if the actual conditions more closely approximate the Upwelling Fracture Flow Model." See also responses to comments 2-63a (page 10-179); 2-88a (page 10-174); and 6-1a (page 10-175).

Comment: 2-90

Response: None of the leases in Long Valley lies within the designated special category lands identified in the Geothermal Steam Act of 1970, therefore this comment does not apply.

Comment: 2-12a

Response: There are no project impacts identified as significant after mitigation in the Draft EIS/SEIR. A landscape plan, including trenching and burial of pipeline segments, revegetation measures and visual screening, has been adopted since the proposal described in the Joint EA/EIR. Furthermore, deer crossing ramps have been designed, and all stipulations which were placed on the project by the BLM after the EA/EIR was written were adopted as part of the proposed project. In most cases where no mitigation is recommended, the proponent has adopted effective mitigation measures as part of their proposal. As a result, all these measures included in the project were not identified as "mitigation" measures in the EIR/SEIR, but they nevertheless result in mitigation of all impacts to levels of insignificance. These measures are described in Chapter 2 and are discussed in appropriate impact sections.Table 2-5 is a summary. It is not meant to substitute for the full body of the text and, of necessity, is brief. To understand the many measures which have been included as part of the project and which are not recommended as mitigation measures in the EIS/SEIR, it is necessary to read the project description or the text immediately preceding the mitigation statement in each section.

The specific comments made in Attachment C of the comment letter are addressed in responses to Comments 2-27 through 2-88.

Comments: 2-13a, 2-28, 6-5, 7-1, 7-3, 8-28, 8-30, 10-12

Response: Comment noted.

Comments: 2-13b, 2-76a, 6-37

Response: These comments are not responsive to the document under review. Material submitted before this document was written are not comments regarding this document and, therefore, specific responses are inappropriate. However, all issues raised during scoping meetings have been addressed in this EIS/SEIR.

Comment: 2-29

Response: The appropriate page has been edited to include springs in the Casa Diablo area.

Comment: 2-34

Response: The California Department of Fish and Game has been added to the list of consulting agencies.

Comment: 8-1

Response: The appropriate pages have been corrected to read 1,510 acres.

Comments: 2-30, 2-31, 2-32, 2-33, 2-58, 2-76b, 3-5, 3-35a, 6-39a

Response: 43CFR 3261 specifically authorizes and directs the authorized officer, (in this case the Bishop Resource Area Manager) to carry out the provision of 43CFR3200, Geothermal Resource Operational Orders, lease terms, and to enforce all stipulations placed on the project. This would include monitoring compliance with provisions in the project description to avoid mature trees "whenever possible," to locate fencing and deer crossing ramps in consultation with the California Department of Fish and Game and BLM and Forest Service wildlife biologists, to evaluate the results of the hydrologic monitoring program and implement mitigation measures in consultation with U.S. Geological Survey and other experts, and all other provisions of the project and stipulations placed on the project by the BLM.

The assumption must be made that the authorized officer will carry out these tasks effectively and in good faith in accordance with the regulatory requirements. Specificity is deliberately omitted from some stipulations to allow the authorized officer to respond to situations, such as: abnormal weather conditions; variability of deer migration dates; and timing specific reclamation actions when there is a reasonable expectation of success. Because the mitigation measures listed in Chapter 2 have been specifically incorporated into the project description by the project applicant, they cannot be altered here.

Comments: 6-19, 6-20, 6-21

Response: An abandonment plan is required by the BLM. Stipulation 27 in Chapter 2 is included as part of the project.

43 CFR 3262.4-1 (7)(k) requires the submittal of methods of final abandonment and requires compliance with all applicable lease provisions, GRO Orders, and regulations. These are legal responsibilities born by the applicant. The U.S. Government now holds a lease bond and the licensee must also supply a site facilities bond prior to operation.

Comments: 6-39b, 6-54, 6-55, 6-56, 6-57, 6-58, 6-59

Response: A landscaping plan is part of the proposal and describes specifics of tree planting, painting schemes, pipeline locations, and lighting. The text has been edited to clarify this. The intended flexibility of pipeline location is limited to within a few feet of the location shown on Figure 2-1. See also response to comments 2-35, 2-64, etc, page 10-209.

Comments: 2-12b, 2-36c, 2-81, 2-87, 3-54

Response: The cumulative analysis identifies for the person who is deciding the approval or denial of a specific project what that project's increment of impact is compared with other past and reasonably forseeable projects in the area. However, neither NEPA nor CEQA requires or suggests that a specific project be responsible for mitigation of the impacts of other projects in the cumulative assessment. In the cumulative analysis, it is shown that the impacts of this project would contribute little to the total measure of impacts to each of the resources of all the projects. We agree that a comprehensive, cumulative study for the overall Mammoth area would be beneficial, but such analysis would do little to help understand the impacts of this project, or its relationship to other projects. This project is not exempt from mitigation measures, which are described in Chapter 4.

Comment: 6-17

Response: The two golf courses were considered for all resources except surface water hydrology and induced growth. The two geothermal projects may never be developed and in any case are years from production. The reasons stated on page F-5 clearly explain why the particular projects were excluded from the analysis for some resources. The resources most likely to be impacted by the Town of Mammoth Lakes wells and golf course would be shallow groundwater and induced growth - neither are issues for the Casa Diablo projects.

Comment: 2-88a

Response: Appendix F is a list and description of the projects considered in the cumulative impact analyses. The impact analyses are contained in the body of the Draft EIS/SEIR. Appendix F is not intended to contain the cumulative analyses. In each resource discussion there is an analysis of cumulative impacts using available information from agencies and environmental documents for the projects described in Appendix F.

The discussions are on pages 4-16, 4-19 to 4-20, 4-23, 4-24 to 4-25, 4-32 to 4-33, 4-34 to 4-35, 4-64 to 4-65, 4-68 to 4-69, 4-73 to 4-74, 4-78, 4-84 to 4-87, 4-89 to 4-90, 4-92, 4-93, 4-96 to 4-99, 4-100, 4-103 to 4-104, 4-107, 4-113 to 4-115, 4-118, and 4-120.

Comments: 8-29, 8-31, 8-32, 8-33

Response: The suggested changes have been made.

Comment: 2-44

Response: A copy of GRO Order No. 4 is attached as Appendix G.

Comment: 13-1

Response: We apologize for the missing pages. The error was not widespread, since no other copies have been found with missing pages.

10.3.2 ALTERNATIVES

Comments: 2-10, 6-4

Response: As a result of the original analysis, the proposed action in the EA/EIR was not selected as the BLM's preferred alternative because of its greater visual impacts and only minor advantages with respect to deer habitat. Since the lead agency found it less suitable for development than the presently proposed project, reanalysis in the present EIS/SEIR would not have increased its suitability over the present proposed location. See page 2-1.

Comments: 3-1, 3-13

Response: Plot plans in Chapter 2 for the power plant site show disturbed areas, pipeline routings, and road locations for all alternatives. The disturbed area, including the O/CR building and well pads, was calculated using engineering drawings, which included road widths, supplied by Pacific Energy. The O/CR building is shown in Figure 2-4 as the Control Building and is fully analyzed in all alternatives.

Cut and fill has been balanced on the site of the proposed power plant and would be at the alternative site, so there would be no spoil sites. Detailed grading plans have been done for the proposed project only; however, it is not necessary to perform full engineering studies for all alternatives in order to assess the relative impacts of the alternatives. Complete sets of engineering drawings are not required or necessarily beneficial in EISs or EIRs.

The geology and soils information is included in the Section 3.1.2.5.

Comment: 6-1a

Response: It is unclear from this comment what specific data are incomplete. It is our opinion that the data available at this time are sufficient to make a reasoned choice among alternatives.

Comments: 6-2, 6-11, 6-12, 6-13, 7-13a

Response: NEPA requires sufficient discussion of each alternative so that the relative impacts can be compared. It is not required that full engineering studies be done for all alternatives. For each resource, there is adequate information to compare the alternative location to the proposed project. The alternative may expose the ephemeral ponds along Highway 395 west of the project to spills, where the proposed project would not. The alternative location would require additional geothermal fluid to provide enough energy for transporting the fluid the added distance and elevation to the power plant from the production and injection fluids. The larger power plant and longer pipelines required for the alternative location would disturb more area than would be disturbed by the proposed project. Acreages, lengths of pipeline, and use of geothermal fluids are quantified in the discussion. Vegetation, especially thermal marshes and rhyolite buckwheat and wildlife, especially mule deer, would be affected more by the alternative location than the proposed project. Complete discussions of all these issues are provided in the body of the EIS.

The commentor (6-11) suggests that by saying 10 to 20% more geothermal fluid would be required, the EIS implies an increased impact to the hydrothermal reservoir. The 10 to 20% increase is based on design estimates of transporting the brine additional distance and uphill. The use of "super insulated pipelines" would not reduce the energy necessary to pump the fluid uphill. The impacts associated with this increase are detailed in section 4.1.4.3.2.

References to Section 2.1.7.9 have been corrected to read 2.1.6.9.

Comments: 6-3, 6-7, 6-16, 7-15

Response: The smaller size power plant was included because it was reasonable to expect that it could have reduced impacts. The fact that it would not be financially advantageous to the project sponsor is not enough to disqualify it from consideration. If it were determined that the environmental benefits associated with the smaller alternative justified the financial burden on the applicant, then this alternative could well have been the preferred alternative. The analysis showed little benefit to decreasing the plant size. The proposed alternatives would all vary geothermal production rates to some degree in response to ambient air temperature. We believe that the impacts from the commentor's proposed alternative would not differ sufficiently from those of the analyzed alternatives to be considered a separate alternative.

Comment: 6-6

Response: The decision to propose three units is based on available equipment. The binary units selected for this project come in 5 MW increments. The existing MP I (nominal 10 MW) plant which consists of two units and generates a net annual average 7MW. In order to supply a net annual average 10MW, three units would be required. Therefore, the next smaller alternative would be similar to the existing MP I plant composed of two 5MW units.

Comments: 6-39c, 7-14

Response: The text on the appropriate pages has been edited.

Comment: 7-19

Response: As stated on page 2-1 of the EIS/SEIR, "using solar generated electricity ... is not being considered because the basic action under consideration by the BLM is the appropriate development of the federal geothermal lease. Any alternative which does not consider the development of the geothermal lease becomes functionally equivalent to the no-action alternative."

10.3.3 PHYSICAL ENVIRONMENT

Air Quality

Comment: 3-17

Response: The appropriate page has been edited.

Comment: 3-18, 3-19

Response: The analysis conservatively assume H_2S concentrations of 8.0 milligrams per liter, based on observed values ranging from 1.6 to 7.5 ppm by weight of fluid from wells at Casa Diablo (see Table 3-6).

Open tanks at short-term well testing:

500 gpm x 10 min/hr x 3.79 l/gal x 8 mg/l x 1kg/10^6 mg = 1.0 kg/hr

Spill of entire production for five minutes:

5,000 gpm x 5 min x 3.79 l/gal x 8 mg/l x 1 kg/10^6 mg = 0.76 kg

Well blowout:

685 gpm x 60 min/hr x 379 l/gal x 8 mg/l x 1 kg/10^6 mg = 1.2 kg/hr

As stated on page 4-6, open tank testing would not violate PEL standards. The reference to nuisance has been removed.

Comment: 6-18

Response: The areas mentioned in the comment are disturbed areas. The statement on page 4-2 is accurate as written.

Comments: 9-1, 9-2

Response: It is unclear what the potential health threat due to indoor air quality would be. The only indoor areas at the PLES I facility would be the control room and maintenance facility. Leaks or spills or geothermal fluid or isobutane could only occur at the power plant or pipelines, all of which are open-air facilities. Isobutane, H_2S, or radon from the geothermal fluid would disperse rapidly and would not accumulate inside buildings.

The wording on the appropriate page has been edited for clarity.

Comment: 8-10

Response: Comment noted. The recommended mitigation measure has been changed to limit speeds to 15 mph, which would still reduce fugitive dust emissions.

Noise

Comments: 2-45, 2-63a, 3-15, 3-28, 3-44

Response: Dispersed recreational use is identified as a noise-sensitive land use in Section 3.1.3.3. People who are driving in a car along Hot Springs Road would not be able to hear the power plant over the noise of the car. Vehicular traffic and the existing power plant would cause louder noises along the road for cyclists, joggers, and walkers than the proposed power plant.

The difficulty in describing the effects of noise on wildlife is mentioned in Section 4.2.2.1. Wildlife continues to use the site now with MP I in operation and will likely continue to adjust to the small increase in continuous long-term noise levels. In the absence of evidence to the contrary, one cannot predict dire consequences to wildlife from noise if the proposed project is constructed. Since the impacts of noise to wildlife are not well documented, designating it as a sensitive receptor serves no purpose - noise standards have not been formulated which are applicable to wildlife.

Stipulation 12 (Section 2.1.1) restricts noise intensive activities during deer migration periods in the spring and fall and the requirements of Geothermal Resources Operational (GRO) Order No. 4 apply throughout all phases of the project - exploration, development, and operation - and are enforced by the authorized officer. These are not listed as mitigations because they are required by the BLM and have been incorporated into the project design. The authorized officer, under the provisions of GRO Order 4, may impose more restrictive criteria than the 65 dB(A) maximum level and may require muffling devices. The project sponsor accepts the conditions as part of the approval process.

The proposed power plant will produce no more noise than the existing power plant. As stated in Section 3.1.3.2, the noise level 0.5 mile distant from it is approximately 40 dBA.

Comment: 3-29

Response: The text has been edited to encourage carpooling or busing of workers as a mitigation for construction traffic.

Comment: 3-30

Response: The authorized officer has the authority to require BACT as appropriate.

Comment: 3-31

Response: Comment noted.

Geology - Geologic Hazards

Comments: 2-41, 3-2, 3-20, 6-22, 6-23, 7-17, 8-11, 8-12

Response: In January 1988, SEA Incorporated completed a geophysical investigation of the proposed power plant site. The results of that investigation were interpreted to indicate the possibility that a fault crossed the plant site. In October 1988, SEA Incorporated completed a second investigation, consisting of borings and trenches, designed to explore the area of the suspected fault. The results of this second investigation were that no fault existed on the site. What was originally interpreted as a fault was in fact an abrupt change in the density of old hot spring deposits which underly the site.

Groundwater was encountered beneath the hot spring deposits in some of the borings and one of the trenches. The water was warm but was not hot enough to produce steam. Groundwater encountered in the vicinity of structure footings is delt with through footing design and adherence to Uniform Building Code requirements for footing drainage systems.

There was never any indication that moving any of the structures off the site or relocating the site would be necessary.

Comments: 2-43, 3-22, 3-23, 3-24

Response: The proposed project already contains a spill containment plan and other measures specifically designed to prevent the impacts or concerns, so no additional mitigation is proposed. The effects of a major volcanic eruption would overwhelm any environmental effects created by the eruption on the project. Designing facilities to function through a nearby volcanic eruption is not feasible.

All facilities would be built to Uniform Building Code criteria for Zone No. 4 areas. This would include more than sufficient strength for structures to withstand ground elevation changes which could occur at the site. GRO No. 4 requires subsidence monuments as a means of detecting ground movements. Reservoir management techniques would be used if significant adverse subsidence attributable to fluid withdrawal were detected.

Comments: 3-21, 7-10

Response: If required, pumping groundwater would be the mitigation. Installation of piezometers is a means of determining if the mitigation is necessary. There is no need to install the piezometers until after the project is built. Mitigation (2), Section 4.1.2.1, would establish groundwater levels before construction.

Groundwater would be pumped if it rose high enough to interfere with the power plant and could not be dewatered by passive means. Please see revised mitigation in Section 4.1.2.1. This would not deprive plants of water at normal depths, but would prevent the groundwater from rising as high as it would without pumping.

Comment: 8-3

Response: The text on the appropriate page has been edited.

Water Quality and Hydrology

Comments: 1-1, 2-24b, 12-12, 13-7

Response: The discussion of water chemistry in the Draft EIS/SEIR was provided as a small component of the attempt to summarize the two major conceptual models of the Long Valley hydrothermal system, i.e., the Lateral Flow model and the Upwelling Fracture Model. It is less detailed than proponents of the two models would have liked, but is believed by the authors to be sufficient because their basic conclusion was that the existing data did not "prove" either model. As a consequence of this conclusion, the authors elected to concentrate their analyses on reasonable worst-case scenarios based on the Lateral Flow model. The text on appropriate pages has been edited to eliminate the apparent bias. See also response to comments 2-14, 2-15, etc., page 10-187.

Comments: 1-2, 6-34b

Response: The authors believe that it should be clear to all readers that the analytical models used are over-simplications of actual hydrologic processes at work in the region. As indicated by the commentor, such processes could include partial or total injection support without cold water breakthrough. The models and calculated results are intended to be consistent with existing data. Any reservoir changes due to lack of sufficient recharge or injection breakthrough would affect the Casa Diablo projects first. These effects, such as pressure or temperature changes, would serve as indicators.

As mentioned in the response to Comment 1-1, there is need to mention the treatment of recharge to the reservoir. Paragraph a) in Section 4.1.4.3.1 describes the assumptions made with respect to modeling recharge and pressure changes. The complete explanation of model limitations is in Appendix C.

It is a common practice in scientific reporting to acknowledge limitations in existing data and corresponding uncertainty in the analysis. This is followed by a description of data which would decrease those inherent uncertiainties. Failure to acknowledge potential sources of error would be a breach of proper scientific reporting.

Comment: 1-3

Response: The method suggested by the commentor of calculating the relationship between reservoir pressure and spring flow is innovative and could be pursued as research on an individual spring and well basis. However, the authors feel that there are insufficient reservoir / spring data available to include such an analysis in the Final EIS/SEIR. Such a calculation for each spring could be very misleading, in that multiple sources of error are introduced by basing one method of analysis on the results of another. This is particularly true in the hatchery area because of the complex mixing and boiling processes known to be taking place which vary with each spring. The authors agree that the statement in the DEIS/SEIR regarding a 1 psi pressure change and its effect on static water levels does not translate directly into the effect on springs flow. However, it specifies the magnitude of the impact on the reservoir, which can be converted to effects at the surface when the relationship is better understood. Any further assumptions regarding the precise effects on springs detracts from the effort made to model and quantify potential effects in the reservoir based on the available data.

Comment: 1-4

Response: The reference to "no temperature decline at Casa Diablo" in the Draft EIS/SEIR was made on the basis of static production well temperature profiles and production fluid temperatures. It was meant to apply only to the production reservoir. Of course, a temperature survey of an injection well will show lower (non-static) temperatures, especially opposite zones taking fluid. Consecutive surveys taken in a shut-in injection well show progressive warming, but return to a true static condition could take many months. This cooling of the injection zone is expected, as indicated by the bulk model analysis. Under any reasonable scenario, consequences of injection zone cooling would be felt in Casa Diablo production wells first. For the flowrates considered by the modelling, however, the analysis showed that cooled fluid cannot travel far without being reheated. The appropriate page has been revised to clarify the reference to temperature declines.

Comment: 1-5

Response: Whether a more accurate model is based on low recharge and high reservoir volume or low reservoir volume and high recharge, the heat balance model presented in the Draft EIS/SEIR is still believed by the authors to represent a conservative scenario. In contrast, the authors feel that most of the values Papadopulos assumed were unreasonably low. The calculations in the Draft EIS/SEIR are based on the same rate of recharge as used by Papadopulos, which is very conservative in itself. Reservoir size was increased in the Draft EIS/SEIR model in order to arrive at a more realistic value for heat-in-place, based on well data, while allowing a flow regime (i.e., lateral flow with unlimited hydraulic communication from Shady Rest to Hot Creek Gorge) consistent with the constraints assumed for the other two methods of analysis.

Comment: 1-6

Response: These comments and the letters referenced are now entered in the Final EIS/SEIR.

Comment: 1-7

Response: Injection well survey data indicate much of the fluid is injected in a 100-foot zone, though the injection wells have open intervals of approximately 500 feet. However, the injection fluid is not likely to be confined to the 100-foot injection intervals as it moves away from the wells due to limited lateral continuity of stratigraphic permeability and the proximity of high angle fractures and faults. If such a thin injection zone had been assumed for the bulk model calculations, thermal breakthrough would have been calculated to have occurred in the region of the existing production wells already. This would not have been consistent with present production experience.

The bulk model calculations presented are believed to represent worst-case conditions due to five basic assumptions, i.e.,: 1) injection zone thickness remains constant at 500 feet; 2) uniform lateral flow occurs throughout the region; 3) no density effects allow cooler fluid to sink to greater depths; 4) no dispersion allows cooler fluid to occupy a greater reservoir thickness as distance from the injection well increases; and 5) the assumed porosity (5%) is quite low.

Even if the injection zone thickness were 100 feet, the thermal front would not reach Hot Creek Hatchery.

Comment: 1-8

Response: The missing information has been added to the appropriate page. The authors agree that the data available for use in assembling any current model are minimal from outside the Casa Diablo area. For both the hatchery and Hot Creek Gorge areas to be included in the Lateral Flow model, a continuous reservoir must be assumed. The result is an overall heat-in-place of 10×10^{17} cal. The authors believe it would be even more difficult to justify smaller blocks (i.e., Numbers 2, 3, 4) east of Casa Diablo to allow a sinuous path of lateral flow which includes the hatchery and the gorge areas. The authors contend that if consideration of a region the size of the blocks modeled is unwarranted, then there is little likelihood that areas included in them, such as the hatchery and gorge, will be affected.

Comment: 2-2

Response: The commentor's contention that "a significant and unmitigatable impact to the Hot Creek spring system is to be expected" is based on the initial report prepared by S.S. Papadopulos & Associates, Inc. (Papadopulos) for the California Department of Fish and Game (CDFG). Large portions of this report are presented as comments 2-14 through 2-24, and are addressed individually below. It is appropriate at this point to note in response to this general indictment, however, that this report has been reviewed with great skepticism by informed members of the scientific and engineering community involved with Long Valley Caldera thermal resources for many years. Reviewers have no difficulty with the method of analysis employed, but the assumptions used cannot be related to actual data or substantiated. Most of the report's conclusions are, in fact, based on a preliminary analysis which the author has revised in the course of further work (see minutes of the LVHAC Meeting, 1/12/89, in Appendix H).

Comment: 2-5

Response: Pumping of geothermal water at MP I or at the proposed project could reduce flow at Casa Diablo Geyser, but flow could also be reduced or stopped by three other mechanisms. They are (1) calcium carbonate precipitating in the fractures which carry the water, (2) caving or erosion of the fluid outlet, and (3) dissipation of the thermal water into the shallow freshwater aquifer during dry years. Any combination of these four mechanisms could contribute to decreasing flows at Casa Diablo. Flow paths characteristically are opened during earthquakes. It is possible that reducing production from wells in the Casa Diablo field would restore flows, but it is also possible that one or more of the other three mechanisms are responsible for diminished flow (as during the period 1972 to 1981).

Comments: 2-7, 2-89, 7-11, 7-16, 8-5, 8-7

Response: The accuracy of past temperature measurements is noted. As stated on pages 3-26 and 3-27, the H-2,3 spring varies in flowrate and temperature less than others in the hatchery spring group. The temperature fluctuation is believed to be due to its relatively low thermal component. It should be noted that if the H-2,3 spring's thermal component were completely cut off, the spring's temperature would be similar to that of Laurel Spring, a nearby spring with no thermal component. This temperature range is 52.7 to 54.1°F. Since the lower range temperatures of the broodstock springs are already equivalent to the non-thermal springs in the area, complete removal of the thermal component could not reduce the current lower range temperatures of these springs. The appropriate page has been revised accordingly.

Comment: 2-8

Response: Temperature data were reproduced in the Draft EIS/SEIR in units as originally reported. Degrees Farenheit have been added to the text for readers unfamiliar with S.I. units. For example, recent public documents and government agency reports use S.I. units in scientific papers. Degrees Centigrade were used for the heat-balance calculations for comparison with the Papadopulos report. Impacts were projected 40 years, even though the project life is stated to be 30 years. Temperatures would slowly rebound after 30 years as indicated by the calculated values at 40 years (10 years after shut-in). Because both temperature and pressure rebound are indicated after 40 years, calculation for periods 60, 80, and 100 years would only indicate continuing rebound. Figures 2-1 and 2-3 in Appendix C show project pressure and temperature effects for 40 years.

Comments: 2-14, 2-15, 2-16, 2-17, 2-18, 2-20, 2-24c, 2-52, 8-15a, 12-1 thru 12-5, 12-7, 12-8

Response: These comments are largely a description of the Papadopulos report's concept of how "thermal pits" are formed and "inevitably" migrate downstream to the hatchery springs area. They are not really comments on the Draft EIS/SEIR. We believe that the Papadopulos theory of uncontrolled hydrologic impacts migrating as "pits" is inaccurate. No example is known for a fractured geothermal (or any other) fluid reservoir behaving in such a fashion. What the commentor describes is a highly simplified view of chemical transport in an isothermal porous medium. Most significantly, the commentor's analogy does not account for dispersion of the fluid and reheating by contact with hot reservoir rock as it migrates.

The "crude models" used in the Draft EIS/SEIR referred to by the commentor include an updated and more detailed version of the heat-balance model used by the commentor in the initial Papadopulos report. The Draft EIS/SEIR heat-balance model is, in fact, an improvement on the commentor's version in that it uses input assumptions that conform to the known resource data. Furthermore, contrary to the commentor's assertion that the Draft EIS/SEIR "neither acknowledges this ultimate outcome (i.e., migration of heat deficit pits) nor attemps to analyze it in any meaningful manner," the bulk model analysis and accompanying migration calculation are specific attempts to quantify this impact. In contrast, the commentor makes no attempt to quantify this impact in his report, but rather simply asserts that it is significant and unmitigatable. The Draft EIS/SEIR models may be simplistic relative to the actual hydrothermal system, but they are far more sophisticated and realistic in input assumptions than the single, brief, preliminary analysis offered by the commentor.

This is not to say that the analyses presented in the Draft EIS/SEIR are perfect. The text several times cites the uncertainties involved with reservoir predictions, particularly for the Long Valley data base available at this time. Neither have the analyses been endorsed or embraced in entirety by qualified reviewers, such as those of the USGS. However, the authors believe that all the qualified experts agree that development is possible with a cautious approach involving an authoritative monitoring and management plan. See Appendix H.

Lastly, the commentor claims that his conclusions are valid regardless of the conceptual model that is applied to the geothermal system. This is clearly not the case for the fracture upwelling model since this model precludes impacts at the hatchery and gorge springs because they are then in separate thermal systems from the Casa Diablo system. Only by making the "worst case" assumption of lateral flow connectivity do any of the analyses presented apply.

The fact that impacts have not yet occured is important for input to the models. The models are constrained by the existing data. The results of the models have not been used as proof that impacts will not occur. Rather, they were used as a basis for the decision to implement a monitoring program.

Comments: 2-19, 12-6

Response: The fluid velocities calculated in the Draft EIS/SEIR are based on USGS data (Farrar et al. 1985; Sorey et al. 1978). The bulk permeabilities used for calculations in the Draft EIS/SEIR are averages based on data from Casa Diablo and Mammoth/Chance well tests. The values are not based on speculation. The values used can be considered higher than average, because those specific areas are within faults and accompanying fracture zones. The regions in between are probably less fractured and permeable, so the values used for calculating them represent worst-case values.

Comment: 2-21

Response: The commentor contradicts himself by stating that "the heat-balance model can only provide qualitative indications of the direction of long-term predictions of regional impacts, and it cannot produce quantitative predictions of the magnitude of impacts." Since the commentor's own conclusions are admittedly based on his own heat-balance modeling attempt, it is unclear as to how the commentor can conclude that the "PLES I project ... will have a significant adverse impact on the thermal component of spring discharges" unless he attempts to produce quantitative predictions in his own model if no quantitative prediction is possible from these models.

Comments: 2-22, 2-24a, 12-9, 12-11

Response: Block sizes should be chosen based on existing reservoir data. The block sizes and initial temperature assumed affect the calculated temperature changes. Expected (or pre-determined) results should not affect the size of the blocks chosen. It appears that the boundaries for the Papadopulos model were based on arbitrary assumptions, not on actual resource and well data. Though it is generally believed that his promised future modeling will be improved in this regard, this is not the proper approach to modeling. The results of models should indicate the extent of influence due to production at Casa Diablo, not the assumptions prior to running the calculations.

Comments: 2-23, 12-10

Response: This comment is another statement of the commentors opinion. No previous or continuing research considers the actual size of the resource in terms of areal extent or heat content to be as small as assumed in the Papadopulos report.

Comment: 2-37

Response: The Long Valley KGRA includes a much larger area than could be affected by this or any other project in the Mammoth/Hot Creek area. It would be both unnecessary and inappropriate to present data on thermal resources throughout the KGRA, and is not consistent with CEQ regulation 1501.15.

Comment: 2-46

Response: The text has been corrected on appropriate pages.

Comments: 2-51, 10-7, 13-9

Response: More accurate water use figures have been provided by Pacific Energy (see Table 10-2). These estimates are based on actual water use at MP I and estimated use at PLES I and MP II. Text on appropriate pages has been changed to reflect this recently acquired information.

TABLE 10-2: ESTIMATED AVERAGE GROUNDWATER USE IN GALLONS PER MONTH

	Year 1	Year 2	Year 5
Utilities:			
PLES I/MP II	6,000	6,000	6,000
MP I	3,000	3,000	3,000
Irrigation:			
PLES I	98,000	65,000	1,500
MP II	120,000	80,000	1,000
MP I	500	500	500
Total gallons per month	227,500	154,500	12,000
Average gallons per minute	5.27	3.58	0.28

SOURCE: Pacific Energy

Irrigation would require relatively large amounts of water during the first year. Water use for irrigation would decline as planting became established and is expected to stabilize at the level shown for Year 5.

It is remotely possible that the local shallow groundwater source currently used at Casa Diablo is in communication with the ponds in question. However, the ponds are more likely to be influenced by changes in annual precipitation and highway maintenance by CalTrans than by withdrawal for irrigation at Casa Diablo, especially in view of the limited water use at Casa Diablo. Should impacts to the perched water table be detected due to increased pumping of shallow cold groundwater at Casa Diablo, the most effective mitigation would be to reduce pumping. However, no impacts are expected.

Mammoth/Chance was not included because it is in a different shallow groundwater basin.

Comments: 2-42, 2-55, 8-16, 10-2

Response: Comments noted.

Comment: 2-48, 6-25a

Response: The reference on the appropriate page has been corrected.

Comments: 2-50, 3-33, 6-25b, 6-30

Response: Mitigation (7) has been changed.

Comment: 2-53

Response: The discussion in Section 4.1.4 has been expanded to give a more complete explanation of the purpose of monitoring and how monitoring will affect decisions implementing mitigation changes in reservoir production/injection operations at Casa Diablo. The authors agree that feasible and enforceable mitigation measures must be a condition of the project permit, and these are incorporated into mitigation measure (7). Detailed plans for implementation of these mitigation measures are required in mitigation (7), which must be completed prior to commencing commercial operations. The authorized officer of the BLM has full authority to approve or reject such plans. See mitigation (8) for protection of Hot Creek Gorge.

Comment: 2-54

Response: The use of cold water from wells was originally unacceptable for the Mammoth/Chance project because the proposed use was consumptive, i.e., evaporative cooling. The mitigation proposed in the Draft EIS/SEIR for cooling the hatchery springs with cold water from wells simply involves "rerouting" a small portion of the Mammoth/Hot Creek watershed groundwater or surface water flow through the hatchery springs. The end result of downstream flow into Hot Creek is the same and no cold water would be consumed.

Even if water treatment were required for recycled water , this would be purely an economic problem. There is no question of technical viability.

The discussion regarding the Effectiveness/Impact of mitigation measure (6) has been expanded to provide additional clarification.

Comment: 2-56

Response: The purpose of injecting geothermal fluid in the geothermal reservoir upgradient of Hot Creek Gorge is to maintain both the temperature and pressure of the gorge springs. Wording of the mitigation measure proposed for the Hot Creek Gorge springs has been revised to clarify the meaning. No replacement or repair of these features is considered possible or acceptable. Mitigation measure (8), injection of hot water up-gradient of these springs, is the only remedial measure being considered. The purpose of the monitoring program is to avoid impacts to these features by requiring changes in operations at Casa Diablo far in advance of changes in the reservoir near the hatchery or Hot Creek Gorge springs. The Forest Service considers Hot Creek Gorge a geologic interpretive site, and officially discourages public bathing.

Comment: 3-4, 7-2

Response: The initial Papadopulos report was reviewed and considered in the Draft EIS/SEIR. At the time of preparation, no indication of further analysis was given within the report of by the CDF&G. While an improved modeling effort was to be completed by mid-December 1988, no such follow-up report has been issued as of this writing in April 1989.

As stated above, (see response to comments 2-2, page 10-185, and response to comments 2-14, 2-15, etc., page 10-187), this report has been reviewed with great skepticism by knowledgeable reviewers.

Comment: 3-9

Response: The explanation preceding mitigation (6) explains the functioning of the mitigation/monitoring program. Specific mitigations to compensate for a decrease in thermal waters at the hatchery or gorge springs are described in Section 4.1.4.3 of the Draft EIS/SEIR. This explanation has been expanded in the Final EIS/SEIR to provide additional clarification. Approval of the details of how these mitigations are to be accomplished rests with the authorized officer. Replacing a geothermal spring component with similar geothermal water from elsewhere (the basis of all the proposed mitigations) involves a like-for-like exchange which should result in no significant difference in water chemistry or degradation of the aquatic ecosystem.

Comment: 3-10

Response: The EIS/SEIR for PLES I does not state that there is no risk from spills. There is a carefully designed spill containment plan to protect Mammoth Creek and Hot Creek from spills, which reduces the risk to insignificance.

Spills at Casa Diablo could occur from ruptured lines in the closed loop from production to power generation to injection. The geothermal fluid, however, is not used for other purposes, such as cooling, and is not treated to make it secondarily useful. Furthermore, there are no chemicals hauled to treatment plants in steep terrain over winding roads as in the Geysers. Because only about 15% of the Casa Diablo fluid flashes to steam, it does not concentrate chemical constituents markedly and the main danger would be from thermal effects. (These are described in Section 4.1.4.1) For these reasons we feel that comparison of the PLES I facilities to the Geysers facilities is still misleading even with the large volume of liquids being moved.

Comment: 3-11

Response: The mud pit would be lined in accordance with RWQCB specifications.

Comments: 3-25, 6-28

Response: The spill containment plan is included as Appendix A for those readers who want more information than is provided in the body of the text. The reliance on a manual closure system would occur only during project construction before the plant control room were operational, because there would be no means of activating automatic sluice gates. The construction period would last about nine months. Each well pad and the plant construction site would have spill containment facilities during all drilling and construction activities.

Automatically controlled valves and gates are commonly available and would be installed before operation began. The issue of spills and their potential effects were fully analyzed in Section 4.1.4.1.

Comment: 3-27

Response: The areas for the projects listed were taken from project maps and environmental documents. Snow Creek, Sherwin Bowl and Juniper Ridge all drain into Mammoth Creek, as does the part of Doe Ridge around the airport which is included in the cumulative analysis: The calculation is 13 / (13+ 60 + 400 + 200) = 0.0193. That is, 13 acres is less than two percent of the cumulative area.

Comment: 3-32

Response: The wording has been changed on the appropriate page to make the meaning clear.

Comment: 3-34, 8-18

Response: The hydrologic monitoring program required by the BLM includes all monitoring locations, methods and frequencies recommended for this project by the Long Valley Hydrological Advisory Committee (LVHAC) in their October 1987 monitoring plan. In addition to the LVHAC's 1987 recommendations, BLM is requiring monitoring of the Hatchery CD springs, monitoring the unnamed stream through the Casa Diablo area, monitoring the combined Casa Diablo Spring flow, and monitoring of the unnamed springs in Chance Meadow.

Table 2-4 describes BLM's Hydrologic monitoring requirements prior to the addition of the Chance Meadow Spring monitoring requirements.

The modifications made to the LVHAC hydrological monitoring plan in the May 1988 revision are found in Table 2-4. Under Sites, "New production and injection Wells..." is changed to "ALL production and injection wells...". Under Data Collection, last paragraph, last sentence," During development..." is changed to "During production...". CDG (Casa Diablo Geyser) monitoring is added. On observation well SF 65-32, the frequency of temperature, chemistry and isotopy monitoring is added (this was omitted in the Oct. 1987 version). None of these changes affects the BLM requirements as they are already required as part of the approved Plan of Baseline Data Collection.

All future changes in the LVHAC Hydrologic Monitoring Plan will be reviewed by the BLM. It is the BLM's intent to include all reasonable and pertinent monitoring recommended by LVHAC.

Comment: 3-40

Response: The Lahontan Regional Water Quality Control Board, as mentioned in Section 4.2.3.1, has storage requirements for hazardous materials.

Comment: 5-4

Response: The temperature range for the AB springs has been corrected to read 59.5°F to 64.5°F during the period 1976 to 1987.

Comment: 5-3

Response: The table is intended to indicate that water level/pressure data are to be measured continuously during the first year and on a monthly basis after the first year. Temperature profile, ionic and isotopic chemistry analyses are to be obtained semi-annually. Should monitoring done during the first year indicate a need for more frequent or different monitoring techniques the authorized officer may require it.

Comment: 6-9

Response: Monthly monitoring of spring temperatures was specified by the LVHAC and is considered adequate to detect any meaningful long term trends. If monitoring results indicate the need for more frequent observations, the authorized officer could require more frequent monitoring.

Comment: 6-10

Response: The pressure measurement device at SF 65-32 is a permanent and continuous installation. There is no plan to change this after the first year. However,the authors concur with recommendations from the LVHAC that monthly data, after one year, are sufficient to establish long term trends in observation wells. As with all monitoring requirements, the authorized officer can change the PBDC.

Comments: 6-24, 13-10, 13-11c

Response: The EIS/SEIR now includes an estimate of Mammoth Creek temperature impacts in the event of simultaneous failure of pipelines at all the plants at Casa Diablo. See pages 4-32 to 4-33.

Comments: 6-31, 6-32, 6-33, 6-36, 6-63, 8-20

Response: The BLM has full legal authority to enforce stipulations placed on the project. The authorized officer would base decisions on all available data, not just specific information from a few wells or springs. Specifying trigger points would require development of a multitude of scenarios with the likelihood that none would describe the actual situation. Mitigation measure (6) has been revised to indicate that the entire body of data produced by the monitoring program will be evaluated at least annually to determine implementation, as necessary, of addition monitoring and mitigation measures. Other revisions to clarify the monitoring and mitigation program have also been included.

It is feasible to carry out the entire monitoring/mitigation plan as it is appears in the Final EIS/SEIR. The plan includes provisions for substantial mitigation which would be based on data supplied by the monitoring program. It is an integrated approach to effective mitigation.

Comment: 6-34a

Response: While the monitoring of a great number of natural features are included in the monitoring program, the features of greatest importance for detecting early changes in the geothermal reservoir, prior to any impacts to natural hydrothermal features, are man made features (production, injection and monitoring wells). Detection of significant changes in the developed geothermal reservoir will allow imposition of mitigation measures, which will prevent these reservoir changes from migrating to significant natural features. In this way impacts to significant natural features as defined by NEPA, will be avoided.

Comment: 6-35

Response: See mitigations (7) and (8), pages 4-60 and 4-61.

Comment: 6-46

Response: The BLM does not have jurisdiction over MP I, which is located on private property, and cannot require implementation of mitigation measures at MPI.

Comment: 6-62

Response: With the implementation of the monitoring/mitigation plan, it is unlikely that it would ever be necessary to provide thermal water to the hatchery. Since the feasibility of providing water has been demonstrated in Section 4.1.4, it is not necessary to construct the water supply system without any reasonable expectation that it would be needed. The text has been expanded to clarify the Effectiveness/Impact of this mitigation measure. See also mitigation (7) which requires the development of an implementation plan to ensure that any necessary additional monitoring or mitigation can be implemented in a timely manner.

Comments: 8-4, 8-13, 8-15b

Response: The text has been edited.

Comment: 8-17

Response: The explanation on the appropriate page has been expanded.

Comment: 8-19, 8-21, 8-22, 8-23, 14-1

Response: Based on internal BLM review and the expert advice of the LVHAC Hydrologic Subcommittee and consultation with Forest Service, BGI, Mesquite Group, and BLM experts, mitigation measure (6) has been revised to delete the drilling of a monitoring well into the injection zone near well 65-32 (mitigation (9) of the draft and not to require the drilling of the second monitoring well at this time. Appropriate changes have been made in the text. Pressure changes in the injection zone can and will be effectively monitored through wellhead pressure meters and annual pressure fall-off surveys conducted on the injection wells. No data yet produced indicate a technical need for drilling a second monitoring well at this time. As specified in mitigation measure (6), the BLM will continue to review and analyze the available data and will require implementation of these mitigation measures should changes in the reservoir, beyond normal variations, be observed.

Comment: 10-4

Response: LVHAC has wide membership which reviews all the data on behalf of Mono County. Although the operator is responsible for monitoring, there is enough redundancy in measurement taking that falsification of data or improper monitoring is not in the operator's interest. The authorized officer may require independent checks of equipment and techniques at any time.

Comment: 13-2

Response: The text has been corrected.

Comment: 13-4

Response: The zone referred to is that defined by repeated surveys in MBP-2 and UM-1 as shown on Figure 17 in Appendix C. Because IW-1 is across a major fault (Taylor/Bryant) and is an area outside that proposed or actually used for production or injection its profile was not included. Hence, the zones referred to were at elevation 6600 to 5400 ft at Shady Rest and 7100 to 6600 ft at Casa Diablo. The zones boundaries are not definitive but do intersect the same elevation. However, the statement in the EIS refers to the offset between the top of the zones at each area.

Comment: 13-5, 13-11b

Response: The three reports cited (including Setmire, 1984) were reviewed for indications of any degradation of surface water quality in the region since the 1960's. The only water quality problem noted was fecal coliform due to cattle grazing. The authors believe that the context of the discussion, the remoteness in the time frame of the geothermal discharge (1962) versus the reference (1984), and the title of the reference ("Water-Quality Appraisal of Mammoth Creek and Hot Creek, Mono County, California") make it clear that the Setmire report was not a specific investigation of the 1962 geothermal discharge. The Department of Water Resources report in 1967 acknowledged the 1962 geothermal discharge, but made no note of any lasting effects. The point of the discussion in the Draft EIS/SEIR is that if serious consequences had occurred as a result of the spill, it is likely that they would have been noted.

Comment: 13-6

Response: The text has been revised.

Comment: 13-8

Response: Both the alluvium and basalts overlying the Early Rhyolite thin from north to south in the Casa Diablo area. The fresh ground water from these overlying rocks is tapped by the existing water well about 200 yards northwest of the MP I power plant. At the location of SF 35-32 south of the plant, there is no groundwater because there is virtually no alluvium. Furthermore, the size of the watershed and basin contributing to surface and ground water flow in the Casa Diablo area is insignificant compared to that of the main Mammoth/Hot Creek drainage. The text in Section 4.1.4.2.1 has been revised.

Comment: 13-11a

Response: As mentioned in the Draft EIS/SEIR, the most significant potential impact to Mammoth/Hot Creek water quality would be due to an uncontained spills of large quantities of geothermal fluid. Because this would be a short duration event, the greatest impact is considered to be due to the temperature effects (see analysis, Section 4.1.4.1). Based on the same scenarios used to calculate the mixed fluid temperatures (geothermal plus creek water), a table could be constructed to show the mixed fluid chemistry. However, this cannot be done as easily by simple mathematics due to potential changes in chemistry as a result of the mixing. Furthermore, no chemical constituent found in the geothermal fluid, would, after mixing, result in a concentration likely to have an impact on the aquatic environment given the short term nature of the event.

Comment: 13-12

Response: The commentor is correct to be skeptical of detailed results of the numerical modeling performed thus far because of an insufficient data base. However, the authors believe that the commentor overstates the "unreliability" of results as indicators of the general magnitude and direction of impacts. In the Draft EIS/SEIR three independent, commonly used reservoir modeling techniques have been employed to predict worst-case reservoir temperature and pressure changes which could occur as a result of the PLES I Project in different areas assuming the Lateral Flow model is correct. As described, the use of conservative reservoir values in the modeling means that the actual changes will be substantially less than those predicted. Maximum temperature and pressure changes of 15.4°C (27.7°F) and +2.2 psi were predicted in the Casa Diablo reservoir and -2.6°C (-4.7°F) and +0.55 psi in the Hot Creek reservoir after 30 years of PLES I operation. As noted, a pressure change of +2.2 psi in the Casa Diablo reservoir is insignificant, although the worst-case prediction of a 15.4°C (27.7°F) temperature decline in the Casa Diablo production reservoir would decrease the ability of the power plant to operate efficiently.

These model calculation indicate that, assuming hydraulic communication exists, the potential for significant subsurface changes to extend the three to five miles to Hot Creek Hatchery and Hot Creek Gorge is very low. What is more difficult to precisely predict is the effect that these small predicted temperature and pressure changes in the geothermal reservoir will have on the hatchery and gorge springs. At the hatchery springs, it is estimated that approximately 3 percent of the flow is thermal water. The temperature of the thermal fluid component of these springs is unknown; but it is estimated that a loss of the entire thermal component could result in a lowering of the average spring temperature of 2° to 3°C (3.6°F to 5.4°F) (Sorey, M.L., 1976).

No effects have been measured at the hatchery or gorge springs to date, and none would be anticipated on the basis of the reservoir measurements made to date at Casa Diablo. Based upon the minor changes in reservoir temperature and pressure predicted to occur under these worst-case examples, and considering the complex nature of the hydrothermal connection to the surface, it is extremely unlikely that any significant impacts would occur to the distant thermal features of concern.

The authors certainly agree with the commentor's concluding remarks.

Comment: 13-3

Response: Thank you for indicating this error. The 73°C reading is anomalous and should not have been included in the summary description. The sentence on p. 3-26 now reads, "seasonal spring temperatures have varied from 90° to 94°C (194 to 201°F) at HC-1, 76.2° to 92°C (169° to 198°F)at HC-2 and 88.3° to 92.8°C (191° to 199°F)at HC-3 during the 1983 to 1985 monitoring period." Further the sentence has been qualified with the statement: "Measured temperature fluctuations may result from spring conduit clogging and resulting flow losses."

10.3.4 BIOLOGICAL RESOURCES

Vegetation

Comment: 3-26, 6-15, 10-6

Response: Figure 3-5 includes the alternative power plant site and pipeline routes. It does not show the ephemeral ponds to the west for which detailed surveys have not been conducted. However, as the EIS/SEIR states, the ponds would be protected and their biological resources not impacted by the power plant at the alternative location through the mitigation measures.

In accordance with NEPA (1502.14(b)), the EIS presents sufficient information to evaluate the relative levels of environmental impacts created by each of the alternatives. Knowing more about the resources of the ponds is not required to understand that the environmental effects of the alternative location are greater.

Comment: 2-49

Response: All habitat types in the immediate area could be affected, although the text has been revised to clarify the point. See Figure 3-5.

Comments: 3-12, 3-14, 3-37

Response: Areas where seedlings and larger plants would be planted are shown on maps submitted to the BLM Bishop Resource Area. In general, they are the graded areas between project facilities (well heads, power plants, and appurtenant structures) and public roads. The larger plants would screen the facility from view. The landscape contractor is required to guarantee a success rate of 70% for a five year period (Appendix B, page 4). The authorized officer is responsible for monitoring to ensure that the project is carried out as described.

Comment: 2-68

Response: A mitigation measure has been added to section 4.2.2.5.

Comment: 2-78

Response: A description of the earth ramps has been added to Section 2.1.6.9.

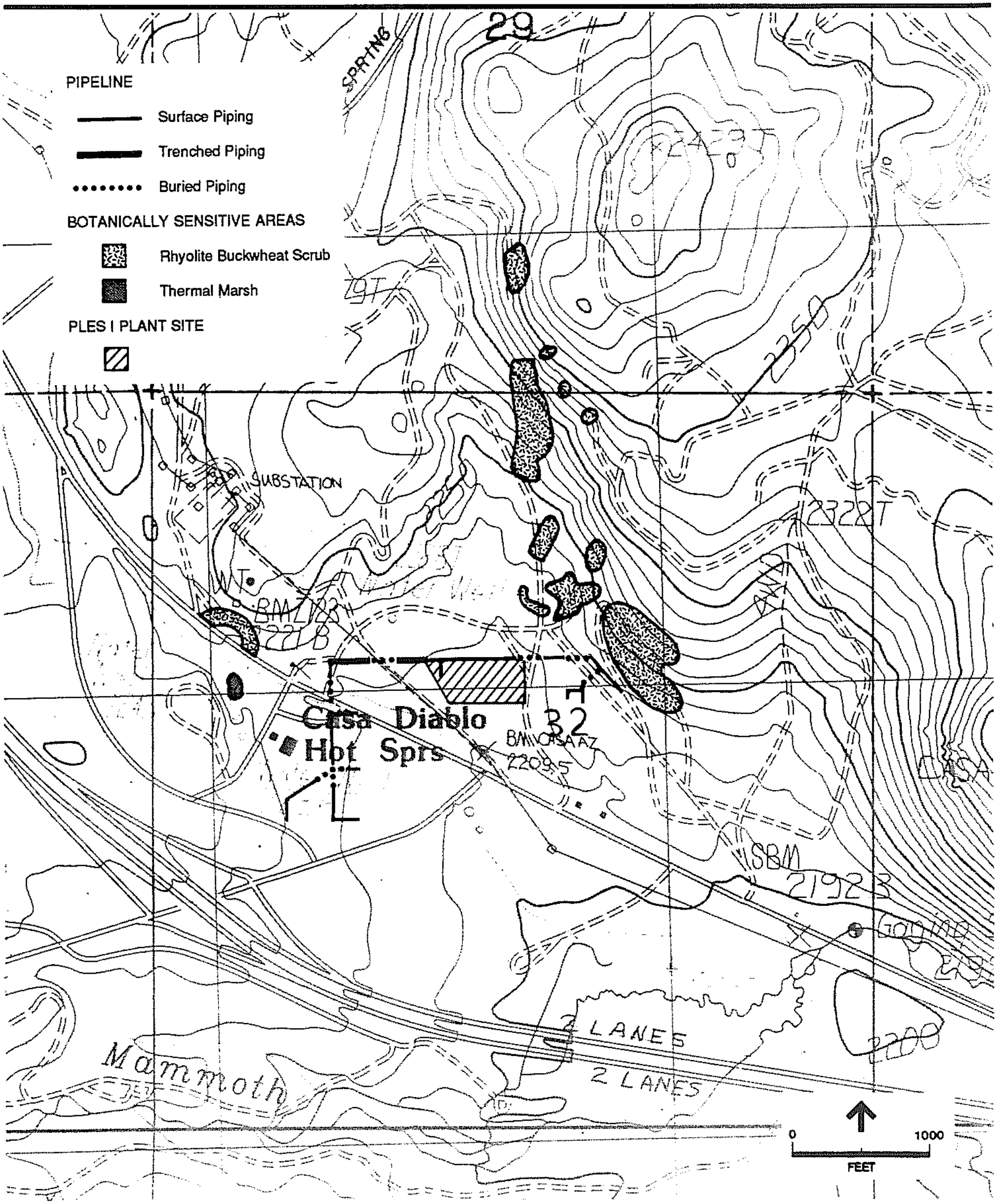
Comments: 2-6, 2-25, 2-36a, 2-57, 2-59, 2-60, 2-79, 2-80, 3-35b, 3-36, 4-1

Response: Neither of the two identified biologically sensitive habitats, namely rhyolite buckwheat or thermal marsh, would be directly impacted by the proposed project (Figure 10-1). It is possible that botanically sensitive rhyolite buckwheat areas could be damaged during construction activities near injection wells, but only if equipment is driven outside designated areas. The wording has been changed to clarify how damage might occur to rhyolite buckwheat and to add a mitigation requiring clearly marking rhyolite buckwheat areas, which would minimize the potential impacts of accidental contact during construction activities.

Casa Diablo geyser could be impacted by the project, but historically it has had highly variable flow. From 1972 to 1981 it did not flow, then it began to flow in 1982 and the flow increased after the 1984 earthquakes. The geyser has been inactive since April 1987 which may be related to the current drought conditions in the area.

Revegetation of a thermal marsh would be ineffective if thermal water were no longer being supplied to the marsh. That action is not suggested as a mitigation in this document since no marshes would be affected by PLES I except, conceivably, the one at Casa Diablo and it has not had thermal water since 1987 and did not have it for the period 1972 to 1981.

The impacts to the thermal marsh at Casa Diablo and the rhyolite buckwheat scrub mentioned by Taylor and Buckberg (1987) in Appendix D occurred during the long history of this area and are not related to this project. Their survey was used in siting the facilities so that the proposed project has implemented all the mitigations recommended in the study for rhyolite buckwheat habitat. As stated in Section 4.2.1.1, no rhyolite buckwheat would be directly impacted by PLES I. Their recommendations with respect to Casa Diablo geyser are not appropriate because that area is not part of the PLES I project site.



SOURCE: Biosystems Analysis Inc., Jan 1987; Pacific Energy

FIGURE 10-1
Locations of Botanically Sensitive Areas in Relation to Proposed Project Facilities

The monitoring/mitigation plan will protect the thermal resources in the Mammoth Hot Creek drainage and their habitat value.

Although not all thermal springs in Long Valley have been inventoried for biota, all thermal areas in the Casa Diablo graben were inventoried for botanical resources (Taylor, D.W. and R. Buckberg, 1988. Terrestrial Biota Base-line Data, Casa Diablo Hot Springs, Mono County, California August, 1988. Casa Diablo Bio Systems Analysis, Inc., Santa Cruz, California). The risk of damage to these other thermal areas from this project is low. None of the field or literature searches conducted to date of treatened, endangered or sensitive species or habitat, and neither NEPA nor CEQA require comprehensive knowledge about all resources in the Affected Environment. In terms of cumulative impacts to vegetation, this document can suggest only general mitigations. The environmental review for each project should analyze the proposed project and recommend specific mitigations.

Identified riparian vegetation is located along Mammoth Creek, approximately 0.6 mile east of the project site, which is supported by water from Mammoth Creek. No impacts are expected to this community or to the adjacent sedge meadow from the maximum estimated 2.5 gpm additional pumping from the MP I well.

Comment: 6-14

Response: If the alternative location were selected, the pipelines would be sited to avoid rhyolite buckwheat scrub, where feasible. Detailed engineering has not been done for the alternative location. See response to Comment 6-2, 6-11, 6-12, ..., page 10-176.

Comment: 8-2, 8-26

Response: The text on the appropriate pages has been corrected.

Terrestrial Wildlife

Comments: 2-9, 2-11, 2-61, 2-62, 2-66, 2-69, 2-70, 2-71, 2-83, 2-84a, 2-85, 2-86a, 3-38, 6-38, 6-40

Response: Although the project vicinity supports a diversity of resident and migratory wildlife, the removal of 13 acres of sagebrush scrub and Jeffrey pine wildlife habitat by siting the proposed power plant is not expected to significantly impact any of these species given the abundance of these habitats in the project area. Furthermore, as part of the project design, disturbed areas would be revegetated as outlined in item 24 of Section 2.1.1.

In terms of potential project impacts on wildlife species of special concern, the project area appears to offer minimal to moderate value to each of the eight migrant or resident species discussed in Section 3.2.2. Each species, while potentially using a portion of the area at a given time, generally uses a much larger area or an area outside the project area for the majority of its foraging, resting, and mating activities.

For example, the sage grouse is dependent on sagebrush stands for nesting, thermal cover, and feeding during the fall and winter. Large open areas in the sagebrush are used for strutting grounds (leks) during the breeding season. While the southern portion of the survey area (see Figure 3-5) provides limited amounts of moderately suitable sage grouse habitat, the vital lek habitat does not occur in the immediate vicinity of the survey area. Thus, the site provides for moderate rather than essential sage grouse use.

The wildlife cumulative impact discussion estimates the total number of acres of habitat that would be altered resulting in the potential loss of foraging and nesting areas for the goshawk, pygmy nuthatch, and hairy woodpecker. Removal of this quantity of habitat is not expected to be a significant loss for any of these species and mitigation is unnecessary.

The Draft EIR/EIS suggests that cumulative impacts to deer herds are potentially significant. This tentative assessment is based on the inclusion in the cumulative analysis of Sherwin Bowl and Snow Creek, both of which are in a major migration corridor, constricted by topography and/or existing development, leading across the Sierra Nevada to summer range. With respect to the geothermal plants located at Casa Diablo, Kucera (1987) states:

> "Assuming a 'worst case' scenario, one in which deer completely avoid proposed facilities and associated human disturbance, it is difficult to see how making several dozen deer move several hundred yards around the facilities would constitute a great hardship. Given the existing terrain, such an avoidance would have a trivial impact on migrating deer. Of course, certain facilities, e.g., fences, pipelines, etc., could be designed to minimize any impacts to deer and to facilitate their passage... There will be loss of summer habitat causing some reduction local carrying capacity and fawn production. Regarding migration, in the worst and unlikely case that deer avoid the project entirely, there are at present alternate routes available to allow migrating deer to reach their summer ranges. Thus, the Casa Diablo Geothermal Project (both the Mammoth Pacific Geothermal Project and the PLES I Geothermal Project) by itself will likely have minimal negative impact."

Taylor (1988) (Appendix D) discusses summer habitat utilization and clearly identifies quaking aspen riparian habitat as the major type utilized by the radio-collared deer from the Casa Diablo herd. Deer summering in areas consisting primarily of Jeffrey pine and Great Basin sagebrush habitat, typical of the Casa Diablo project area had home ranges more than twice as large (averaging 384 hectares or about 950 acres) as those deer ranging in riparian habitat (34 to 167 hectares or 84 to 413 acres) (Taylor, 1988). From these observations, the carrying capacity of the Casa Diablo project areas as potential deer summer range can be estimated as follows:

> Construction of the PLES I project would disturb about 13 acres. Since it requires about 950 acres of Jeffrey pine or sagebrush scrub to support one deer, the loss of 13 acres represents the loss in carrying capacity of 13/950 = .014. If one conservatively assumes that noise and human activity at the plant cause deer to completely avoid an area within 0.25 mile of the plant, than an area of 126 acres would be impacted. The carrying capacity loss would be 126/950 = 0.13. Therefore, in the worst case, the land required to support 0.13 deer would not be available as habitat. This does not result in an <u>annual</u> loss of 10 does and 15 fawns.

The project area has not been designated critical deer habitat and in fact receives rather light use by deer. None of the radio-collared deer followed in Taylor's study crossed the site and Kucera's tracking study provides the most accurate information available on use of the site. We believe that the proposed action is in conformance with the deer herd management plans, and the comment does not indicate why conformance is not achieved. See also response to comments 2-12b, 2-36c, ... page 10-173 and page 2-1.

We can find no basis in the California Department of Fish and Game's statement that implementation "of the project as proposed would result in non-compliance" with the referenced Buttermilk, Sherwin Grade, and Casa Diablo Deer Herd Management Plans. Each plan provides numerous general management unit goals, programs, objectives and prescriptions regarding the respective deer heard and its habitat which the signatory agencies are to consider as each carries out its own directives. As the Department did not identify which plan elements it believes would be compromised by the implementation of the proposed project, each plan has been reviewed. Because the proposed project area is not critical or key winter or summer deer habitat or a critical deer migration corridor, and because it is not anticipated that there will be any significant impact to any of the deer herds, few of these plan elements are directly, or even indirectly, applicable to the proposed project or any of the alternatives. Upon review of the plans, we disagree with the Department's statement and believe that implementation of the proposed project would not be in conflict with the various elements of each of these plans.

Comments: 2-38, 2-39, 2-82, 2-86b, 3-16, 8-6

Response: Part g) of Section 3.2.2 states "...deer from the Casa Diablo herd are thought to cross the survey area as they migrate.. to summer range."

Appendices D and E both substantiate that the Casa Diablo project site lies within the migratory corridor of the Buttermilk, Sherwin Grade and Casa Diablo herds, but neither of these reports defines the site as an irreplaceable portion of the migratory route given the "generally somewhat dispersed pattern of deer activity in and movement through the Study Area" (Kucera, 1987). Taylor and Buckberg's biotic survey in Appendix D identifies specific trails and "yarding" areas concentrated in the eastern and northern portions of the study area based on sign observed November 25 and 26, 1986. By contrast, Kucera's track studies (1987) were carried out on 37 days in the period April 22 to November 14, 1986. Conclusions reached on the basis of Kucera's work indicating dispersed use of the site cannot be invalidated by Taylor and Buckberg's observations.

The authors of the Biotic Assessment note the limitations of this survey both on page 11 where it was noted that "no quantitative assessments of habitat parameters were measured on the study area. The field visits provided only qualitative assessments of habitat suitability" and on page 26 where they noted that the Deer Observation Map, Figure 4, was "based only on observations conducted during November, 1986." Kucera's report on the other hand include actual deer track counts and over a period which include the periods on spring migration, summer, and fall migration 1987. Where there are conflicts between the two reports especially regarding use of habitat by deer, we consider Kucera's report more authoritative.

Results from on going tracking studies would be included in the information used by the authorized officer to determine fencing and deer crossing ramp locations and to limit noise intensive activities.

Comments: 2-35, 2-64, 2-65, 2-72, 2-84b, 3-39, 6-8, 6-41, 8-24, 8-25

Response: Pipeline configurations for the proposed project are shown on Figure 2-1. Not only does this figure show pipeline routing, it shows areas where pipelines would be trenched or buried. Appropriate text has been edited to make entirely clear that Figure 2-1 is accurate.

Only single pipelines (i.e., lines from one well) outside fenced areas are neither buried nor trenched; multiple lines have buried sections or trenched sections. They can, at the direction of the authorized officer in consultation with CDFG and other agency wildlife biologists, be crossed by deer crossing ramps.

It is unlikely that deer could be fatally trapped by a single pipeline less than three feet above the ground and no more than 24 inches across. Although the information from Sunset Western Garden Book is not a scientific journal article, it relates commonly observed behaviour when deer encounter barriers.

The distances deer can jump are mainly related in anecdotal accounts. However, studies summarized by Taylor (1975), done on white-tailed deer indicate that deer routinely jump distances of 12 to 20 feet when running and have jumped as much as 30 feet. They have also been observed to jump 8-foot high fences without a running jump.

The description of measures included in the project description in Section 4.2.2.1 has been expanded to remove ambiguity about precisely what is included to reduce impacts to deer to levels of insignificance.

See response to comments 2-3, 2-63b, etc., page 10-170, and 2-9, 2-11, etc. p. 10-207

Comment: 2-77

Response: Comment noted.

Comment: 2-67

Response: The argument used by Kucera is that less habitat is affected if impacts are aggregated. That argument can be used just as effectively when comparing the presently proposed project to the alternative location north of the hill as it can when comparing the original site adjacent to MP I with its alternative (the presently proposed project). In fact, the argument applies more strongly in the current situation, because the well fields remain in the same locations for both alternatives, but longer pipelines would be required for the more distant power plant and human activity and noise would affect a larger area.

Comments: 6-44, 10-1, 10-8, 10-11

Response: In general, the same kinds of techniques would be used in construction at the alternative site as for the proposed project. This would include burying some segments of the pipelines, trenching other segments, and constructing ramps for deer to use in crossing trenches. No additional mitigations would be feasible and there would still be more pipeline and a larger area impacted by the plant at the alternative location. The text has been edited in Sections 4.2.2.2 and 4.3.6.2 to list mitigations for the alternative location.

Comment: 2-36b

Response: Noise impacts to deer are described in Section 4.2.2.1. Noise-intensive activities are specifically restricted during deer migration periods as stated in item 12, Section 2.1.1. The dispersed nature of deer use in the area makes it possible for deer to avoid activities at the project site. Section 4.2.2.1 has been edited for clarity.

Comment: 6-42

Response: The appropriate text has been edited.

Comments: 6-43, 10-3

Response: Sufficient mitigation has been applied to reduce impacts to deer habitat to an insignificant level, so no compensation appears appropriate. If a mechanism could be developed whereby contributions were made on the basis of the project's relative contribution to impact, it could provide protection for those deer using the Casa Diablo area. A cooperative agreement between the Town of Mammoth Lakes, Mono County, BLM, and the Forest Service would be desirable, but no such agreement exists at this time. See also response to comments 2-9, 2-11, ... and 2-12, 2-36c, page 10-207.

Biological Environment - Aquatic Resources

Comment: 2-4, 2-26

Response: As noted in the comments, limited information is available on the aquatic invertebrates in the project vicinity. However, the proposed project has been designed such that disturbance to the aquatic resources, either of Hot Creek and Mammoth Creek from the potential accidental release of geothermal fluid or to thermal springs from geothermal fluid production or injection has been decreased to insignificant levels. Accordingly, although a survey and inventory of invertebrate resources in the project vicinity maybe of interest to the CDFG, neither NEPA nor CEQA require comprehensive knowledge of resources which will not be significantly impacted by the project. See also response to comments 2-6, 2-25, page 10-204.

The monitoring/mitigation program included as part of the proposed project is a phased series of mitigations which would be implemented in response to results of the monitoring program. It would prevent damage to geothermal features from migrating away from the Casa Diablo field. See Section 4.1.4 for a full discussion of both surface and subsurface water quality and resources.

Comments: 4-2, 7-6

Response: As the EIS/SEIR makes clear, is unlikely that the thermal component of springs supplying the spawning facilities would be lost, but the potential worst case is considered. It is true that of all California hatcheries, Hot Creek is the only one to operate year round. Hot Creek Hatchery could function without a thermal component, but it would not be as productive as it is now. Without the thermal water contribution, it could not have fall-spawning trout.

For a full discussion of the geothermal resource, see Section 4.1.4.3 (as revised).

Comments: 2-40, 2-47, 3-42

Response: The appropriate pages have been corrected.

Comments: 3-41, 3-43, 3-45, 6-27, 6-45, 7-18, 8-14

Response: As stated in Section 4.2.3.1, a bioassay of the geothermal fluid would be required under the revised Plan for Baseline Date Collection prior to project approval. The bioassay should not be considered a mitigation, and Sections 4.2.3.1 and 4.3.3.1 have been edited to include an appropriate mitigation.

Comments: 2-73, 3-8, 3-46, 6-26, 6-29, 6-49

Response: There are no data to support the theory that a geothermal spill would have the catastrophic effects which the commentors portray. Mammoth Creek has a small, variable, natural component of geothermal input, but in the 1960s, a geothermal well was intentionally flowed into the creek for 60 days. There is no evidence that this flow produced the impacts assumed by the commentors, and it certainly has not affected the streams' classification as a blue ribbon trout stream today. The entire spill containment plan is mitigation for geothermal spills. See Section 4.1.4.1 for the discussion of spills. Pacific Energy has committed to restock the stream to speed reestablishment of natural populations. (No additional bond would be required because Pacific Energy has both bonds and other financial obligations sufficient to restrock the stream. Trout from above and below the reach of stream potentially affected could recolonize the stream after normal temperatures were restored, as could organisms lower on the food chain. The authorized officer has the authority to require clearing streambed if sediment is delivered to Mammoth and Hot Creeks.

Comments: 2-1

Response: Comments noted.

10.3.5 SOCIAL ENVIRONMENT

Cultural Resources

Comments: 6-47, 8-8

Response: Comments noted.

Recreational Resources

Comments: 6-51, 7-4

Response: Sight-seeing has been added on the appropriate pages.

Comments: 6-48, 6-50

Response: Recreational resources of the area are described in Section 3.3.3. The discussion of impacts on in Section 4.1.4.2.6 includes those recreational impacts which could reasonably be expected by the project. Those impacts are limited as is the discussion.

Comments: 2-74, 2-75

Response: The recreational value of the thermal features is described in Section 3.3.3.0. Thermal water is hot water; it is mentioned in Section 4.3.3.1. The mitigation measures are described in full in Section 4.1.4.3.

Comments: 7-5, 7-7, 7-8

Response: The Forest Service considers Hot Creek Gorge a geologic interpretive site, and officially discourages public bathing. See the discussion of the monitoring/mitigation program in Section 4.1.4.3. The monitoring/mitigation plan is designed to identify and eliminate negative impacts long before they could reach Hot Creek Gorge. A mitigation for the worst-case situation suggests injecting make-up water into the reservoir, not into the creek.

Comment: 7-12

Response: Comment noted.

Timber Resources

Comment: 8-9

Response: Comment noted.

Transportation

Comment: 11-1

Response: Comment noted.

Visual Resources

Comment: 3-6

Response: Upon reconsideration of the effectiveness of the landscape plan, trenching and burying pipelines, in conjunction with similar plans for PLES I, and reconsidering the evidence presented regarding the lack of project impacts to mule deer, the Mono County Board of Supervisors unanimously approved the MP II project on December 6, 1988.

Comment: 3-47, 3-51

Response: The discussion in Section 3.3.6.1 explains the Visual Management System (VMS) used by the Forest Service. The visual environment can be made worse by additional development and simply because there are unsightly facilities (such as those listed in Section 3.3.6.4), they should not be used as justification for locating the project at the proposed site. However, the extensive measures included in this project would screen the new facilities and improve the appearance of the existing geothermal development. Section 3.3.6.2 has been corrected to read Section 3.3.7.2.

Comments: 6-52, 10-9

Response: The viewpoint used for the analysis was selected by the Forest Service. As stated in Section 3.3.6.4, this point is the viewpoint from which most viewers would see the project. The thousands of acres from which the project area is visible include land many miles away. The project, when viewed from several miles away, would be almost imperceptible to the naked eye. Landscaping and neutral earth tone colors used for painting would make it inconspicuous, even from a mile away. Terrain also screens it from view from many nearby areas.

Comment: 3-7

Response: There is no evidence provided in the comment that landforms could not be restored. The terrain is gently sloping or level and could be easily recontoured after wells were plugged and surface facilities removed.

Comment: 3-50, 6-53, 7-9

Response: Appendix B describes the revegetation plan in considerable detail, including species to be seeded, transplanted as seedlings, grown in container, or tree spade transplanted. The landscape treatment at well sites, pipeline segments, and the plant site is also described in Appendix B. Irrigation, planting, trenching, and retaining walls are also mentioned.

Since the Draft EIS/SEIR was circulated, 30-foot tall pines have been transplanted on the site. This would reduce the time to meet the VQO to no more than five years - the time to establish vegetation. The text has been edited. The VQO is a guideline, not a regulation. Compliance is not an issue.

The general nature of the lighting is described in Section 4.3.6.1. As with all these features, the authorized officer is responsible for compliance with stipulations (see response to Comments 2-30, 2-31, p. 10-172 ...).

Comments: 5-1, 5-2

Response: The grading plans for the power plant balance cut and fill so that no spoils are produced. Since the landscape plan effectively screens the power plant, in this case it is not necessary to change the grading plans.

Some of the pipelines would be buried and some trenched, although the trenches would not be lined. The spill containment basins would collect any liquid which escaped from bermed areas.

Comment: 7-13b

Response: The alternative location does provide better visual screening of the power plant. However, piping water to the power plant would require pumping more water to the power plant, partially because heat would be lost due to the longer pipeline, but also because the alternative site is at a higher elevation and pumping requires energy. There is no way to transport the geothermal fluid without using part of the power which is generated at the plant to do the work, and since the alternative site is both higher and further away from the producing wells than the proposed site, more geothermal fluid must be pumped to supply the necessary energy. Heat loss from the line is a less important factor since the lines already are heavily insulated - with relatively low temperature resource such as the one found at Casa Diablo, it is important to preserve as much heat as possible. Improving the insulation, which already increases the overall pipe diameter by as much as ten inches, would increase the height of the pipelines, making them more visible and more difficult for deer to jump.

Locating the power plant at the alternative site to totally mitigate visual impacts of the power plant, which with the landscape plan and other measures are minor, would be accomplished at greater impact to wildlife and increased risk of spill. However, the alternative location is viable and the decision makers could select it.

Comments: 3-48, 3-49

Response: Screening all lighting is part of the proposed project. See item 18 in Section 2.1.1.

Comment: 10-5

Response: The appropriate page has been edited as requested.

Land Use and Planning

Comment: 3-52

Response: Comment noted.

Comment: 6-60, 6-61

Response: The proposed project is not inconsistent with the concept of Mammoth Trout Park. The potential risk to the riparian habitat of Mammoth and Hot Creek is very low. If a spill were to occur, it would be containable, short-term, and mitigable. Flow would stay in the existing streambed and flooding would not result. Riparian habitat along Mammoth and Hot Creeks are at far greater risk from natural flooding and grazing impacts (see Taylor and Buckberg, page 16) than from the geothermal facilities.

The concept of a National Recreation Area in and of itself does not preclude commercial or light industrial development. Natural Recreation Areas encompass many combinations of environments, from those which are nearly wilderness to those in urban settings.

The National Recreation Area Concept is in its infancy, with no maps yet published to show the area which could be included. Some areas would be required for commercial and industrial use - the immediate Casa Diablo area which already has one power plant, an electrical substation, and transmission lines, would be logically designated as suitable for light industrial use.

Comment: 3-3

Response: When the geothermal lease was granted, pursuant to the programmatic EIS and Lease Block I EA, it granted the rights to develop the resource, if it were properly mitigated to protect the environment.

We do not agree that the construction and operation of the PLES I project would have a significant impact on tourism or the recreation values of the Long Valley Area. We support the designation of the Long Valley area as an outstanding recreation area, and we have carefully planned this project so the landscaping and operation of the power plant would not interfere with the recreational values of the Long Valley area. Migitation measures have been developed through the environmental review process to prevent interference with the tourism and recreation values of the area. Water consumption would be controlled at all times and would be limited. As discussed above, the specific location of the power plant was selected so as to prevent impacts to recreation and to maintain the open-space environment of the Long Valley area.

Economics

Comment: 6-64

Response: We disagree. Agencies must be prepared to carry out their normal business, including appeals to decision. This cost is not part of the economics of the project.

Comment: 2-27

Response: As stated in Sections 3.3.7.3 and 4.3.9.1, it is possible to obtain trout eggs on a year-round basis for $10 to $20 per 1,000 eggs, depending on the number purchased. The 800,000 Coleman strain eggs which could not be produced without the thermal water component at Hot Creek Hatchery would be worth almost $16,000 at prices prevailing in mid-1988.

The California Department of Fish and Game has produced no evidence to support the contention that these eggs would be worth $250,000 if they were available.

Comment: 3-53

Response: The dollar values are shown in Section 4.3.9.1.

Comment: 8-27

Response: Section 4.3.9.1 has been edited to include the suggested wording.

Community Services

Comment: 6-65

Response: On-site fire-fighting equipment is described in Section 2.1.5.3.

Comment: 10-10

Response: Section 4.3.10.1 has been edited to correct the inaccuracy.

Geothermal Resource Lease

Comment: 6-66

Response: This document identifies no significant, unmitigable impacts which would preclude approval of the project.

10.3.6 REFERENCE CITED IN RESPONSE TO COMMENTS

Taylor, Walter P., editor. 1965. Genus *Odocoileus*. Their history and management: The Wildlife Management Institute, Washington, D.C.

PLES I GEOTHERMAL DEVELOPMENT PROJECT

APPENDICES

Prepared for:

U.S. Bureau of Land Management
Bishop Resource Area Office

U.S. Forest Service
Inyo National Forest

Great Basin Unified Air
Pollution Control District

May 1989

Prepared by: Environmental Science Associates, Inc.

FINAL ENVIRONMENTAL IMPACT STATEMENT

AND SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

PLES I Geothermal Development

CA-017-P006-60

State Clearinghouse No. 86122913

Mono County, California

VOLUME II: APPENDICES

Federal Lead Agency: Bishop Resource Area U.S. Bureau of Land Management

State Lead Agency: Great Basin Unified Air Pollution Control District

Cooperating Agency: Inyo National Forest U.S. Forest Service

For further information contact:

Area Manager
Bishop Resource Area
787 N. Main Street, Suite P
Bishop, California 93514
(619) 872-4881

May 1989

PLES I GEOTHERMAL DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT
AND SUPPLEMENTAL ENVIRONMENTAL
IMPACT REPORT
May 1989

VOLUME II: APPENDICES

TABLE OF CONTENTS

PLES I GEOTHERMAL DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT
AND SUPPLEMENTAL ENVIRONMENTAL
IMPACT REPORT
May 1989

VOLUME II: APPENDICES

TABLE OF CONTENTS

PLES I GEOTHERMAL DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT
AND SUPPLEMENTAL ENVIRONMENTAL
IMPACT REPORT
May 1989

VOLUME II: APPENDICES

TABLE OF CONTENTS

PLES I GEOTHERMAL DEVELOPMENT PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT
AND SUPPLEMENTAL ENVIRONMENTAL
IMPACT REPORT
May 1989

VOLUME II: APPENDICES

TABLE OF CONTENTS

APPENDIX A

EMERGENCY SPILL CONTAINMENT PLAN

PACIFIC LIGHTING AND ENERGY SYSTEMS UNIT I
GEOTHERMAL DEVELOPMENT PROJECT
EMERGENCY SPILL CONTAINMENT PLAN

This Emergency Spill Containment (ESC) Plan for the Pacific Lighting and Energy Systems Unit I Geothermal Development Project (PLES I) is prepared in conformance with the stipulations of the Bureau of Land Management (BLM) and the Inyo National Forest; the specifications of the California Regional Water Quality Control Board, Lahonton Basin Region (RWQCB); and applicable federal regulations (40 CFR 112) for a Spill Prevention, Control and Countermeasure (SPCC) Plan pursuant to the Clean Water Act, as amended.

I. PURPOSE

The Purpose of this ESC Plan is to: (1) identify potential sources of spills; (2) define measures which have been taken to prevent spills of geothermal fluid, isobutane or any other substance from the project area; (3) describe spill containment systems which have been engineered into the facility to keep spilled substances confined to the site; and (4) outline response actions which would be initiated in the event of a spill.

II. OPERATIONAL SOURCES OF ACCIDENTAL SPILLS

There are principally two phases of operations (short term and long term) associated with the PLES I project with specific spill prevention and containment measures, as appropriate.

(a) Short term operations include well drilling, testing, and servicing operations; and site construction; and

(b) Long term operations consist of commercial power production and maintenance operations.

With the exception of constructing and drilling make-up well sites, as necessary, most significant short term operations will be completed before the power plant begins commercial production operations. Because the source and composition of potentially spilled substances, the maximum credible size of potential spill events, and the spill prevention and containment measures proposed differ for the short term and long term operations; the ESC Plan has been organized by operation to facilitate identifying appropriate spill response procedures.

A. Well Drilling, Testing and Service Operations

Three generic spill events have been identified which could occur during well drilling, testing, and service operations.

1. Drilling Mud Spill:

Drilling muds (a mixture of water, non-toxic chemicals and solid particles used in drilling operations to lubricate and cool the bit in the hole and to carry cuttings out of the hole) will be discharged into a lined on-site mud pit. Accidental discharge of drilling muds are unlikely, but could occur by overflow of the mud pit, mud pit wall seepage or wall failure, or discharge from equipment failure.

2. On-Site Chemical or Fuel Spills:

Small quantities of diesel fuel, mud additives, and workover chemicals may be stored on-site during drilling, testing or workover operations. A potential exists for small on-site spills of these substances.

3. Loss of Control of a Well (Well Blowout):

Although unlikely, a possibility exists for an accidental geothermal fluid spill or discharge due to temporary loss of well control or a well blowout. Geothermal fluid in the Casa Diablo area is essentially hot salty water (about 200 degrees Fahrenheit after being exposed to the atmosphere, and about 1,300 to 1,500 ppm of total dissolved solids) with trace concentrations of heavy metals. Salt water kill fluid could also be added to wells during drilling operations to facilitate well control. Salt water kill fluid is typically a clear salt water solution of up to 14 percent sodium chloride, or in some extreme well control cases, up to 30 percent calcium chloride.

Because of the differences in specific circumstances in which a geothermal spill might occur it is difficult to estimate how long a spill event would continue; however, experience with geothermal fluids in the Casa Diablo area suggest the maximum credible spill rate from an uncontrolled well would be about 500 gallon per minute.

The possibility of well blowout is greatest during drilling operations. As such, a specific Blowout Contingency Plan and Related Field Development Emergency Plans relative to well drilling operations has been prepared for the project (Appendix I).

B. Construction Operations

During site construction the principal sources of potential spills will be small quantities of diesel fuel and lubricants which may be stored on-site to fuel and service construction equipment. Action described hereafter for well drilling, testing, and servicing operations as they relate to small quantity miscellaneous spills are also applicable to actions to be taken for spills during site construction activities.

C. Commercial Production Operations

There are three principal areas from which accidental spills could occur during production operations, including: (a) the production and injection well sites; (b) the production and injection pipelines; and (c) the power plant site itself.

1. Wells and Well Sites:

A very small potential exists for geothermal fluid to be spilled or discharged from any given production or injection well during commercial production operations from channeling of geothermal fluid around the well bore to the surface as a result of improper or inadequate casing cement; near surface fracturing of casing as a result of a major seismic event; or corrosion of surface facilities at the wellhead. Miscellaneous small volumes of paints, solvents or lubricants temporarily stored on-site during well service operations could also be spilled during the life of the project.

2. Production and Injection Pipelines:

Surface pipelines carry hot geothermal fluid from the production wellfield to the power plant and carry warm geothermal fluid from the power plant to the injection wells. A rupture anywhere along the length of the pipeline would cause a spillage of geothermal fluid. The maximum credible spill volume is estimated to be the total flow (about 5,000 gpm) of geothermal fluid for a five-minute period (or a total of about 25,000 gallons). No other substances would be subject to spilling along the pipeline corridors.

3. Power Plant Site:

There are three principal substances which could be spilled on the power plant site. These substances include: (1) isobutane, (2) geothermal fluid, and (3) miscellaneous substances including diesel fuel or small quantities of solvents or lubricants which may be used on site.

Isobutane is the hydrocarbon working fluid used in the power plant heat exchangers. Up to 20,000 gallons of isobutane will be stored on site at any given time, which represents the maximum potential spill volume. Isobutane could be spilled as a result of a system failure or rupture of either the closed system storage vessels (including the accumulator and the storage tank) or the fluid circulating system. Minor isobutane spills also could result during charging of the system or from small leaks. Isobutane is a highly volatile substance which would vaporize shortly after being spilled under most atmospheric conditions. At temperatures below the boiling point of isobutane, about 14 degrees Fahrenheit, isobutane will not vaporize and will remain in liquid form.

Geothermal fluid flowing from the production wellfield to the power plant heat exchangers, or from the heat exchangers to the injection wellfield could be spilled on-site as a result of a leak or rupture.

An underground diesel fuel storage tank is proposed for the power plant site to store fuel for the emergency diesel fire pumps. Miscellaneous small volumes of paints, solvents, or lubricants may be stored on-site at any given time. Further, the on-site electric switchyard will utilize transformers containing a non-PCB oily substance. Small spills from any of these sources could occur during the life of the project.

III. SPILL PREVENTATIVE MEASURES

Several steps will be undertaken to guard against the possibility of a spill. Each of the identified potential spill areas will have safety features to reduce the likelihood of a spill occurring and to prevent a spill from travelling off-site or leaving the project area.

A. Well Drilling, Testing and Service Operations

During well site construction prior to drilling, each well site will be graded to drain to a lined mud pit. The entire well site will be bermed to contain small spills on-site during drilling and testing operations. Sedimentation basins will also be constructed on each well site to contain site runoff from storm events which may occur during drilling operations. Down gradient sides of cut or fill slopes will be lined with filter fences or hay bales to retard soil erosion and sedimentation in the event on-site containment should fail. Erosion control is the subject of a separate specific Drainage and Erosion Control Plan.

During well drilling operations 10,000 gallons of cold water will be stored on-site to be available to kill the well in the event that well control problems should arise. During power plant operations 50,000 gallons of cold water will be stored within the project area and will be available for well control problems after commercial operations begin.

The possibility of geothermal fluid spills or discharges due to loss of well control or blowout is addressed in the Blowout Contingency Plan and Related Field Development Emergency Plans, incorporated into this ESC Plan as Appendix I.

In addition, a project area-wide spill containment facility will be utilized as a backup containment mechanism to prevent spills from leaving the project area. A complete description of the spill containment facility is provided in section IV.

B. Commercial Production Operations

1. Wells and Well Sites

Except for a small wellhead area (about 60' x 130') well sites will be graded after drilling to natural contours. The reduced wellhead area will be bermed to prevent minor spills from leaving the site such as could occur during well servicing operations.

2. Production and Injection Pipelines

Seamless welded pipes will be used along the entire length of production and injection pipeline to minimize the possibility of leaking connections. Isolation valves will be strategically located within the pipelines to prevent a significant backflow of geothermal fluid, should a leak occur. Major pipeline leaks or ruptures would be almost instantaneously detected by in-line sensing equipment as discussed in Section IV.

3. Power Plant Site

The power plant facility will be diked and drained to an on-site catchment basin of approximately 88,000-gallon design capacity. The catchment basin will collect site runoff and would be available for emergency spill containment. This basin is designed to catch any surface runoff of rain water up to the volume from a 20-year one-hour design storm event. Rain water in the catchment basin will be allowed to infiltrate and evaporate.

Under almost all expected atmospheric conditions, isobutane, if spilled, would evaporate before the spill could spread. Any identified potential spill sources in the power plant, such as the isobutane accumulator and switchyard transformers, will be individually curbed to contain spills during commercial production operations. In the unlikely event that spills are not fully contained by the on-site source specific containment facilities, leakage would flow to the on-site catchment basin. In addition, a fail-safe spill containment facility will be constructed down gradient of the power plant site, as discussed in Section IV, and will provide a redundant means for preventing spilled substances from the leaving the project area. A sample of any contained spilled substance will be analyzed and disposed of in a manner approved by the RWQCB.

C. Area-Wide Spill Preventative Measures

In addition to the area specific spill preventative measures described above the following facility-wide operating procedures will be followed.

1. Equipment and Facility Inspection Program

An inspection program will be implemented to prevent and detect system malfunctions and equipment or facility deterioration which, if allowed to continue, could lead to an accidental spill. The inspection program is designed to provide early warning of the potential for such events in order that corrective and preventative actions be taken.

All major equipment and facilities will be identified for routine inspection on an itemized inspection schedule subsequent to facility construction. The schedule will provide a checklist of potential problems associated with the equipment to facilitate inspection. The schedule will also identify the frequency with which the equipment or facilities are to be inspected. A brief, generic, example of the itemized inspection schedule is provided as Table 1. It is anticipated that the schedule will provide the basis for a comprehensive inspection and maintenance program.

2. Personnel Training Program

A personnel training program shall be implemented for both short term and long term operations. Short term operations conducted by contractors, including: well drilling, testing, and servicing; and site construction will require contractors to instruct their employees to comply with applicable portions of this ESC Plan, particularly with respect to emergency response actions to take in event of loss control of wells.

The training program for power plant operators will include instruction on spill prevention, equipment and facility inspection guidelines, and emergency response actions to be taken in the event of a spill. A scheduled training program for all operators and supervisors will be conducted during their first week of job orientation. Training will include a review of equipment which may be used to control or cleanup spilled substances, and the required safety procedures. All potential spill sources, as defined in this ESC Plan, shall be reviewed and appropriate preventative and emergency spill response measures defined.

IV. EMERGENCY SPILL CONTAINMENT SYSTEM

Prior to well drilling or power plant construction, emergency spill containment facilities will be constructed down gradient of all proposed PLES project facilities. The emergency spill containment facilities will take advantage of the natural drainage in the project area and will be available to contain spilled substances from anywhere in the project area.

A. System Design and Normal Operation

The spill containment facilities will be constructed by installing vertical sluice gates down gradient of the project area on extensions of two existing culverts which drain the project area. One culvert crosses beneath State Route 203 and the second culvert crosses beneath Old Highway 395 (aka Hot Springs Road). The vertical sluice gate details are provided on attached Drawing C-0416/0420-E-101, and the location of facilities are identified on the site Drainage Plan (Drawing C-0416-E-104).

The existing culvert pipes under State Route 203 and Hot Springs Road (County Road #346-A) will be extended to approximately 42 feet from the centerline of the existing road where a concrete headwall will be constructed, as shown on the enclosed drawing C-0416/0420-E-101. A vertical lift gate of the culvert size will be installed on the headwall. The vertical lift gate will have an electric operator for automatic operation and a handwheel for manual operation. The valve will be open under normal operating conditions, but closed in the event of a spill from a pipeline or wellsite. The spill would be held in the containment facility, analyzed and disposed of in a manner approved by the RWQCB.

These containment facilities will be constructed before any new construction or well drilling takes place. Each portion of the project will drain to one of the two spill containment areas as shown on the site drainage plan attached (Drawing C-0416-E-104). Therefore, should any discharges or spills occur during drilling, testing or servicing activities, the spill containment facilities will be in place to handle them.

During the short term well drilling, testing, and site construction activities prior to commercial production, the sluice gates would be maintained in a closed position except to permit natural drainage from rain, snow melt, or spring flow from the area. The closed sluice gates would thereby provide secondary emergency spill containment prior to installation of an automatic control system for commercial production operations. Operation of sluice gates would be manual during this preliminary phase of development.

During normal commercial production operations the sluice gates would remain open allowing natural drainage. However, if a major spill should occur the gates would be closed providing secondary containment of any spilled substance in the project area. The gates could be actuated to close manually from the control room, or the gates would automatically close as a result of a system upset during commercial production operations as described below. Valve position will also be displayed in the control room.

B. Automatic Closure Control System

Automatic operation of the containment sluice gates will be triggered by either of two circumstances.

1. Loss of Electrical Power

The pneumatic closure of the sluice gates will be based on a de-energized to trip philosophy, that is should electric power be lost, the valve actuator (utilizing bottled nitrogen) will close the sluice gates. Thus, under circumstances which could result in both a power outage and a spill, such as a major seismic event, the sluice gate would automatically close providing fail-safe spill containment protection. Low nitrogen pressure will be alarmed and displayed in the control room; thereby, assuring continued availability of nitrogen to close the valve.

2. Geothermal Fluid Flow Rate Imbalance

Automatic operation of the sluice gates will be accomplished by measuring geothermal fluid flow from each production well and to each injection well and transmitting those flow rates to an electronic summation device in the control room. The production well flow (supply) will be totalized as will the injection well flow (return). The totalized production and injection flow will be continuously compared electronically. Under normal circumstances the totalized flows should be equal with minor fluctuations. Should there be an order-of-magnitude difference between the production flow and the injection flow (such as would occur if there were a major geothermal fluid leak or pipeline rupture) the sluice gate valve actuators will automatically close, the production pumps and injection pump(s) will stop, and an alarm will sound and be displayed in the control room.

V. SPILL RESPONSE MEASURES

In the event of discharges or spills, the On-Site Supervisor will make an immediate investigation and initiate emergency spill response measures and notifications as appropriate (dependent upon the type and location of discharge or spill). The On-Site Supervisor will then call out equipment, regulate field operations or do other work as applicable for control and cleanup of the discharge or spill. For off-site spills, responsible agencies, as listed in Section VI, will be notified as soon as practical.

The action required to respond to a spill is dependent upon the size of the spill. Small spills (spills of less than 250 gallons) which are easily containable without endangering watershed will be cleaned up immediately under the direction of the On-Site Supervisor. An incident report will be completed by the On-Site Supervisor for subsequent review by plant management to implement measures to prevent similar occurrences.

Large spills (spills of greater than 250 gallons) or spills which cannot be easily contained, or spills which endanger or have entered watershed, will be managed under the discretionary direction of the On-Site Supervisor, using the guidelines in this ESC Plan. The On-Site Supervisor will proceed to take the necessary action to curtail, contain and clean up the spill. If public safety is endangered the On-Site Supervisor shall immediately contact one or more, as appropriate, of the Emergency Response Agencies identified in Section VI. As soon as practical, the On-Site Supervisor will also notify the appropriate Interested Agencies listed in Section VI.

A. Spill Response Measures During Drilling, Testing and Service Operations

If drilling mud or fluids are spilled, an attempt will be made to contain the spill to the well site. If necessary, repairs will be made to the mud pit or on-site sedimentation basins. The liquid fraction of drilling mud or fluids will be removed by vacuum truck to an available tank for subsequent sampling, analysis, and disposal. The solid fraction will be retained on-site, and also sampled and analyzed for characterization prior to disposal in conformance with requirements of the RWQCB.

Spills of geothermal fluid will be contained on-site in mud pits, sedimentation basins, or within the bermed sites. If a geothermal spill threatens to flow off of the well site, the spill containment gates of the emergency spill containment facility (see Section IV) should be manually closed to prevent spilled materials from leaving the project area. Contained geothermal fluids should be cooled and disposed of in a manner acceptable to the RWQCB.

Small petroleum product or chemical spills should be contained on-site with available manpower. Absorbants should be used to contain the spill and contaminated soil should be sampled, analyzed and removed to a disposal site approved by the RWQCB.

All prescribed safety practices should be followed. The members of the drilling, well testing, construction field and operations crews will perform duties assigned specifically for the situation, following applicable rig or construction safety practices and procedures (See also the Blowout Contingency Plan and Related Field Development Emergency Plans provided as Appendix I).

B. Spill Response Measures at the Wells and Pipelines

In the event of a large geothermal spill, such as may occur from a pipeline rupture, all flow from the production wells will be shut off. The gates of the emergency spill containment facilities should automatically close (see Section IV), and confirmation of the gates closing should be indicated in the control room. As soon as practical, plant operators should visually confirm the gates are closed. In the unlikely event the gates did not close automatically, plant operators should close the gates manually, and keep the gates closed until the spill incident is over. The pipeline leak or rupture should be located and repaired as soon as possible. Spilled geothermal fluids stored in any of the containment facilities will be disposed of in manner acceptable to the RWQCB.

C. Spill Response Measures at the Power Plant Site

Geothermal fluid spills occurring within the boundaries of the power plant site will be managed in the same manner as geothermal spills from pipeline ruptures. The power plant site provides the added opportunity to contain the spill at the site because the on-site site catchment basin has greater capacity than the largest credible spill volume. Spill response measures should parallel those earlier discussed in Section V.B.

Spills of isobutane should be contained within the internally bermed areas of the power plant site. Extreme caution and effort should be provided to keep the isobutane away from potential ignition sources. The source of the leak or the cause of the spill should be identified and repaired or remedied as soon as it is safe to do so. As much of the isobutane as possible should be recovered by vacuum truck and absorbants should be used to collect any material which cannot be recovered by vacuum. The isobutane will then be reclaimed or disposed of in a manner approved by the RWQCB.

In the unlikely event that an isobutane spill should escape the internally bermed power plant site areas, the leakage would flow to the on-site catchment basin. The catchment basin contains far in excess of the total volume of isobutane stored on the site at any given time. The contents of the catchment basin would then be recovered or disposed of in the manner described above.

Given the redundant on-site containment and the vaporization characteristics of isobutane, no off-site isobutane spills can credibly be expected to occur. However, the emergency spill containment facilities described in Section IV could be utilized to contain spilled isobutane if some currently unforeseeable spill incident should occur.

VI. NOTIFICATION PROCEDURES

The drilling supervisor and/or the PLES supervisor (On-Site Supervisor) will immediately notify one or more of the local emergency response agencies, as appropriate, if public safety is threatened by a spill. The On-Site Supervisor will, as soon as practical, contact any contractors required to respond to the spill and will notify the PLES Project Manager.

Local Emergency Response Agencies	Emergency Nos.
Mono County Sheriff Department	911
California Highway Patrol	911
Long Valley Fire District	911
Mammoth Lakes Fire Department	911
Ambulance - Paramedics	911

PLES Project Manager
6055 East Washington Boulevard
Commerce, California 90040
(213) 725-1139

In the event of a large spill, the On-Site Supervisor will follow the same notification procedures provided above. In addition, the PLES Project Manager will notify the following agencies as soon as practical and work closely with them in all phases of the curtailment, containment and cleanup operations:

Responsible Regulatory Agencies:

California Regional Water
Quality Control Board (RWQCB)
Lahonton Region - Victorville Office
15371 Bonanza Road
Victorville, California 92392-2494
(619) 241-6583

Bureau of Land Management
Bishop Resource Area Office
873 N. Main Street, Suite 201
Bishop, California 93514
(619) 872-4881

Inyo National Forest
Forest Supervisor Office
873 N. Main Street
Bishop, CA 93514
(619) 873-5841

Inyo National Forest
Mammoth Ranger District Office
State Route 203
P. O. Box 148
Mammoth Lakes, California 93546
(619) 934-2505

VII. INCIDENT ASSESSMENT AND SITE RECLAMATION

After a spill has occurred, an incident assessment will be undertaken to determine the cause of the spill and to initiate counter measures to guard against any reoccurrence.

Site reclamation shall be undertaken to repair any damage resulting from the spill and to remove and dispose of wastes or contaminated soils in a manner consistent with the requirements of the RWQCB. Berms, basins and other containment facilities or equipment will be repaired, as necessary. The Erosion and Sedimentation Control Plan will be consulted to ensure conformance with that Plan, and the site will be revegetated as necessary.

TABLE 1
EMERGENCY SPILL CONTAINMENT PLAN
EQUIPMENT AND FACILITY INSPECTION SCHEDULE

EQUIPMENT	CHECKLIST	INSPECTION FREQUENCY
Sluice gates	Open or closed	Once a day
Warning signs	Existent Condition	Once a month
First aid kits	Completeness	Once a month or After use
Absorbants	Stock	Semiannually or After use
Berms	How full Structural soundness	Once a month
Monitoring equipment	Run test checks	Once a month
Pipelines	Leaks Corrosion	Once a month
Wellhead equipment	Leaks Corrosion	Once a month
Valves	Packing Wear	Semiannually
Pipe support	Structural soundness	Semiannually
Tanks	Structural soundness	Annually
Heat exchangers	Efficiency check	Semiannually
Oil-lubricated equipment	Lubrication check	Daily

APPENDIX I

PLES I - GEOTHERMAL FIELD
WELL BLOWOUT CONTINGENCY PLAN AND RELATED FIELD DEVELOPMENT EMERGENCY PLANS

The purpose of these plans is to provide guidance to field personnel and management in the event of an uncontrolled well flow (i.e., "blowout") or other field related emergency. The plans are intended to be comprehensive in that they describe the nature of various hazards or problems that might encountered and specify appropriate preventive or anticipatory actions and equipment, as well as specific responses, notifications and follow up procedures that are required in the event of such a field emergency. In addition to blowouts, emergencies such as injury, fire, spills and hazardous gas releases are covered.

A. Blowout Contingency Plan (See also the attached Hazardous Gas Contingency Plan and the Blowout Action Plans)

The Blowout Contingency Plan and related Hazardous Gas Contingency Plan and Blowout Action Plans describe actions and equipment aimed first at preventing blowouts and, in the event of uncontrolled well flow, the specific responses required to regain control and minimize hazards and damage.

1. In order to prevent blowouts the following precautions will be observed:

   a. Blowout prevention equipment will be kept in operating condition and tested in compliance with regulations and industry standards.

   b. During drilling operations, a minimum of 10,000 gallons of cool water and 12,000 pounds of barite will be stored at the well site for use in killing the well.

   c. When pulling or running pumps or conducting other well operations for which only clear fluid should be used to kill the well, the following precautions will be observed:

      i. For wells which are known to have a standing water level below ground level, a minimum 10,000 gallon supply of cool water will be available at the well, either through a pipeline from the plant water supply system or from a storage tank at the well site.

      ii. For wells which are known to have a standing water level near ground level or above, the following items will be kept at the well site:

         - a water supply as described above,

- a tank and circulating pump for mixing up to 4,000 gallons of salt water kill fluid, and

- a minimum of 6,000 pounds of sodium chloride salt or 15,000 pounds of calcium chloride salt, depending on the kill fluid density that would be required to kill the well.

d. In the event of an emergency, such as a blowout, immediate efforts will be taken to shut surface valves and blowout preventer(s).

2. If the means to shut-in or control the flow from the well is lost, the Drilling or Workover Supervisor is to:

a. Initiate appropriate control procedures.

b. Arrange for any injured person to be transported by the fastest appropriate transportation to the nearest medical facility, as shown above in the Injury Contingency Plan.

c. Notify the Sheriff if there is a threat to local residents, at:

Mono County Sheriff's Department
Mammoth Lakes, CA
(619) 934-6058 or 911

d. If fluid flow is of an uncontained nature, immediately dispatch personnel to close the appropriate containment basin gate and attempt containment by constructing sumps and/or dikes as rapidly as possible and as needed.

e. Secure and maintain control of access roads to the area to eliminate entry of unauthorized personnel.

f. Contact the Project Manager and advise of the situation.

g. Follow cleanup and abatement procedures of the Spill or Discharge Contingency Plan - Section D.

h. Initiate any further or supplemental steps which may be necessary or advisable, based on consultation with the Project Manager.

i. Be certain that all safety practices and procedures are being followed and that all members of the crew are performing their assigned duties correctly.

j. Attempt to control the well at the rig site with rig personnel and supervisors.

k. Attempt to construct and/or fabricate and install any well head facilities required to contain fluid flow at the well or casing head.

l. Maintain a continuing inspection of the pad area immediately around the well site subject to erosion that could cause failure to the rig structure. Take necessary steps to avert possible erosion by excavation and rebuilding of the area as necessary.

m. Following complete containment of the well, initiate steps to return the area to its normal state prior to the blowout or fluid flow.

B. Injury Contingency Plan

In the event injuries occur in connection with a PLES operation, specific and immediate attention will be given to proper transportation to a medical facility.

Ambulance Service

Ground - Aegis Ambulance Service
2835 W. Line STreet
Bishop, CA
(619) 873-8904

Mono County Paramedics
Mammoth Lakes (619) 937-3049 or 911
June Lake (619) 648-7234 or 911

Bishop Sierra Ambulance Service
457 W. Yaney
Bishop, CA
(619) 873-4140

Hospital

Centinela Mammoth Hospital
Sierra Park Road
Mammoth Lake, CA
(619) 934-3311

Northern Inyo Hospital
150 Pioneer Lane
Bishop, CA
(619) 873-5811

Mono General Hospital
Bridgeport, CA
(619) 932-7011

C. Fire Contingency Plan

In the event of fire in connection with PLES operations, immediate control attempts and appropriate notifications should be implemented in accordance with the following:

1. Any small fires which occur around the well pad during workovers, drilling or testing operations should be controlled by rig personnel utilizing on-site fire fighting equipment.

2. The Forest Service (619 934-2505) and local fire fighting agency should be notified of any fire, even if the available personnel can handle the situation or the fire poses no threat to the surrounding area.

3. A roster of emergency phone numbers is to be available on site so that the appropriate fire fighting agency can be contacted in case of a fire.

D. <u>Spill or Discharge Contingency Plan</u>

The following plan is consistent with the Emergency Spill containment Plan developed for the PLES I Project. The purpose of this plan is to: (1) identify potential sources of spills; and (2) define emergency response actions which would be initiated by rig and field development crews if a spill should occur during well drilling, testing or servicing operations.

1. Potential Sources of Accidental Spills or Discharges

a. Geothermal Fluid

Accidental geothermal fluid spills or discharges are very unlikely. However, accidental discharges or spills could result from any of the following:

i. Loss of well control (blowout)

ii. Pipeline leak or rupture

iii. Leakage from test tank.

b. Drilling Muds

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

i. Overflow of the reserve pit.

ii. Reserve pit wall seepage or wall failure.

iii. Discharge from equipment failure on location.

iv. Shallow lost circulation channeling to the surface.

c. Salt Water Kill Fluid

Clear kill fluid is a solution of water and salt which will be necessary to kill some wells for pulling and running pumps or some workover operations. Only those wells which have a standing water level near or above ground level would be expected to require salt water kill fluid. For most such wells, 4,000 gallons or less of 14% (by weight) sodium chloride solution will be adequate. For wells with an unusually high shut-in surface pressure, it may be necessary to use a 30% calcium chloride solution. Specific fluid volumes and salt concentrations must be engineered for each application. These salts are natural components in the geothermal water and, except in the case of an accidental discharge, the kill fluid will be confined to a mixing tank and the geothermal production and injection reservoirs.

Accidental discharges of salt water are unlikely, but could occur by:

i. Loss of well control after the kill fluid was in the well

ii. Discharge from equipment failure on location.

d. Lubricating or Fuel Oils and Petroleum Products

A discharge of this type would probably be very small and be from equipment used in the field. Potential locations for accidental spills are:

i. Drilling equipment and machinery at and around the drilling location.

ii. Other miscellaneous equipment and machinery at well site and roads.

e. Construction/Maintenance Debris

Typically a minor consideration, one which is usually cleaned up on the job. Potential locations are the same as for lubricating or fuel oils listed in Item d, above.

2. Plan for Cleanup and Abatement

In the event of discharge of formation fluids, drilling muds, petroleum products or construction debris, the person responsible for the operation will make an immediate investigation, then contact the Drilling, Workover, or Plant Supervisor (as appropriate) and advise him of the spill. The Supervisor will in turn call out equipment, regulate field operations, or do other work as applicable for control and clean up of the spill, as follows:

a. Action - Small, Containable Spill

If the spill is small (i.e., less than 250 gallons) and easily containable without endangering the watershed, the Supervisor will direct and supervise complete cleanup and return to normal operations.

b. Action - Large or Uncontainable Spill

If the spill is larger than 250 gallons, or is not easily contained, or endangers, or has entered the watershed, the Supervisor will proceed to take necessary actions to curtail, contain and cleanup the spill, as above, and notify personnel as listed below.

c. Notifications

i. The Supervisor will, as soon as practical:

- Call out contractor(s), as required.
- Notify the Project Manager.
- Notify the local law enforcement agencies if the public safety is threatened.

ii. The Project Manager will notify the following as soon as practical and work closely with them in all phases of the curtailment, containment and cleanup operations:

Bureau of Land Management,
Bishop Area Office
873 N. Main St., Suite 201
Bishop, CA 93514
(619) 872-4881

Inyo National Forest
Forest Supervisors Office
873 N. Main St.
Bishop, CA 93514
(619) 873-5841

California Regional Water Quality Control Board
Lahontan Region - Victorville Office
15371 Bonanza Road
Victorville, CA 92392-2494
(619) 241-6593

Mammoth Ranger District Office
State Route 203
P.O. Box 148
Mammoth Lakes, CA 93546
(619) 934-2505

Project Manager
Pacific Lighting Energy Systems
6055 E. Washington Blvd.
Commerce, CA 90040
(213) 725-1139

The Supervisor will also advise local population and affected property owners if spill affects residents or property.

d. Specific Procedures

i. For geothermal fluid or salt water spills:

- Contain spillage with dikes, if possible, and haul to approved disposal site by vacuum or water trucks or dispose of in a manner acceptable to the regulatory agencies including, the Regional Water Quality Control Board.

ii. For drilling mud:

- Repair sump or contain with dikes. Haul liquid to another sump, available tanks or approved disposal site. Dry and solidify remaining material.

iii. For petroleum products:

- Contain spill with available manpower. Use absorbents and dispose of same in approved disposal area.

  For i. through iii. above, Pacific Lighting Energy Systems will have the source of spill repaired at the earliest practical time, and continue working crews and equipment on cleanup until all concerned agencies are satisfied.

e. Confirm telephone notification to agencies and regulatory bodies. Telephone notification shall be confirmed by the Project Manager in writing within two weeks of telephone notification. Written confirmation will contain:

i. Reason for the discharge or spillage.

ii. Duration and volume of discharge or spillage.

iii. Steps taken to correct problem.

iv. Steps taken to prevent recurrence of problem.

E. Emergency Personnel and Telephone Numbers

Fire

Inyo National Forest	Bishop	(619) 873-3300 (Fire only) or 911
	Mammoth Lakes	(619) 934-2505 or 911
Long Valley Fire Dept.	Crowley Lake	934-2200 or 911
Mammoth Lakes Fire Dept.	Mammoth Lakes	911

Law Enforcement

Mono County Sheriff	Mammoth Lakes	(619) 934-6058 or 911
California Highway Patrol		911 or (619) 873-3531

Agency Representatives

U.S. Bureau of Land Management:

District Manager	Bakersfield	(805) 861-4191
Area Manager	Bishop	(619) 872-4881

U.S. Forest Service:

Forest Supervisor	Bishop	(619) 873-5841

Company Representative

Pacific Lighting Energy Systems:

Project Manager	Commerce	(213) 725-1139

CASA DIABLO GEOTHERMAL FIELD

HAZARDOUS GAS CONTINGENCY PLAN

To Be Posted on Rig

Introduction

There is a possibility of encountering noncondensible gases during the drilling of a well. Although noxious or dangerous amounts of noncondensable gases, particularly hydrogen sulfide and ammonia, have not been associated with other wells drilled in the general area, it is necessary to be prepared in the unlikely event of an emergency. It is our intent to provide a safe working environment by taking measures not only to prevent the endangerment of personnel, but also that of public health, safety and the biotic environment.

The possibility of encountering ammonia gas is regarded as extremely remote. In addition, ammonia is considerably less toxic than hydrogen sulfide. Ammonia is included in the contingency plan to provide maximum safety and advance understanding should the improbable event of an emergency situation arise.

The effectiveness of this plan is dependent upon the cooperation and effort of each person who participates in drilling on working on wells. Each individual must know his responsibilities, not only under normal operating conditions, but also under emergency operating situations. Thus all personnel should familiarize themselves with the location and operations of all safety equipment and see that their own equipment is properly stored, easily accessible at all times, and routinely maintained.

General Information

All personnel involved with the mechanics of drilling, evaluating and testing the wells will be trained in the recognition of warning signals, the use of breathing equipment, individual and group responsibilities in case of emergency rescue or first aid, and other emergency procedures.

Each drill site shall have two briefing areas situated so that one would be upwind from the well at any given time. Before drilling begins, all personnel will be advised of an escape route other than the main access road.

A list of emergency phone numbers of personnel and agencies to be contacted in case of an emergency shall be posted in the following places:

1. Drilling Foreman's trailer
2. Drilling crew's dog house

Toxicity of Various Gases

Common Name	Chemical Formula	Specific Gravity(SG) SG Air = 1	Threshold[1] Limit	Hazardous[2] Limit	Lethal[3] Concentration
Hydrogen Cyanide	HCN	0.94	10 ppm	150 ppm/hr	300 ppm
Hydrogen Sulfide	H_2S	1.18	10 ppm[4]	250 ppm/hr	600 ppm
Sulfur Dioxide	SO_2	2.21	5 ppm	-	1000 ppm
Chlorine	Cl_2	2.45	1 00m	4 ppm/hr	1000 ppm
Carbon Monoxide	CO	0.97	50 ppm	400 ppm/hr	1000 ppm
Ammonia	NH_3	0.597	100 ppm	1700 ppm	5000 ppm
Carbon Dioxide	CO_2	1.52	5000 ppm	5%	10%
Methane	CH_4	0.55	90000 ppm	Combustible - above 5% in Air	

[1]Threshold Limit - Concentration at which is is believed that all workers may be repeatedly exposed day after day without adverse effects.

[2]Hazardous Limit - Concentration that may cause death.

[3]Lethal Concentration - concentration that will cause death with short-term exposure.

[4]Threshold Limit = 10 ppm - 1972 ACGIH (American Conference of Governmental Industrial Hygienists).

[5]Threshold Limit = 20 ppm - 1966 ANSI acceptable ceiling concentration for eight-hour exposure (based on 40-hour week) is 20 ppm. OSHA Rules and Regulation (Federal Register, Volume 37, No. 202, Part II, dated October 18, 1972).

Physical Effects of Hydrogen Sulfide

Percent	0 to 2 Minutes	15 to 30 Minutes	30 Minutes to a Hour
0.001 (10 ppm)- 0.002 (20 ppm)	Detectable by "rotten-egg" smell.	Detectable	Detectable. Maximum allowable concentration for 8-hour exposure without protective mask
0.01 (100 ppm)	Coughing, slight irritation of eyes. Loss of sense of smell.	Disturbed respiration. Pain in eyes. Sleepiness	Throat and eye irritation
0.025 (250 ppm)	Loss of sense smell.	Throat and eye irritation.	Throat and eye irritation.
0.035 (350 ppm)	Irritation of eyes. Loss of sense of smell.	Irritation of eyes and respiratory tract.	Painful secretion of tears, weariness; may cause death in longer exposure.
.045 (450 ppm)	Irritation of eyes. Loss of sense of smell.	Difficult respiration. Irritation of eyes.	Increased irritation of eyes and nasal tract. dull headache. Serious respiratory disturbance.
0.09 (900 ppm)	Coughing, unconsciousness. Serious respiratory disturbances.	Respiratory disturbances. Eye irritation. Unconsciousness.	Serious eye irritation. Slow pulse, rapid shallow breathing. Respiratory paralysis, convulsions, asphyxia and death.
0.10 (1000 ppm)	Unconsciousness.	Death	Death.

Physical Effects of Ammonia Gas

Concentration		Physical Effects
Percent (%)	PPM	
0.005	50	Odor detectable. Prolonged repeated
0.01-0.02	100-200	No adverse effect for average worker. Exposure produces some discomfort but no lasting effects.
0.03-0.07	300-700	Produces nose and throat irritation and eye irritation with tearing. Exposure should be avoided but usually no serious after effects with short infrequent exposures.
0.17-0.30	1700-3000	Produces convulsive coughing and severe eye irritation. Dangerous for even short exposure. May be Fatal.
0.5-1.0	5000-10,000	Produces respiratory spasm; rapid asphyxia. Exposure is rapidly fatal.

Safety Procedure, Equipment and Training

The following procedures apply primarily to drilling operations. For operations on existing wells which are known to not have dangerous concentrations of hazardous gases, the procedures relating to hazardous gases may be eliminated.

Training Program

A scheduled training program for all personnel and supervisors will be conducted at the beginning of the drilling program and for new hires on their first day of work. This program will assure that all personnel will be familiar with the location and proper use of safety equipment. They will be informed of prevailing winds, briefing areas, and evacuation procedures.

Equipment:

The drill site will be equipped with the following safety equipment for H_2S detection and personnel safety:

1. First aid kit, sized for the normal working number of personnel.
2. Stokes litter, or equivalent.
3. Wind direction indicating equipment at prominent locations.
4. Protective breathing apparatus of OSHA Standard for the working crew (Minimum of 2).
5. Wind socks or streamers, positioned to be readily visible from the rig floor and both briefing areas during both night and day.
6. Portable hand operated hydrogen sulfide detectors. These can also be utilized for detection of sulfur dioxide and ammonia. H_2S, SO_2 and NH_3 detector ampules will be readily available for spot checks.

There shall also be an adequate supply of H_2S scavenger chemicals on site to treat the mud system, should the mud become contaminated with hydrogen sulfide.

Warning signs will be available for posting on the access road to the location.

Drills

Drills with breathing equipment will be conducted for each crew, including the mud loggers and mud engineer. Each crew member will be instructed in utilization of the protective breathing apparatus.

Procedures for Operating Conditions

The Drilling Foreman or, in the event he is not present, the Drilling Contractor Tool Pusher in charge of the working crew will have full responsibility for safety precautions and will direct operations necessary to the safety and health of all personnel on the drill site.

Normal Operating Conditions

Prior to drilling into the first zone suspected of possible H_2S gas, all personnel will be instructed on the hazards of H_2S, and the location and the use of safety equipment onsite. They will also be informed of the H_2S monitors, their locations and the related alarm system along with the ventilation equipment, prevailing winds, briefing areas, and evacuation procedures.

Subsequent to penetrating into a possible H_2S bearing zone, a meeting will be held covering the above if not previously held.

Upon drilling into any suspected H_2S zone, the evolved gas will be monitored at the shaker. Should H_2S be present in concentrations between 10 ppm to 20 ppm, all personnel shall be advised.

H_2S and NH_3 Emergency Conditions

After H_2S and NH_3 have been detected, operations will proceed as follows:

Condition I - Potential Danger

Routine checking of the drilling fluid and the monitoring equipment will alert the mud loggers to the presence of hydrogen sulfide in concentrations less than 10 ppm. The mud loggers will notify the Drilling Foremen of the hydrogen sulfide concentrations. No danger to personnel exists as long as H_2S concentration remains below 10 ppm.

General Actions:

1. Personnel will be alert for any changes in H_2S concentrations.

2. All safety equipment, monitors and alarms will be checked for proper functioning.

3. Drills and review of emergency programs will be conducted.

Condition II - Moderate Danger

When H_2S concentration reaches 10 ppm.

General Actions:

1. All personnel on the rig and in the area of the mud pits will be advised to put on their breathing equipment.

2. The Drilling Foreman and the Drilling Engineer will be notified. Their instructions will be followed.

3. Steps to locate the source of H_2S will begin immediately. Required steps to suppress the H_2S will be taken. Drilling will not proceed until the source is determined, the well circulated, and the gas controlled.

4. All nonessential personnel will be sent out of the potential danger area.

5. All gas monitoring devices will be checked and gas monitoring activities with the portable hand operated gas detector unit will be increased.

6. The Drilling Engineer and Drilling Foreman will assess the situation, outline a control program, and assign duties to each person or group as required to bring the situation under control.

7. Access to the drill site will be limited to authorized personnel only.

8. If the H_2S concentration should rise to 20 ppm, warning signs will be posted on the access road(s) to the location indicating:

"DANGER - POISONOUS GAS"

"HYDROGEN SULFIDE - H_2S"

Condition III - Extreme Danger to Life:

This condition is reached when one or more of the following occurs: well control problems, poisonous gas exceeds threshold levels (as defined under "Toxicity of Various Gases"), and loss of well control.

1. All personnel will put on protective breathing equipment.

2. All personnel not required for well control or with perforated eardrums will proceed to the upwind briefing area for evacuation instructions.

3. The Drilling Engineer and Drilling Foreman will assess the situation, outline a control program, and assign duties to each person or group as required to bring the situation under control.

4. Any steps necessary and feasible to minimize environmental impacts will be taken.

5. The agency representatives will be notified.

6. If there is no hope of containing the well under prevailing conditions, and there is a definite threat to human life and property:

   a. The Emergency Plan will be initiated.

   b. The Blowout Action Plan will be referred to and followed.

   c. If all else fails, the well will be ignited. Instructions for igniting the well are as follows:

      i. Two people are required for the actual igniting operation. Both people will wear self-contained breathing units and will have 200' retrieval ropes tied around their waists. One person is responsible for checking the atmosphere for explosive gases, the other is responsible for lighting the well. Personnel not assigned special duties will be kept within the safe briefing area. Those in the safe briefing area will be alert to the needs of the two people assigned to ignite the well. Should either of these people be overcome by fumes, they will immediately pull then to safety by the retrieval ropes.

      ii. The primary method for igniting the well is a 25 mm meteor type flare gun. It has a range of approximately 500'. If this method fails or well conditions are such that a safer or better method is apparent, then the alternate should be used.

iii. If the well is ignited, the burning hydrogen sulfide will be converted to sulfur dioxide which is also poisonous. Thereafter, DO NOT ASSUME THAT THE AREA IS SAFE AFTER THE GAS IS IGNITED. CONTINUE TO OBSERVE EMERGENCY PROCEDURES AND FOLLOW THE INSTRUCTIONS OF SUPERVISORS.

d. Initiate the program to kill, plug and abandon the well.

Emergency First Aid Procedures

While extensive preparations for personnel safety have been made, all personnel should be aware of first aid procedures in the event of an accident. First aid for H_2S and/or NH_3 victims is based primarily on moving the victim to fresh air immediately.

1. Warning - Do not jeopardize your own safety. Always wear a self-contained breathing apparatus while attempting rescue.

2. If people are trapped or unconscious in an ammonia vapor cloud, the ammonia vapor in their immediate area can be reduced considerably by use of a water fog or spray. Since ammonia is water soluble, a water fog or spray is effective in removing the gas from the surrounding atmosphere. a fog nozzle can be attached to a fire hose and the fire hose turned on, playing the stream of spray or fog through the ammonia vapor to form an ammonium hydroxide (NH_4OH) fog, which condenses as it cools and will fall to the ground. This technique could also be used to protect personnel trying to approach a leaking line or valve to make repairs or shut down equipment.

3. If a victim is unconscious and not breathing, immediately move the victim to a safe breathing area and apply an approved method of artificial respiration, continuing without interruption until normal breathing is restored.

4. Symptoms may pass rapidly, but keep the victim warm and transport him to a hospital under the care of a physician as soon as possible.

CASA DIABLO GEOTHERMAL FIELD

BLOWOUT ACTION PLAN FOR DRILLING AND WORKOVERS

To Be Posted on Rig

1. The hole is to be kept full of drilling or completion fluids at all times unless this becomes impossible due to lost circulation.

2. Before starting out of hole with drillpipe or tubing, circulate off bottom until mud is properly conditioned.

3. Close and open rams and annular preventer once per day and log on tour sheet. Pressure test BOPE prior to drilling out of casing shoes and coincident with casing test. Log results on blowout preventer check list.

4. Close blind rams or master valve when out of hole and log on tour sheet.

5. Fill hole at five (5) stand intervals or less while pulling drillpipe out of hole. Count pump strokes or use chart attached to the pit volume indicator to determine the volume required to fill the hole.

6. Watch pit flow or pit level indicator when running in the hole to insure that the volume of mud displaced by the drillpipe is not exceeded.

7. The drillpipe will be run in the hole to the shoe of the casing with the inside BOP installed to perform any of the following operations:

    a. Slip and cut drilling line.
    b. Repair equipment (if possible).
    c. Any foreseen delay.

8. Record reduced circulating pressure at 30 strokes per minute (SPM) or other suitable kick control SPM daily and after each bit change.

9. An approved inside blowout preventer and full opening safety valve with wrench must be immediately available on the rig floor.

10. A blowout prevention drill will be conducted by the rig tool pusher under the supervision of the Drilling Supervisor for each drilling crew to ensure that each person is properly trained to carry out emergency procedures. Assign kick control duties in advance: i.e., mud mixing assigned to floorman, operating pumps assigned to derrickman, etc.

11. At first indication of gain in pit level (or other sign of possible blowout), the driller will immediately do what is necessary to control the well. In most cases this action should be:

While Drilling:

a. Pull kelly up out of rotary table and stop pumps.

b. Open valve(s) on choke line.

c. Close the blowout preventer and gradually reclose choke line.

d. Record shut-in drillpipe (Pdp) and casing (Pcg) pressure. Maximum allowable casing pressure to be dependent on casing depth and burst rating. Allowable pressure for each string to be posted and noted in driller's instructions and on well control data sheet.

e. Inform the Drilling Supervisor and/or proceed with appropriate kick control measures as follows in Step 12.

While Tripping:

a. Install full opening safety valve.

b. Open valve on choke line(s).

c. Close safety valve.

d. Close blowout preventer and gradually reclose choke valve(s).

e. Record shut-in drillpipe and casing pressure. Maximum allowable casing pressure to be dependent on casing depth, mud weight and burst rating.

f. Inform the Drilling Supervisor. Run drillstring in hole as far as practical after first installing inside BOP and reopening safety valve, and/or proceed with appropriate kick control measures as follows in Step 12.

12. Open choke line, start pump and run at 30 SPM or other previously set SPM while adjusting choke line valve to <u>set drillpipe circulation pressure equal to normal circulation pressure at 30 SPM or other previously set kick control SPM. plus shut-in drillpipe pressure.</u>

13. Calculate and mix mud of weight necessary to keep well under control using the well control worksheet and attached nomograph.

Mud weight increase in lb/ft3 =

$$\frac{Pdp \times 144}{\text{Drillstring depth in feet}} + 3 \text{ lb/ft3}$$

Where Pdp = shut-in drillpipe pressure in psi.

14. When sufficient volume of proper weight mud has been prepared, start pumping the weighted mud through the drillpipe at constant kick control SPM which will reduce circulating pressure downward gradually from Pi (initial drillpipe circulating pressure) as calculated on the well control worksheet to Pf (final drillpipe circulating pressure) when drillpipe is filled with weighted mud. Thereafter, hold drillpipe pressure constant at Pf by adjusting choke valve until properly weighted mud returns to surface.

15. When properly weighted mud returns to surface, stop pumps, release any remaining pressure on casing, and check for additional kick before returning to normal operations.

16. Drill new directional hole as a last resort to kill well.

CASA DIABLO GEOTHERMAL FIELD

BLOWOUT ACTION PLAN FOR PULLING AND RUNNING PRODUCTION WELL PUMPS

To Be Posted on Rig

1. The well will be killed and kept dead during the running and pulling operations by one of the following methods:

   a. For wells which are known to have a standing water level below ground level, maintain a flow of cool, fresh water into the well.

   b. For wells which are known to have a standing water level near or above ground level, kill the well with salt water and monitor the water level frequently. Maintain an adequate supply of salt on location and inject more kill fluid if necessary to keep the well dead.

2. A safety valve will be kept on the rig platform at all times and will be used to shut in the column pipe: (1) in the event of a delay in the pulling or running operation; (2) when the well is unattended; and (3) to control a blowout.

3. Use a double ram BOP on the well. Close and open pipe rams once each shift and log on the tour sheet.

4. Close blind rams when pump is out of the hole.

5. Close pipe rams: (1) in the event of a delay in the running or pulling operation; (2) when the well is unattended; and (3) to control a blowout.

APPENDIX B

LANDSCAPE AND REVEGETATION MASTER PLAN

LANDSCAPE AND REVEGETATION MASTER PLAN

FOR

PLES I
GEOTHERMAL PLANT

February 15, 1988

Josephine Mc Proud
landscape architect
(916) 265-6680 P.O. BOX 1494 - NEVADA CITY

TABLE OF CONTENTS

INTRODUCTION

This Landscape and Revegetation Master Plan is the result of intensive research and field study. The intent of the Master Plan is threefold:

1) To mitigate the visual impacts of the proposed geothermal plant, well sites and pipelines;

2) To restore disturbed areas to their natural state; and

3) To control erosion and sedimentation.

Many resources (i.e. California Department of Transportation, U.S. Forest Service, Bureau of Land Management, U.S. Soil Conservation Service, etc.) have been consulted in forming methodologies to achieve these goals. Much of the information obtained from these resources is included as background and substantiation for these methodologies and can be found as exhibits.

The plant site, well sites and each stretch of pipeline have been evaluated regarding impact upon their immediate surroundings, and the most appropriate solutions specified. Photographs are provided where possible to familarize the reader with each area. We are confident that the proposals specified in this report and accompanying plans provide practical and responsive solutions to a complex and challenging project.

METHODOLOGIES

Several methodologies are repeated throughout the plan. These methodologies are used in different combinations, depending upon each area and its specific needs. A brief description of each methodology and its basis for inclusion follows.

Stockpiling of Topsoil

The plan specifies that topsoil will be stockpiled from all graded areas. The top 4 to 6 inches of soil including all plant material is to be scraped off before grading. The included plant material is to be disked, shredded or chopped into pieces no larger than 6 inches. Topsoil and duff is then stockpiled in windrows during construction. After disturbed areas have been recontoured as per the civil engineering specifications, the topsoil and duff shall be spread at a depth of approximately 4 inches. According to Caltrans studies (See Exhibits A, B and C), this procedure has been very successful in providing a planting bed for seedlings with a bank of seed from the native vegetation which allows for the rapid re-establishment of native flora.

Mulching

Mulching of seeded areas increases germination rates while also decreasing runoff and erosion. All seeded areas are to be mulched by one of several methods:

1) All slopes of 4:1 or less shall be mulched with straw spread at a rate of 2 tons per acre.

2) All slopes of 3:1 are to be covered with a straw erosion control blanket #S150.

3) All slopes of 2:1 or greater are to be covered with a

straw erosion control blanket #SC130.

High winds in the plant area make mulching difficult. For this reason, a straw blanket method has been selected for significant slope areas. Straw erosion control blankets afford immediate cover that is not subject to being blown away. The U.S. Forest Service is enthusiastic about using this material but recommends an alternative staking detail for the volcanic soil types in the plant area. The manufacturer has recommended specific blanket types and will have a representative present for the initial installations (See Exhibit P).

Seeding

After the topsoil and duff has been spread over disturbed areas, these areas are to be seeded with a mix of grass and shrub seeds as follows:

15% Artemisia tridentata	Sagebrush
15% Purshia tridentata	Bitterbrush
10% Orysopsis hymenoides `Nespar´	Indian rice grass
20% Elymus cinereus	Great Basin wild rye
20% Agropyron desetorum `Nordan´	Crested wheat grass
20% Agropyron trichophorum `Mandan´	Pubescent wheat grass

While various seed mixes were considered (See Exhibit D), the consulting biologist has determined that the above mix would be the best for both controlling erosion and re-establishing a native stand (See Exhibit E).

After seeding a 20-20-20 fertilizer shall be applied at a rate of 350 pounds per acre. This is in keeping with the Environmental Impact Report recommendations (See Exhibit F).

Seedling Plantings

In some areas additional planting of shrub seedlings are specified. These seedlings are to be contract grown from locally collected seed. Caltrans has completed extensive testings of native shrub planting and concludes that, "The use of container-grown native shrubs for transplanting in Eastern Sierra roadsides appears highly feasible" (Exhibit G).

The shrubs to be grown and planted include:

45%	Artemisia tridentata	Sagebrush
30%	Purshia tridentata	Bitterbrush
15%	Chrysothamnus nauseosus	Rubber rabbitbrush
10%	Prunus andersonii	Desert peach

Percentages and spacings are designed to match natural plant distribution as closely as possible. Caltrans and the U.S.F.S. have also had success with plantings of Jeffrey pine (Pinus jeffreyii) seedlings (Exhibit C). Reforestation with pine seedlings is specified in some of the more heavily forested areas of this project. Timing of seed collection, seedling planting and propagation techniques have been addressed in the specifications as per recommendations of Caltrans (Exhibits H, I and J) and the U.S.F.S. (Exhibit K).

The contractor is required to guarantee a success rate of 70% for a five year period. This is within the range of success on Caltrans plantings.

Container Grown Plantings

In some areas, plants larger than seedlings are recommended for visual mitigation. Careful consideration has been given to selecting plants which are native to the Eastern Sierra area. Since the availability of nursery-grown natives is somewhat limited, a strict adherence to the "natives only" rule seems impossible. Rate of growth, screening properties and availability were also factors in plant selections (See Exhibits L and M).

Container-grown plantings include:

Ribes cereum - Squaw currant

Salix exigua - Native willow

Rosa woodsi - Wood rose

Amelanchier alnifolia - Serviceberry

Pinus jeffreyii - Jeffrey pine

Quercus vaccinifolia - Huckleberry oak

Tree Spade Transplanting

An important part of the landscape plan involves transplanting native pines from one location on the site to another. Trees of appropriate size and accessibility are in abundance on the areas slated to be graded. In addition, soils reports indicate favorable soil structures for this operation in most areas.

The obvious advantage to transplanting is immediate visual mitigation and the opportunity to use native, site-adapted plant material. While it does not appear that this type of operation has taken place previously in the Mammoth area, tree spade transplanting has been very successful elsewhere in the Eastern Sierra (See Exhibits N and O).

Transplanted pines range in height from 8 to 20 feet and will be guaranteed for a period of one year. Locations have been selected to conceal plant facilities from the immediate view, as well as the distant view.

Irrigation

Irrigation to seeded and planted areas is provided to ensure seed germination and successful establishment of seedlings and container-grown stock. A temporary overhead system will be installed as indicated on the plans. This system will remain in place for at least a two year period for appropriate establishment of vegetation.

A permanent drip irrigation system will be installed to container-grown stock and transplanted specimens. Water usage will be kept to a minimum.

Painting

Colors will be selected for painting of pipelines and other structures. These colors will blend with the natural occurring tones in each specific area. Camouflage techniques are recommended in some areas, involving the use of several colors to create a texture or pattern more in keeping with the natural surroundings.

Trenching

Although more expensive than other techniques, laying pipe in trenches is recommended in some areas which are especially visually sensitive. Trenching ensures that the visual impact of pipelines, in selected areas, is mitigated from the onset. Erosion control and revegetation is specified on all areas disturbed by trenching.

Retaining Walls

Where the new grade encroaches significantly into the drip line of existing trees, retaining walls are included. These walls ensure the survival of many existing trees which would otherwise need to be removed.

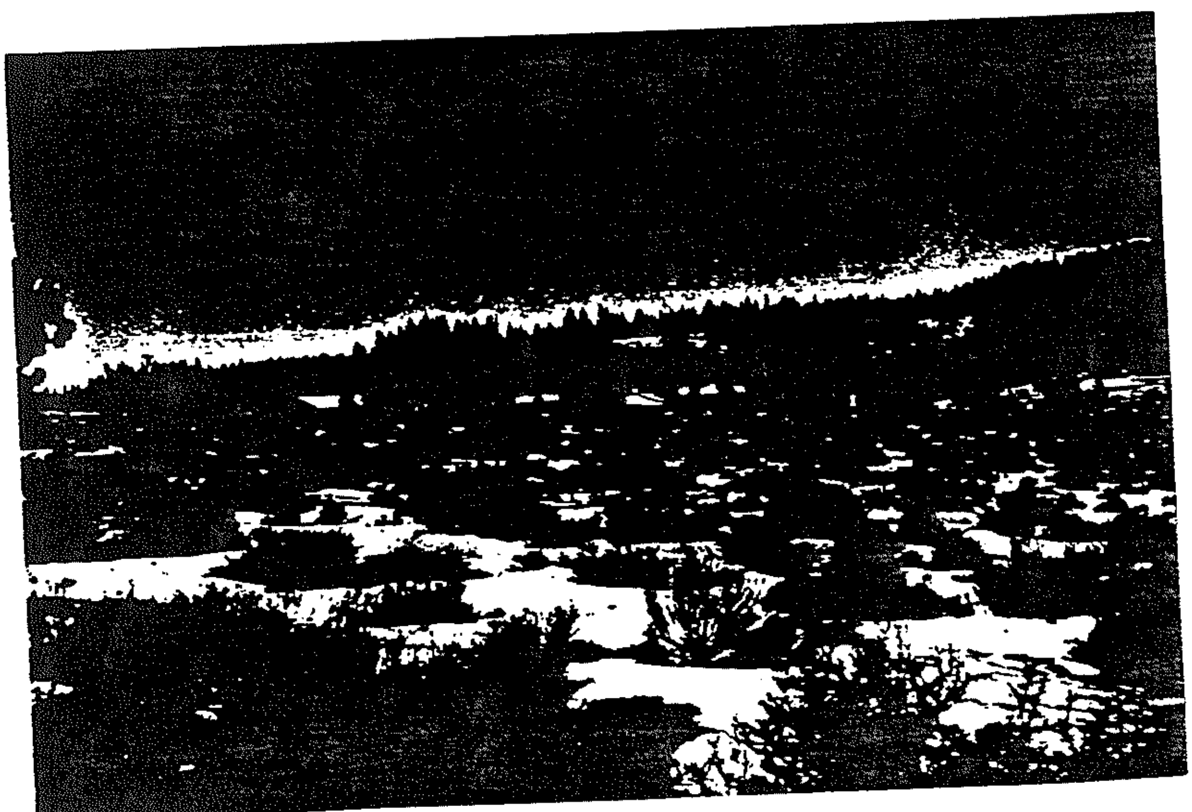
WELL SITE AND PIPELINE TREATMENTS

Pipeline Sections P-A, P-B, and P-C, Well Sites SF 25-32, SF 35A-32, SF 34-32

All of these improvements run through relatively level terrain to the south and east of the existing plant. This terrain is well covered with a mix of bitterbrush, sagebrush, rabbitbrush and desert peach as well as scattered Jeffrey pine. Seeding and seedling planting should restore disturbed areas to this state.

Transplanted Jeffrey pines will help to buffer pipelines and well sites in this area from adjacent roads (Highway 203 and Old 395). The view from Highway 395 into these facilities as well as the existing plant will also be broken by these tree plantings.

Pipelines and well heads should be camouflage painted in sage green and sand brown.

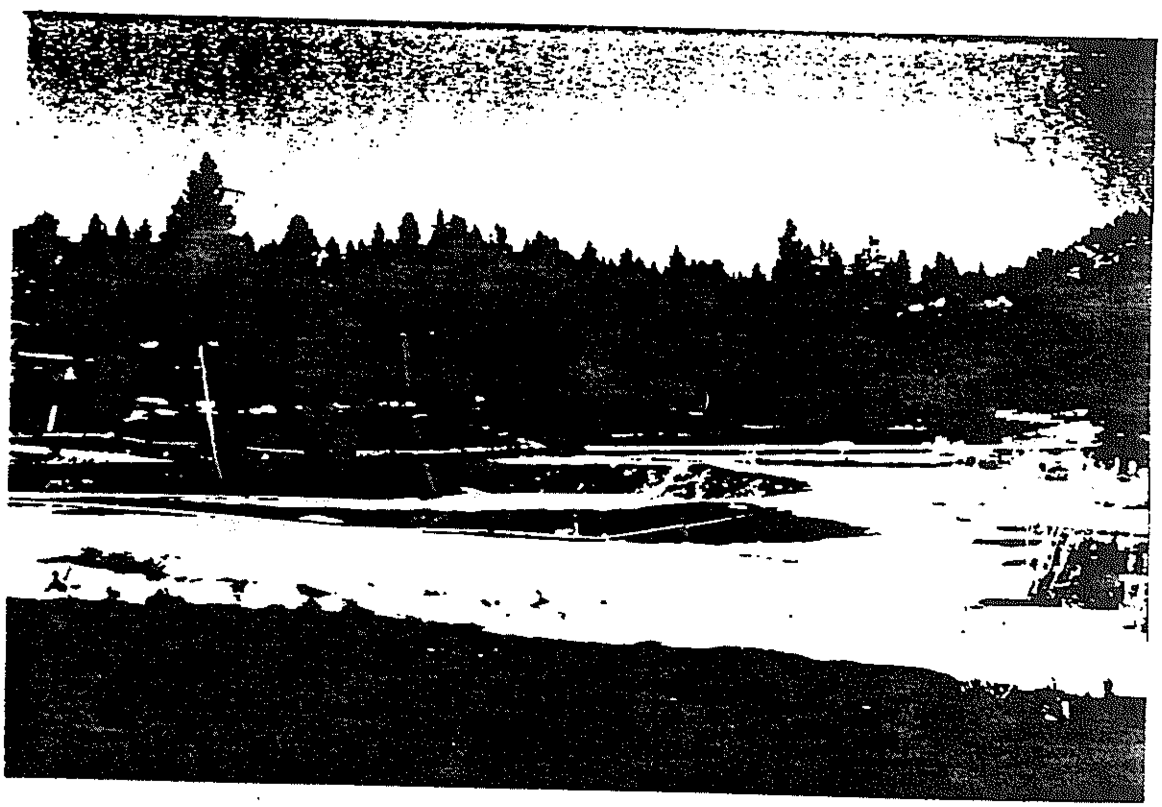


Pipeline Section P-D

This area was previously graded for drainage sumps. The current plan calls for these sumps to be filled and revegetated. Level terrain and proximity to Old 395 make this section of pipe highly visible.

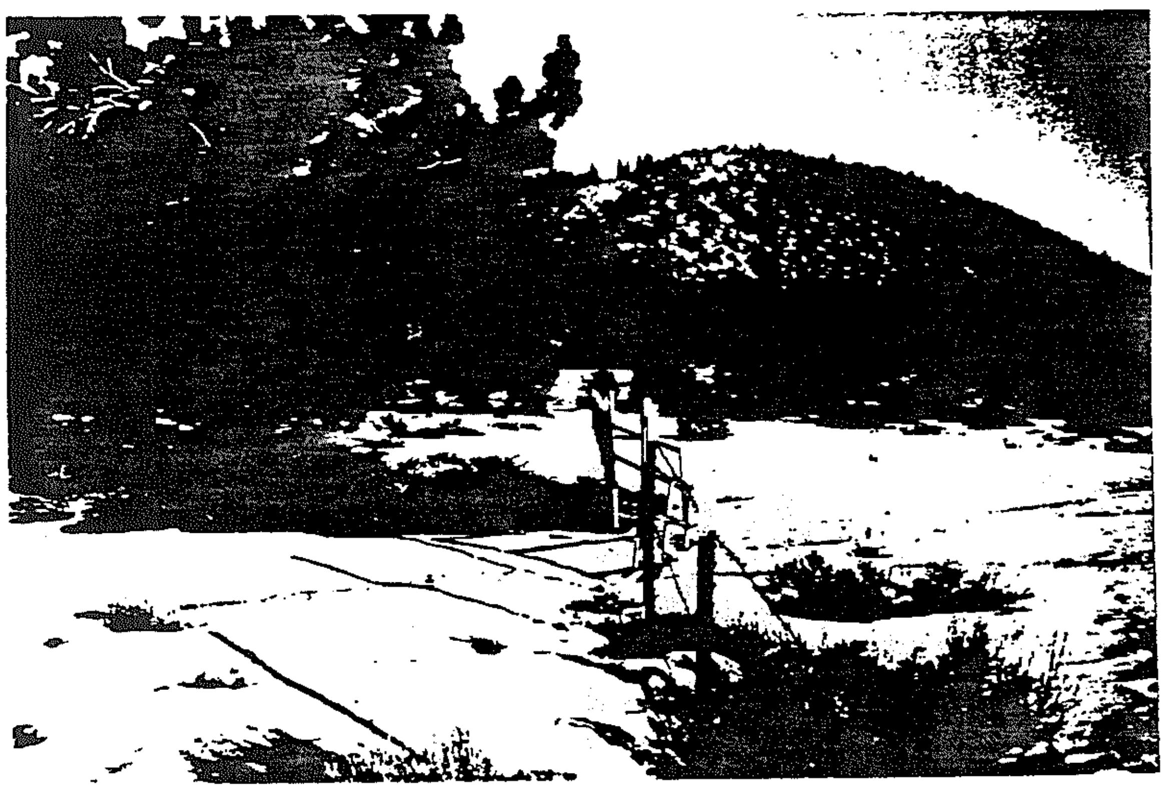
Plantings of native willow (Salix exigua) will modify these visual impacts. Natural drainage patterns in this area should help make these plantings successful.

Additional plantings of ponderosa pine and serviceberry in the drier areas will also help to conceal the pipe.



Pipeline Section P-E

This section is highly visible, as it runs parallel to Old 395 through sparsely vegetated terrain. For this reason, pipe trenches have been designed for immediate concealment of pipes. All disturbed areas are to be seeded and revegetated with seedlings.



Pipeline Section P-F and Well Sites SFI 54A-32, SFI 54-32, SFI 64-32

This area is surrounded by heavy tree cover and removed from roads or other visual access points. The need for visual mitigation is therefore minimal. All disturbed areas are to be seeded and planted with Jeffrey pine seedlings.

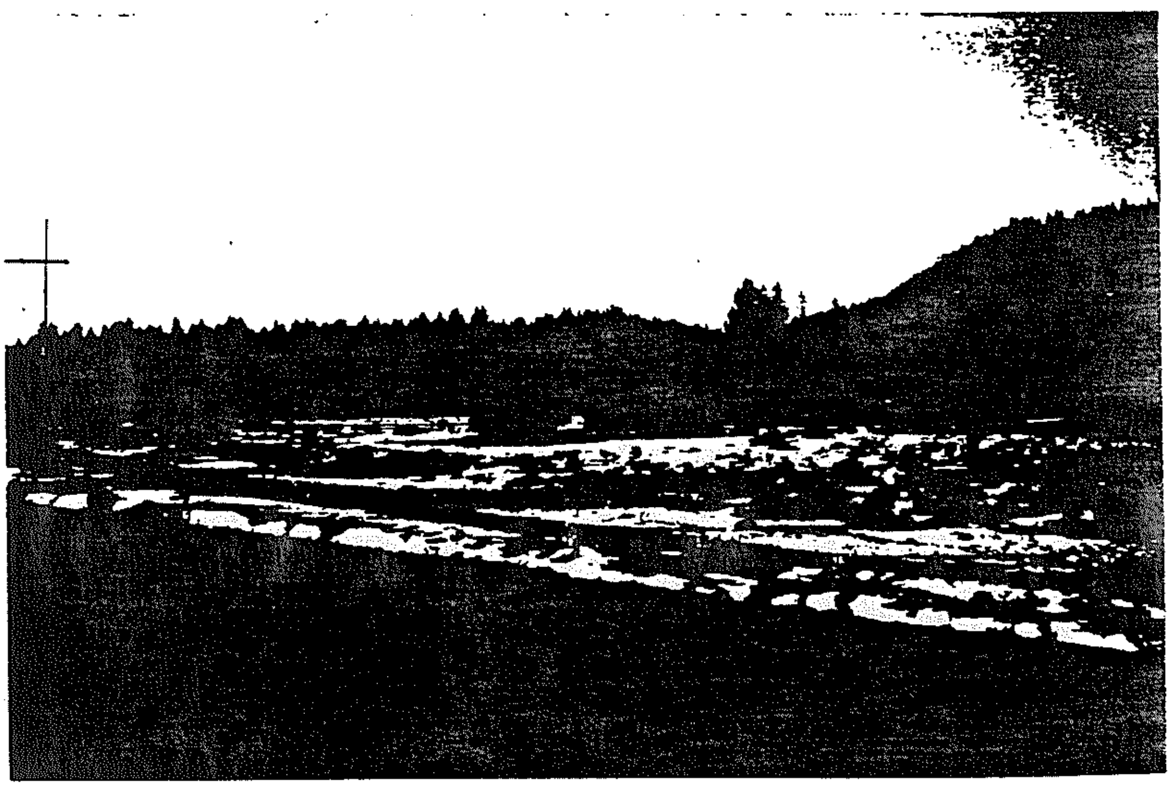
Pipelines and well heads should be painted with a dark grey-brown tone to blend with the soils and tree trunks.

PLANT SITE LANDSCAPING

The plant site is located in a relatively well-forrested area about 600 feet from Old 395. Existing tree cover will help to mitigate visual impacts. Additional transplanted pines have been specified in clearings. These transplants will help to fill views into the plant site. Some trees have been placed relatively close to the road at critical vantage points.

Fill slopes to the south of the plant will be seeded and planted with native shrub and Jeffrey pine seedlings.

The control room building will be landscaped with shrubs.



APPENDIX C

Hydrologic Study for the PLES I Geothermal Project

Prepared by

Berkeley Group Inc. (BGI)

AUGUST 1988

TABLE OF CONTENTS

Table of Contents, cont'd.

List of Figures

List of Figures, cont'd.

List of Tables

INTRODUCTION

The following report is in the form of an appendix due primarily to its length and, in part, to its technical nature. The discussion in the main body of the joint EIR/EA on hydrology was necessarily generalized, and summarizes the data and conclusions contained in this appendix. The important issues concerning potential impacts of geothermal power projects by production to both thermal and non-thermal water in the southwest caldera area require a more rigorous approach and analysis than is usually needed for such an environmental review. While there is no way to precisely predict potential impacts on the hydrologic system on the basis of current data, utilization of the models allow an analysis of reasonably likely potential impacts.

Although a considerable amount of data directly and indirectly related to the hydrologic system has been and is continuing to be collected by governmental agencies and industry, the exact nature of the hydrologic system and how the subsurface system and the surface features are interrelated cannot be defined at this time. However, sufficient information is available to develop reasonable scientific models of the system.

This report is not intended to replace or subsititute for an environmental document in format or content. It is intended as supplemental information. Refer to the main EIS document or related EIR/EA documents for details on issues, impacts, proposed mitigations and their effectiveness.

1.0 AFFECTED ENVIRONMENT

1.1 Overview of Hydrothermal System

Hydrothermal activity is believed to be present throughout the Long Valley caldera, but is most apparent in terms of surface manifestations and shallow, high temperature zones in the south and southwestern region. This includes the area bounded by Casa Diablo Hot Springs to the west and Hot Creek Gorge to the east.

The complex fault-controlled geologic structure and thermal fluid distribution has been subject to study for many years, but is not clearly understood. Identification of the origin of the thermal fluids in each of the areas of concern (Casa Diablo, Fish Hatchery, and Hot Creek Gorge) is important for an understanding of whether increased production at Casa Diablo will affect surface or subsurface hydrologic features.

A variety of methods have been used by numerous investigators in an attempt to characterize the hydrothermal system. These investigators include geologists, reservoir engineers, geochemists, hydrologists and geophysicists from both government agencies and private industry. Many of the studies referenced were conducted for purposes other than to assist in the development of a hydrologic model. For example, several monitoring programs were begun in an attempt to detect changes due to subsurface magmatic activity and the possibility of a near surface magma chamber. All of them have contributed to a growing data base from which to compare past, present and future changes occuring within the Caldera hydrologic system.

1.2 Surface Resources

Surface resources in the south and southwest Long Valley area include cold water streams and numerous springs of varying temperatures. The PLES I Project area is located in the Mammoth/Hot Creek drainage basin. The springs at issue are located in three general areas: 1) at Casa Diablo near the proposed PLES I site; 2) the Hot Creek Fish Hatchery area; and 3) the Hot Creek Gorge area. The Colton Spring area is also of interest. It is located between the proposed project area development and spring groups of concern. This spring is of interest due to potential use for monitoring the hydrothermal system and will be discussed in some detail.

1.2.1 Creeks & Surface Drainage

The major surface water features in the Western Long Valley area are shown in Figure 1-1. The Owens River is the major drainage feature for the entire Long Valley Area with tributaries from several major drainage basins of which the Mammoth Basin is one. The Mammoth Basin contains Mammoth/Hot

Creek and a few lesser tributaries. Mammoth/Hot Creek carries all surface drainage from the Mammoth Basin to the Owens River. The Owens River discharges to Crowley Lake approximately nine miles southeast of the Project area.

The primary surface drainage feature in the PLES I Project site is an unnamed ephemeral tributary to Mammoth Creek (Figure 1-2). This creek originates near U.S. Highway 395 approximately 0.5 miles northwest of the Casa Diablo area and joins Mammoth Creek approximately 0.4 miles southward.

The intermittent stream discharge rate varies seasonally from zero to approximately forty cubic feet per second. (See Table 1-1 for a comparison with flows of Mammoth/Hot Creek.) Flow rate and fluid chemistry are affected by the relative contribution from the Casa Diablo Hot Springs located nearby. In years with above normal late season precipitation this tributary to Mammoth Creek flows year-round. Yearly and seasonal variations in snow and rainfall amounts are the major cause of fluctuations in the flow of this stream. A significant, though unmeasured, amount of creek flow is believed lost into the thin alluvium between Casa Diablo and Mammoth Creek.

There is no published chemical analysis available for the waters of this tributary. However, such an analysis would be likely to show a considerable variation in mineral content depending upon the relative influx of hot spring waters and seasonal changes associated with runoff.

Biological contaminants (e.g., fecal coliform) as a result of seasonal cattle grazing probably render the creek waters unfit for human consumption even during high flow periods. No such consumptive use of the tributary currently exists or is planned. The intermittent stream through Casa Diablo joins Mammoth Creek at a small meadow between new U.S. Highway 395 and old Highway 395. Intermittent stream waters mix with Mammoth Creek at this point allowing potential contaminants to be carried downstream to Hot Creek and eventually to Crowley Lake.

The flow in Mammoth Creek has been monitored since 1932 by LADWP at a flume (MCF) a short distance downstream from the inlet of the intermittent stream as shown on Figure 1-3 (California Department Water Resources; 1967, 1973). Discharge rates measured at this point vary between 3,000 to 40,000 acre-ft/year and average approximately 17,000 acre-ft/yr. The quality of the water in Mammoth Creek is generally very good above U.S. Highway 395, but begins to degrade as hot spring discharge and grazed land runoff contaminants increase downstream (Setmire, 1984). Table 1-2 is a summary of selected measurements indicative of seasonal changes in the Mammoth Creek flow and quality. These measurements show that a portion of the flow is lost to shallow ground waters in the meadow area between

U.S. Highway 395 and the Hot Creek Hatchery. An unknown quantity is diverted during summer months by a local rancher which may account for some or perhaps all of the loss, depending upon the time of year.

Hot Creek begins at the confluence of Mammoth Creek and the effluent from the spring groups supplying the Hatchery. Effluent from the Hot Creek Hatchery contributes approximately 17-28 cfs to the flow of Hot Creek. The flow rates shown in Table 1-2 reflect surface drainage contributions to the creek (Sorey, 1976) (Farrar, 1985). Depending upon daily operations at the Hatchery, a short term increase in some chemical constituents from Hatchery operations may be introduced to Hot Creek with the spring effluent (personal communication, Hot Creek Hatchery manager, 1987). Since this additional volume of flow enters below the Hatchery, its contribution to total stream flow is not continuously measured except as total stream flow at the flume at Hot Creek Gorge (HCF). The Hatchery springs and chemistry are discussed in a following section of this report.

The last point of measurement for surface waters from the Mammoth Basin area is at the flume below Hot Creek Gorge (HCF). This site has been used to gauge stream flow since 1923 and has most recently been used to estimate the rate of discharge from the Hot Creek Gorge springs relative to total stream flow.

Stream flow at this flume (shown as HCF on Figure 1-3) varies between 25,000 to 80,000 acre-ft/year and averages approximately 40,000 acre-ft/year (CDWR, 1967). Of this total 7,000 acre- ft/year (average 9.5 cfs) are contributed by thermal springs in the gorge (Farrar, 1985). Chemical analysis of water samples taken at the flume indicate most of the dissolved mineral load is due to discharge from thermal springs along Mammoth/Hot Creek (CDWR: 1967, 1973) (Setmire, 1984). As Table 1-2 shows, the temperature and conductivity of Mammoth/Hot Creek increase downstream as the various springs join the total flow. Under the present conditions, the quality of the water in Hot Creek at this point (HCF) may not be suitable for human consumption (Setmire, 1984).

1.2.2 Thermal Springs

Numerous hydrothermal features are located between the Casa Diablo area, near the proposed PLES I Project site, and the Hot Creek Gorge area (Figure 1-3). These hydrothermal features consist of springs, with various temperatures and discharge rates, and gas emitting fumaroles. Some of these features maintain a relatively constant level of activity from year to year. Others are known to be intermittent.

1.2.2.1 <u>Casa Diablo</u>

There are several surface thermal features in the Casa Diablo area, and most are located to the west of the PLES I Project area (Figures 1-2 & 1-3). The discharge rates, chemistry and temperature of these features may be closely related to the subsurface hydrothermal conditions.

Though the main surface features near Casa Diablo are on private land, the geothermal developers are aware of the potential relationship between springs and subsurface conditions and have cooperated in the monitoring of the Casa Diablo springs and fumaroles by the U.S. Geological Survey (Farrar, 1985, 1986). The monitoring consists of periodic sampling of several vents, and spring discharge measurement of the main feature, referred to as the Casa Diablo Geyser (CDG). While minor interruptions of flow rate measurements have occurred due to equipment problems, and the results thus far show a distinct correlation between spring discharge and tectonic strain events, as shown by the large increase in flow rate three weeks before a November 1984 earthquake of magnitude 5.8 nearby (Figure 1-4). A less distinct correlation is shown in the 1985 data between existing geothermal well production and total spring discharge, including CDG and two lesser springs (Figure 1-5). The period mid-March through mid-August (1985) shows a possible relationship, but is not consistent through the latter part of the year. The spring ceased to flow in April, 1987.

These more recent events are similar to historical accounts which date back to the late 1800's reporting a wide range of activity from "geysering" 10's of feet high to no visible discharge (LBL, 1984). Recent estimates of total spring discharge vary from 0 to 1.4 cfs with most of the flow from the main vent (CDG). Temperatures between springs vary, with conductive cooling having a greater effect on low flow rate features. The temperature measurements range from 80° to 94°C (Table 1-3).

Chemical analyses can be of use when attempting to correlate the source of spring waters emanating from each feature to subsurface conditions. Hot spring fluid chemistry is characterized as sodium bicarbonate-chloride waters with a total dissolved solids content of 1000 to 1400 mg/l. The data in Table 1-3 indicate the chemistry of each spring is affected by discharge rate and temperature as boiling in the near-surface concentrates constituents in the fluid, which may then partially re-mix with condensate. Published analyses also indicate a complex relationship with possible mixing of cooler less saline shallow groundwaters (Mariner & Wiley, 1976). Efforts at correlation have been based on comparison of prominent chemical species that are conserved during mixing and boiling, such as:

Chloride (Cl), Lithium (Li) and Boron (B) (Table 1-3).

Data in Figures 1-6 and 1-7 of Cl/B and Cl/Li ratios indicate that the ionic ratios, as indicated by the straight line, are similar between the various areas. The data also shows a trend of decreasing ionic concentration away from Casa Diablo, but with ionic ratios preserved (Shevenell, et al, 1987 in print). These data have been used to support models describing a shared source of fluids for the Casa Diablo springs, Hot Creek Gorge and Hatchery springs. A more complete description of the hydrothermal system model based upon chemistry data is given in the Subsurface Resources Chemistry section, below.

Stable isotope data is plotted in Figure 1-8, for the springs identified in Figures 1-6 and 1-7. Large isotope differences are apparent between the Casa Diablo springs, deep wells, and CDG. Figure 1-8 data suggests a more complex thermal fluid chemistry than can be accounted for by simply assuming dilution of thermal waters with non-thermal fluids. A combination of boiling and mixing of thermal and non-thermal fluids is required to explain the isotopic data. Though there exists controversy amongst experts as to whether the conditions required to achieve the composition, by this mechanism, exist. These results were then used to support a lateral flow model based on a shared fluid source.

Another explanation has been proposed based on upwelling along fault zones. This upwelling/fracture flow model attributes differences in isotope chemistry between the thermally active areas to each having a different origional metoric source of fluid that is upwelling from near or in deep basement rocks (Mesquite,1986). A more detailed explanation of this theory is given in the comments included in the Final EA/EIR for the PLES-I project.

1.2.2.2 Colton Spring Area

This area consists of three groups of small springs located approximately one mile southeast of Casa Diablo along Mammoth Creek. Their combined discharge is small and the water is not currently used in any way, although they contribute to the flow of Mammoth Creek. However, their markedly different temperatures and chemical compositions are of interest in attempting to define the local hydrothermal system and to determine whether changes due to increased production at Casa Diablo will extend to the Colton Spring area.

Colton Spring (CS in Figure 1-3) may be affected by the same tectonic processes that affect the Casa Diablo Springs. Colton Spring appeared suddenly at approximately the same time as a large scale seismic event in 1980. Its discharge, estimated at 0.021 to 0.029 cfs between August and December 1985, may fluctuate due to natural causes. The temperature (92.9° to 93.8° C), and chemistry (Table 1-3) are very similar to CDG.

Meadow Spring, located in the meadow southwest of old Highway 395, is cooler (52.2° to 62.5°C) with low, intermittent discharge. The chloride content and ionic ratios (Table 1-3, Figures 1-6 and 1-7) of Meadow Spring suggest that it could result from mixing of waters similar in composition to CDG and that of local, near-surface ground water. The choice of a chemical composition to use as representative of cold fluid for mixing models can significantly affect results and is therefore the subject of some debate. Cooler shallow groundwater is likely to have several sources of recharge, depending upon the specific area in question (e.g. meteoric water, local stream leakage, migration in shallow subsurface from nearby mountains, etc). These may have similar low levels of mineral constituents, but not necessarily similar isotopic concentrations.

Chance Spring (CHS on Figure 1-3), with a temperature of 18° to 20°C, issues from a group of vents along Mammoth Creek. It has a relatively high discharge (approximately 0.81 cfs), and a chemical composition closer to that of meteoric water than other nearby springs, suggesting a small thermal water component. Chemical analyses are not performed at regular intervals and are not presented in Table 1-3. Two analyses (one in 1963 and one in 1984) are presented in Table 1 of Farrar, et al (1985).

1.2.2.3 Hot Creek Fish Hatchery Area

The four major spring groups in the hatchery area, AB, CD, H-I and H-II, III (also denoted as H-1 and H-2,3), discharge from the edge of a basalt flow (Figure 1-9). These are the principal sources of water for Hatchery operations. The discharge temperatures and chemistry of the spring groups suggest a small thermal component which differs among the spring groups (Table 1-3). If this component was reduced or lost it could lower the average temperature of the spring by 2 to 3 degrees Centigrade (Sorey, 1976). The spring temperatures fluctuate naturally. This amount varies for each spring. Figures 1-10 through 1-13 show the average monthly spring temperatures since 1976 as measured by the CDFG. With the exception of the warmer springs, (AB and CD) they show a continuing decline in recent years which begins prior to MP I start up. Yearly temperature fluctuations vary from 4°F (2.2°C) to 0.5°F (0.3°C) depending upon the spring group. In general, the lower temperatures correspond to years with above normal annual precipitation.

Flow rates also vary considerably with seasonal rainfall. Figure 1-14 shows the average monthly spring flow rates for the AB springs. The AB flow rate data collection was initiated in late 1984 and is financed by the Mammoth/Chance geothermal project developer. This spring group shows the influence of a high rainfall year, with flow rate change up to 75%. The only other spring currently monitored for flow rate is spring H-II, III. It shows only 25% change in high rainfall years, such as occured in 1986. This data is to be published shortly by the USGS.

Effluent from the Hot Creek Hatchery (from all four spring groups) contributes a significant portion of the total Hot Creek flow above the gorge during periods of lowest Mammoth Creek flow. Total effluent from the Hatchery springs varies from 17 to 28 cubic-feet/second (cfs) depending upon season (CDFG, 1988).

1.2.2.4 Hot Bubbling Pool

Another surface feature of interest in the area is the Hot Bubbling Pool (HBP), located approximately one-half mile north of the Hot Creek Hatchery (Figure 1-3). This spring-fed pool is of interest because its fluid characteristics are markedly different from the Hatchery Springs, yet it is an equal distance from the Casa Diablo area. The pool is elliptical in shape, measuring roughly 50' x 100'. There is currently no surface discharge from the pool, but the water level and temperature fluctuate regularly at intervals of approximately 7 hours

(Farrar, 1985). The period of these fluctuations is not consistent with earth tides.

The temperature and ionic chemistry of HBP fluid is very similar to that from Casa Diablo area springs (Table 3-1), but simple dilution does not account for different ionic ratios or isotopic concentrations. The Hot Bubbling Pool water level is also believed to display a relationship to local tectonic strain mechanisms and was observed to have drained for a short period after a series of earthquakes in May 1980 (LBL, 1984). The location of the HBP, ajacent to a major fault zone, bears a similar relationship to the structure and occurance of springs at Casa Diablo. Because of the more direct connection to deeper thermal fluid, the HBP could serve as an indicator of changes in subsurface conditions in that area, perhaps registering changes sooner and to a greater degree than would be seen at Hot Creek Gorge springs or the Hatchery springs. No changes in temperature or chemistry of the HBP spring are known to have occurred.

1.2.2.5 Hot Creek Gorge Springs

Several springs discharge at varying rates along Hot Creek Gorge (Figures 1-3 and 1-15). These are associated with a graben structure bounded by two unnamed faults. Temperature measurements have varied from 73° to 94° C (Table 1-3). Total spring flow from this area cannot be measured directly since the major contributing vents are submerged in the creek bed. However, a close estimate of flow rate can be made from chemical flux correlations using the total flow of Hot Creek and its chemical load, measured at the USGS maintained flume (HCF) below the gorge (Farrar, 1985) (Eccles, 1976) (Sorey & Clark, 1981). Such calculations have yielded an average for total Hot Creek spring discharge of 9.5 cfs with a high of 11.6 cfs in 1980, attributed to seismic activity at that time (Farrar, et al 1985). Increases in total flow, apparently due to tectonic strain relationships, appear suddenly and slowly die off returning to normal flow patterns. Recent chemical analyses of the major vents are shown in Table 1-3. They display similar chemical compositions. After allowing for dilution the ionic compositions and ratios are comparable to the Hot Bubbling Pool and Casa Diablo area springs (Figures 1-6 and 1-7). The isotope ratios show significant differences, as described above in the Casa Diablo area discussion and shown in Figure 1-8. No changes in temperature, flow rate or chemistry have been seen in the Hot Creek Gorge springs as a result of MP I power plant operations.

1.3 Subsurface Resources

Subsurface resources in the south and southwest region of the Long Valley caldera include shallow, cold, local groundwaters and deeper thermal fluids. These waters occur at various depths and temperatures. Due to the complex nature of the geologic structure and temperature distribution, the movement of colder groundwater and thermal fluids is not well defined, but the two are believed to interact to some degree. While there is little data on the shallow, cooler water, it is known to occur in alluvial material, which is discontinuous and of varied thickness in the region. More data is available on thermal waters. This data indicates thermal waters circulate in fracture zones allowing mixing to occur with cold groundwater. It may not be possible to characterize these fluids as occuring in distinct vertical zones as might be the case in a layered sedimentary basin.

1.3.1 Shallow, Fresh Groundwater

Shallow, cooler groundwaters are known to occur in the patches of alluvial fill in the area. At least two of these areas located in the Mammoth Basin, are of interest regarding the PLES I Project. The first is a thin, variable layer of alluvial fill at Casa Diablo (0-40 ft thick) which contains cooler groundwater. This water is believed to occur only northwest of the existing MP I power plant and may be connected hydraulically to the shallow basin containing small ponds upslope near U.S. Highway 395. A shallow well in this alluvium is pumped intermittently at a flow rate up to 50 gpm to fill a tank for the existing MP I power plant. It is not used for drinking due to high concentrations of some minerals and possible biological contaminants, but is used to supply water for irrigation and fire protection. A chemical analysis is provided in the PLES I Plans of Operation (PLES, 1986). No analysis of biological contaminants was available.

The alluvial fill becomes much thinner southward of the existing MP I Power Plant and the shallow groundwater may not be continuous in this direction. Shallow groundwater is likely to occur throughout meadow areas near Mammoth/Hot Creek due to its proximity to creek waters. Groundwater may flow near the surface toward the large meadow area east of U.S. Highway 395 extending to Hot Creek Gorge.

Wells located in this meadow indicate a depth of alluvium and lake sediments up to 600 feet (Figure 1-16). These sediments contain groundwater which varies in temperature, but temperature generally increases with depth so that no distinct zones are discernable. Shallow groundwater is likely to be recharged, in part, by water from Mammoth/Hot Creek that runs through the meadow and by meteoric waters flowing in the subsurface from surrounding higher elevations. Possible thermal water interaction is indicated by the elevated temperatures in shallow wells and in the Hatchery springs.

Shallow groundwater from this area probably flows east with the sloping topography. Some of this flow reaches the surface at the Hatchery and between the Hatchery and Hot Creek Gorge which contributes to stream flow. Shallow subsurface flow may then continue toward the Owens River and Crowley Lake.

1.3.2 Subsurface Thermal Resources

Thermal fluids have been located, primarily, in the south and western regions of the Long Valley Caldera. The areas of interest to the PLES I Project are: the Casa Diablo area, the Mammoth/Chance-Fish Hatchery area, and the Hot Creek Gorge area. Well drilling in these areas has identified at least one high temperature fluid zone and has inferred a cooler zone beneath it. Except for well UM-1 at Casa Diablo no other wells drilled in these areas penetrate through the top of the underlying cooler zone to verify the nature of fluids or temperature distributions below.

1.3.2.1 Casa Diablo Area

Well temperature measurements of wells in the Casa Diablo area have identified at least two vertically separate temperature zones. An upper high temperature zone (330-350°F) at 400 to 700 ft. depth, and a lower temperature zone (250-300°F) extending to approximately 2000 feet. A possible third "zone" (300-310°F) is shown in well UM-1 (Figure 1-17). The depth of this zone is approximately 2000 to 2600 feet. Temperatures at depths over 2600 feet tend to be slightly lower and generally isothermal.

As the profiles in Figure 1-17 show, the high temperature zone does not remain at a constant elevation even in the localized Casa Diablo area. The temperature regions do not appear to adhere to distinct stratigraphic boundaries. The upper high temperature zone occurs in various levels of the Early Rhyolite unit and the lower temperature zone extends across the contact between Early Rhyolite and Bishop Tuff. This implies that stratigraphic boundaries may not greatly influence fluid distribution. It is not clear whether the various temperature zones are hydraulically connected. Any such connection involves the fault-fracture network in the area and is complicated by thermodynamic processes.

The likelihood of hydraulic connection between zones and the definition of boundaries is of importance when attempting to model the potential for impacts from the PLES I development on the Hatchery or Hot Creek Gorge springs. Two distinctly different models relating to the source and distribution of thermal fluids beneath the southwestern caldera have developed.

One conceptual model (upwelling/fracture flow model) is based upon the assumption that the source of thermal fluids is thermal upwelling from depth near or in the basement along each prominent fault zone. This would suggest poor lateral hydraulic connection between regions with shallow geothermal fluid. It further implies that there is little potential for direct hydrologic connection between thermal features or reservoirs in the Casa Diablo, Hatchery and Hot Creek Gorge areas.

A second conceptual model (lateral flow model) is based upon the assumption of relatively continuous lateral flow of thermal fluid between the thermally active areas which orginates near the western or southwestern edge of the caldera. This model implies that a direct hydraulic connection exists between the production/injection zones at Casa Diablo and down gradient thermal reservoirs and surface features. Thermal fluids rise from depth in the western caldera and travel horizontally in the shallow (0-2000 ft depth) subsurface. Surface activity and near surface mixing with cooler groundwater occurs in major fault/fracture zones similar to the mechanism described for the previous model.

1.3.2.2 Pressure Data

Whether one or the other proposed conceptual model is correct is of minor importance provided pressure and temperature changes within the hot producing zone, as a result of power plant operations, remains small. If the power plant operation does not significantly change local pressure distributions, then it will not affect the flow or pressure distribution in other areas. Pressure measurement equipment in Casa Diablo wells has recently been upgraded and measurements are now accurate enough for the detection of small scale trends. The improved data quality has confirmed that only small scale effects (1 to 3 psi) take place as a result of present MP-I operations. This response is very low compared to other commercially productive geothermal reservoirs and has led to increased interest in further development (i.e. PLES-I,MP II and III).

The improved data has also allowed more precise calculation of reservoir parameters. This data allowed a value for kh (reservoir permeability-thickness product) to be more confidently chosen for reservoir pressure response calculations presented in Chapters 2 and 3. This value (500,000 md-ft) would generally be considered quite high, but recent test results suggest a kh more than double this value. The value of 500,000 md-ft was chosen to represent the extreme case scenairo. It also takes into account the fact that the calculations in

Chapter 2 represent an area wide approximation. It is likely that an average kh for the region is less than at Casa Diablo since the latter is located directly in a fault zone.

Pump testing of SF35-32 at rates of up to 2100 gpm showed higher productivity with a small pressure drop in SF35-32 and no measurable interference with existing wells (Mesquite, 1986). Chemistry, temperature, and pressure data suggest that both new wells are in communication with the same reservoir as the MP I production wells. However, pressure data from SF65-32 does not indicate direct communication with the injection reservoir since, under simple model assumptions, its pressure should rise 1 to 3 psi due to current MP I injection on the east side of the Casa Diablo area, rather than decrease approximately .1 psi as observed. The pressure in well SF35-32, however, does respond as predicted by the calculations.

1.3.2.3 Temperature Data and Structure

Temperature profiles from selected wells in the area are shown in Figure 1-17. The location of a shallow (400-700 ft deep) high temperature zone in the Casa Diablo area is obvious. A thicker, slightly higher temperature zone can be seen in the Shady Rest well. High temperature zones similar in depth and extent to that found in Casa Diablo wells are seen in the Hatchery and Hot Creek Gorge areas. It is possible that fluid could be flowing laterally from the Casa Diablo area to the Hot Creek Gorge area, cooling along the way. However, a simple lateral flow model does not explain the cooler temperatures in Wells M-1, M-4, and M-5. Subsurface structural complexity, known from drilling in the Mammoth/Chance project area, could help to explain such inconsistencies. For example, Figure 1-16 shows much thicker alluvial fill in the region of the colder, shallow well, M-5.

The upwelling/fracture flow model, describing isolated areas of upwelling thermal fluid associated with fault zones, can be used to explain some inconsistencies such as the Well M-1, M-4, and M-5 temperature data, which are difficult to account for with the lateral flow model.

The theory of lateral flow from the west of Casa Diablo would imply fluids move through or around major faults at Casa Diablo and across fault and stratigraphic boundaries toward Hot

Creek Gorge. Such a path is difficult to envision from the idealized cross-section of Figure 1-16. The extent of fracturing in each of the stratigraphic units would significantly influence fluid flow.

The theory of upwelling in isolated areas does not currently account for hot fluids at Shady Rest, although less is known about the thermal fluid distribution in that immediate area in the absence of temperture data from nearby wells and flow test data. It should be noted that the upwelling/ fracture flow model has associated drawbacks. Past studies and experience show that fault supported reservoirs have limits upon the rate of production and are dependent upon the amount of fluid that is supplied to the fault system from surrounding (hot) rock. The reservoir at Casa Diablo has not yet and may not demonstrate limits if the reservoir is not significantly stressed by the existing or proposed developments. Further drilling and testing will assist in definition of potential limits.

1.3.2.4 Chemistry Data

The chemistry data presented in Table 1-3 indicates a direct relationship between spring and well fluids within the Casa Diablo. This suggests a similar relationship exists at other hydrothermally active areas nearby where little borehole data is available. In particular, the analyses of ionic ratios, and stable isotope groups (regardless of the suggested degree of mixing by cold near-surface groundwater) show close agreement between data from the Casa Diablo producing reservoir and local surface springs. A preliminary analysis of fluid from the Shady Rest well also indicates a composition very similar to that of the Casa Diablo wells, but with a far higher calcium concentration, possibly due to the abundant calcite deposits in fractures observed in the core samples. Differences in fluid chemistry of surface hydrothermal features east of the Casa Diablo and have been explained by a combination of boiling of geothermal fluids and mixing with water of meteoric composition (Sorey, personal communication, 1987). Exceptions do exist, for example the composition of fluid from the Hatchery Area Well CW-2 (Tables 1-3 and 1-4) requires different mixing and boiling percentages to account for its ionic and isotopic composition.

The current status of interpretations of chemical data collected for several years from springs, and more recently from wells, is that the various similarities and differences in the fluid chemistry data base can be used to support both of the proposed conceptual models to some extent. Currently, the chemistry data does not provide indisputable proof for either of the models discussed in this report.

2.0 ENVIRONMENTAL CONSEQUENCES

A description of surface and subsurface hydrologic features which may be affected by operation of the proposed PLES I power plant was given in Section 1.0. The following discussion covers probable consequences with regard to: 1) surface water quality; 2) depletion of shallow, fresh groundwater; and 3) production of geothermal fluid and potential effects on surface springs. To a large extent, potential impacts to springs can only be discussed in a qualitative manner given the current level of understanding of the subsurface hydrothermal system and its relationship to surface thermal features.

2.1 Creeks and Surface Drainage

A potential threat to existing surface water quality downstream of the proposed PLES I site is the accidental discharge of large volumes of geothermal fluid or chemical additives used in well drilling. A lesser threat is posed by natural surface runoff from areas contaminated by spills of fuel or oil from vehicles and machinery and from other chemical compounds used on site for drilling and plant maintenance. There is a low probability of any such contamination occuring if prudent practices are followed. For example, a containment dike is propsed to be built which would prevent any surface runoff outside the plant area and two spill containment structures are proposed outside the plant area which will capture any leakage from piplines or wells. Well blowout and spill contingency procedures are described in the PLES I Emergency Response Plan (see EIS Appendix A). Only a major ground rupture caused by a major earthquake would allow discharge of spilled fluids to local creeks.

In terms of volume released, spills of geothermal fluid resulting from a large pipeline rupture would be the most serious potential event. If a large pipeline carrying the entire plant capacity of geothermal fluid (approximately 5000 gpm at 335°F) ruptured, a loss of several thousand gallons could result even as various pumps are automatically shut off. This includes spillage from pipes located up slope from of the broken line which could drain out. If the breakage occurred on the power plant site, the lost fluid could be contained by a system of dikes and a catchment basin. Outside the plant site the fluid would be contained in the spill containment structures (total design capacity of about 1,700,000 gallons). Approximately 15% would discharge from a broken production pipe as steam, and a further reduction would occur due to evaporation and infiltration into soils. The temperature of fluid from a burst production pipeline would drop to approximately 200°F upon discharge due to a reduction to atmospheric pressure. The discharge temperature of fluid from a burst injection pipline would be approximately 160°F, but none of the fluid would flash to steam. Additional temperature losses would occur as the fluid flows over the ground surface. Temperature effects, though likely to be short term, would be the most significant impact.

The chemical content of the spilled geothermal fluid is essentially the same as that of the nearby hot springs. The chemical content of this fluid would be low in Total Dissolved Solids (1400 ppm) and would not be likely to have a significant impact for a short term event (see chemical analysis of Casa Diablo well fluid, Table 1-3).

It is important to note that approximately 750 gpm of fluid from Casa Diablo wells was intentionally discharged to the creeks for 39 days in 1962 by a former operator. While this caused concern about effects of long term discharge and potential buildup of trace elements in the potable water supply at Crowley Lake, no severe or lasting effects to the creeks or lake were documented (CDWR, 1967, 1973) (Setmire, 1984).

A well blowout, while drilling or due to casing failure, though very unlikely, could result in a loss of 200-700 gpm (after flash) of geothermal fluid at a maximum of 200°C and some drilling fluid. Only production wells drilled in lower elevations at Casa Diablo have shown the characteristic of artesian flow. The duration of geothermal well blowouts would vary considerably, depending upon the circumstances. Such an occurrence would probably have less impact than accidental thermal fluid discharge as mentioned above. The containment structures could hold the spilled fluid while injection of the fluid or control of the well blowout could be completed.

The potential for creek contamination from loss of drilling fluid, such as from a pit or tank failure also has a low probability of occurance. Again, spilled fluid would be captured in the containment structures or pits constructed for drilling purposes. Any residual fluid or solids remaining on the ground surface would be removed during cleanup operations and should not result in environmental damage.

2.2 Shallow Fresh Groundwater

Little is known about shallow groundwater in the south Caldera region. It is generally considered non-thermal, but some mixing with deeper thermal waters probably occurs in areas with surface thermal manifestations (springs, etc.). Shallow fresh water aquifers are belived to occur discontinuously in alluvial material which varies widely in depth over the caldera and the caldera margins.

Environmental impacts resulting from periodic use of the groundwater within the Casa Diablo area are unlikely to occur. A shallow well is currently used to supply the existing MP I plant with water for irritgation, maintenance, sanitation, and fire protection. Some additional amount, similar to current needs, is likely to be required for the proposed PLES I plant. Fresh or reclaimed water will also be necessary for drilling new wells.

A 50 gpm pump relaced the 20 gpm in the groundwater well in 1987 and demonstrated the well is capable of higher flow rates, but continuous pumping of the shallow groundwater could lower the local water table within the Casa Diablo area. An estimate of the likelihood or amount of water level decline cannot be made due to the lack of pump test data for the well. However, no continuous pumping of shallow fresh water is proposed for the PLES I Project. It is unlikely that any significant influence on shallow groundwaters in nearby areas will result since the particular aquifer from which shallow fresh water is produced is probably limited to the Casa Diablo area. No connection is belived to exist between this groundwater aquifer and the more extensive shallow groundwaters in the south caldera area, for example, beneath the meadow along the course of Mammoth Creek toward its confluence with Hot Creek.

2.3 Hydrothermal Resources

Potential impacts of geothermal power production on surface thermal fluid resources (springs and other manifestations) near the Casa Diablo Area are difficult to predict precisely without a more thorough understanding of the geothermal reservoir. Additional drilling testing and analysis of the region would assist in evaluating potential adverse effects on springs. However, standard reservoir engineering calculations can be performed which assist in defining potential limits of what effects may be reasonably considered or have some probability of occuring. Potential effects can only be expected if direct hydraulic connection exists between the geothermal reservoir at Casa Diablo and source of the springs, otherwise no impacts would be likely.

Two distinctly different conceptual models of subsurface thermal fluid origins and flow directions have emerged as discussed in Chapter 1 above. The upwelling/fracture flow model implies that there is no Fish Hatchery and Hot Creek Gorge areas, which in effect precludes the likelihood of potential adverse impacts. The lateral flow model suggests relatively widespread lateral hydraulic communication in the south and southwest caldera region in one or more vertical zones. Such communication between the production/injection reservoir at Casa Diablo and thermal springs at the Fish Hatchery and Hot Creek

Gorge could result in potential adverse impacts to hot springs. However, the principals of groundwater hydrology and reservoir engineering dictate that even large induced changes in the reservoir at Casa Diablo will result is small effects in the reservoir 3-5 miles away, if they are hydraulicly connected. No significant effects have been detected in Casa Diablo reservoir data to date.

2.3.1 Simulated Reservoir Performance Calculations

Since neither reservoir model has been conclusively proven, the lateral flow model has been evaluated below since it allows the greatest probability for potential impacts to surface features. In this way an extreme case scenario can be analysed and the maximum environmental protection will be afforded through applicable mitigation.

Three different methods were used to estimate the effects of producion and injection on the geothermal reservoir under the conservative assumption that hydraulic communicaiton does exist. The first involves a computer program which calculates reservoir pressure responses due to production. It simulates a laterally extensive, homogeneous, isotropic reservoir with no discontinuities or barriers. The second calculation is based on a bulk model and is used to predict the distance that cooler, injected fluid would move outward from the Casa Diablo area and the likelihood of its interference with the various thermal springs. The third calculation involves a heat or energy balance analysis of the region, which predicts the decline in average reservoir temperature due to injection of cooled fluid.

2.3.2 Reservoir Pressure Response Calculation

The computer program used is commercially available (MRMW by BGI) and is currently in use worldwide. It calculates reservoir pressure changes using a linear superposition of the line source solution for radial flow to or from a well that penetrates a homogeneous liquid reservoir or aquifier of constant height. The program can account for the possibility of preferred flow paths along high angle faults and fractures. However, localized hydraulic gradients are not well enough defined in this case, therfore the potential effects of non-uniform flow are not included in the calculations presented below. The model used to represent the region from Casa Diablo to Hot Creek Gorge assumes no hot water recharge. If recharge were included in the pressure response calculation it would significantly reduce fluid pressure declines in the vicinity of production wells. The model also assumes 100% hydraulic communication exists between injection and production zones, even though the actual zones are at different depths. Geologic and temperature logs and recent transient pressure test suggest such complete communication may not occur.

Computer calculations were run for a reservoir permeability thickness product (kh) of 500,000 md-ft. This parameter is the product of average reservoir permeability, and average reservoir height, and is a measure of how much pressure change will occur for known, net flow out of the reservoir. This value is based on recent well test data (not yet published) and previous analysis (Geothermex, 1986). The recent data suggests a far higher kh, therefore the above value may be considered conservative and consistent with other methods used for this study in an attempt to present an extreme case estimate of reservoir impacts. A higher kh would reduce calculated pressure changes (i.e. lower impacts).

The computer model used for the calculations presented below has been successfully applied to predict pressure behavior in other fractured geothermal reservoirs and is used here to provide a quantitative analysis of production and injection at Casa Diablo under the assumptions described above.

First, production from three MP I wells totaling 3800 gpm, at 335°F, with 100% injection in wells UM-1, IW-1, and IW-2 was modeled (Figure 2-1). The second calculation was performed for MP I and PLES-I MP-I plus four other proposed power plants. Operations were assumed to begin in early 1985 for MP I, 1990 for PLES I, MP-II and M/C-I, and 1992 for MP-III. The results of the three cases are presented in Figure 2-1 for comparison, however, cumulative effects are discussed in detail in Chapter 3.

Figure 2-1 shows the calculated reservoir pressure response for Casa Diablo, Fish Hatchery and Hot Creek Gorge areas over forty years. All projects are assumed to be completed after 30 years, but the calculation continues for 10 more years to show the rate of build-up or return to initial pressure conditions.

The results indicate that the 100% injection of produced fluids on the east side of Casa Diablo, as is proposed, prevents pressure in the reservoir from declining at the Fish Hatchery or Hot Creek Gorge areas. Pressure increases are predicted for the east (injection) side of Casa Diablo (not shown in Figure 2-1). Decreases in reservoir pressure are predicted for the west (production) side of Casa Diablo and Shady Rest Well areas. The model indicates most subsurface pressure changes would occur in the first few years of power plant operation followed by a stable or steady state condition. This is due primarily to 100% injection of produced fluid. The results of the calculations are consistent with the low reservoir pressure changes presently observed in existing observation wells (35-32 and 65-32) after approximately 3 1/2 years of operation.

Any combination of effects not accounted for in this model could significantly affect potential reservoir pressure responses. For example, natural subsurface recharge of hot water to the reservoir could reduce the magnitude of calculated pressure changes. Physical boundaries, such as faults or impermeable materials, could increase calculated drawdowns in the Casa Diablo area but at the same time protect areas outside Casa Diablo. However, there is no evidence of pressure boundaries in data to date. Such modeling is normally updated and refined each year on the basis of new and continuing data.

Though the relationship between spring flow rates and reservoir pressure is complex and cannot be modeled precisely, the calculations can be used to establish reasonable limits for potential impacts using extreme case assumptions. The results show relatively low reservoir impacts can be expected, (less than 1 psi at HCG or FH due to MP-I and PLES I) which need not interfere with spring flow rates. These low predicted drawdowns are the result of 100% injection (as proposed). In the absence of 100% injection support, however, a high rate of natural recharge to the system would have similar influence on reducing impacts. One or both effects must be occuring to some degree to allow the extremely low changes in reservoir conditions occuring at Casa Diablo due to MP I operations.

2.3.3 Bulk Model Calculation

A second calculation was performed in an attempt to provide an estimate for the distance that the cooler injected fluid would move from Casa Diablo. The purpose of this calculation is to estimate the potential for interference of cooler injected fluid with the thermal subsurface source supplying fluid to springs. This so-called "bulk model" calculation is based on assumptions of rock thermal properties, porosity, and displacement of fluid outward in an approximately uniform cylindrical front. Average values of rock density, heat capacity and porosity (2600 kg/m , 1000 J/kg C and 5% respectively) were used. An injection fluid temperature of 80 C, injection zone temperature of 150 F and a reservoir thickness of 500 feet were also assumed.

The results, shown in below, include continuous injection of 3800 gpm for MP I and 5000 gpm for PLES I (i.e. total flow = 8,800 gpm). The hydrodynamic front expands outward at a faster rate than the thermal front by the relationship shown below.

$$u_f = \frac{\phi d_f C_f}{\phi d_f C_f + (1-\phi)\ d_r C_r}$$

$$V = r_h{}^2 h\phi$$

$$r_t = u_t r_h$$

Where:

V = reservoir volume containing injected fluid after 30 years

r_h = radius of hydrodynamic front (ft)

h = reservoir height (assume 500 ft)

ϕ = porosity (assume 5%)

r_t = radius of thermal front (ft)

u_t = thermal mass

d_f = fluid density (950 kg/m)

C_f = fluid heat capacity (1000 cal/kg- C)

d_r = rock density (2600 kg/m)

C_r = rock heat capacity (240 cal/kg- C)

The calculated position of the thermal front indicates that the distance cooled fluid moves away from the Project site, for both PLES-I and MP-I operating is shown below:

<u>Distance of Thermal Front From Project Area</u>

After 10 yrs	20 yrs	30 yrs
730'	1130'	1260'

This calculation is simplistic, but useful for comparison with other models. It is possible that fractured rock could allow preferred flow paths to carry injected fluid beyond the calculated fronts. However, results indicate that a very large distortion (approximately equal to twelve times the calculated distance) of the calculated front would be required for the lower temperature fluid to travel as far as the Fish Hatchery (approximately 3 miles distant) or Hot Creek Gorge areas (about 5 miles distant). This thermal front would first be observed in monitoring wells before reaching the Hatchery or Hot Creek Gorge areas. It is also significant that gravity segregation is not accounted for in this calculation. This effect allows colder fluid to sink deeper into the reservoir, decreasing the probability of near surface impacts. Gravity segregation models have been used to study other reservoirs and could be used hereas new data on this reservoir is obtained. At present, gravity segregation modeling would not be meaningful until subsurface fluid movement is better defined.

The assumed porosity of 5% may be low based on recent estimates of porosity within Casa Diablo area. In this calculation, the higher the porosity, the smaller the computed distance of thermal front propogation. Thus, using 5% is in keeping with the extreme case scenario presented here. Also, the reservoir thickness of 500 feet may be low based on lithologic and temperature data. It is possible that the effective injection zone thickness is greater than the 500 feet assumed for this calculation. This would decrease the calculated distance of the hydrodynamic and thermal fronts, reducing the potential for impacts on springs. These two parameters, porosity and reservoir thickness, have compensating effects in the calculations. Using slightly different values for each would not alter the results significantly.

A separate calculation, related to distortion of the bulk model thermal front, was performed. It is based only on the subsurface hydraulic gradient which may induce lateral west to east flow. The effect of this gradient would be to allow a buldge or distortion of the injected fluid down-gradient to the east which is not accounted for in the bulk model.

As previously mentioned, there is some debate among experts as to whether such a lateral west-to-east flow exists. Assuming it does exist for the purpose of estimating an extreme case scenario, a rough estimate of its effect can be calculated from the regional groundwater/geothermal gradient. A fluid velocity of 0.06 ft/day was calculated based on a horizontal permeability corresponding to kh= 500,000 md-ft. (used in the computer model) and a value for the local groundwater gradient of 0.0135 ft./ft. (estimated from the water level contour map of Farrar, et al, 1985).

The results indicate that fluid moving from Casa Diablo would take about 100 years to reach the Hatchery, and 150 years to reach Hot Creek Gorge, areas. Therefore, any potential changes would migrate excecedingly slowing and would provide ample time for implementation of mitigation measures to reduce or eliminate the potential for impacts to the Hatchery or Hot Creek Gorge areas.

These results are based on the assumption that lateral west-to-east subsurface flow occurs in the region and no provision is made for the effect of preferred flow paths, which are often associated with fractured reservoirs. Calculations of the movement of fluid in the subsurface induced by the local groundwater gradient does not take into account reheating of injected fluid through contact with hot reservoir rock which could significantly slow or reduce impacts naturally.

The estimated position of the thermal front, including some distortion by lateral flow, indicates breakthrough of cool injection fluid is not likely to be a potential threat to existing springs.

2.3.4 Heat (Energy) Balance Calculation

A third method of predicting the effects of geothermal production and injection within Casa Diablo area is by the heat or energy balance technique. This method is used here to estimate the geothermal reservoir temperature declines which may be anticipated due to heat withdrawal. Usually this method is used as a research tool to establish the evolution of natural heat inflow and outflow from an undisturbed hydrothermal reservoir. It has not proven effective for calculation of effects on commercially productive reservoirs, because the amount and the effect of recharge to the reservoir are usually underestimated. The recharge rate cannot be easily measured since it does not necessarily discharge at the surface. Recharge, if measured by surface discharge, is usually found to be minor in comparison to subsurface recharge actually available to support commercial production. Currently productive commercial geothermal reservoirs in the Western United States demonstrate far greater recharge than is measured by surface discharge. However, overproduction and large pressure drawdowns can and do occur as a result of geothermal production without appropriate reservoir management.

This method is presented for completeness in analysis methods and because a previous EIR (Westec, 1987) and a recent study (Papadopulos, 1988) have used this technique. A worst case scenario is presented based upon collectively conservative assumptions of high porosity (15%), heat in place (10 x 10^17 calories), low recharge (equal to surface discharge, assume 130 kg/s) (Sorey and Lewis, 1976, use 250 kg/s) and 100% power plant capacity factor.

The equations used are based upon Papadopulos 1988 report and are summarized below.

$$I - O = dS/dt$$

Where:

I = rate of heat inflow (recharge + injection, cal/sec)

O = rate of heat inflow (spring flow + production, cal/sec)

d/S = change of heat stored over time

$$S = V \quad C_f d_f + (1-\phi) \, C_r d_r \, T$$

Where:

S = quantity of heat stored

V = reservoir colume ($11 \times 10^9 \ m^3$)

C_f = heat capacity of fluid (1000 cal/kg-C)

T = average reservoir block temperature
(i.e. 1 = 180°C, 2 = 150°C, 3 = 130°C, 4 = 100°C)

d_f = density of fluid (950 kg/m)

d_r = denisty of rock (2600 kg/m)

ϕ = rock porosity (assume 15%)

Natural Recharge + Total Injection - Natural Outflow + Total Production = Change in Stored Heat with Time

$$Q_{re} C_f d_f T_{re} + Q_i d_f C_f T_i - Q_o C_f d_f T_o + Q_p C_f d_f T_p = V \left[\phi C_f d_f + (1-\phi) \, C_r d_r \right] dT/dt$$

Where:

Qre = Recharge flow rate (m^3/s)

Qi = Injection well flow rates (m^3/s)

Qo = Natural surface outflow (m^3/s)

Qp = Production well flow rates (m^3/s)

Tre = Temperature of Recharge water (assume 200°C)

Ti = Temperature of injected fluid
(assume 80°C at Casa Diablo and 60°C at Mammoth/Chance)

To = Temperature of natural outflow (Block temp.)

T_p = Temperature of produced fluid

Note: Natural Outflow term should include surface conductive heat loss (cal/sec) if significant.

The equation is solved for the temperature of each block for any period of a geothermal project life. It can also be extended after project completion to predict natural temperature buildup caused by continued recharge flow. For this calculation, all power plants are assumed to start up and shut down simultaneously. Also, a 100% plant capacity factor (i.e. no breakdowns or maintenance stoppages occur) is assumed.

The reservoir volume assumed by Papadopulos is 3.55x10^9 m , using a thickness of 300 m. This volume is too small to allow even a conservative reservoir heat value of 10 x 10^17 calories to be considered and does not include the Hot Creek Gorge springs area. A larger area is used for this calculation (see Figure 2.2) with the same reservoir thickness (300m). It includes areas for which there is well temperature data available (i.e. from the Shady Rest Well area to Well CH-10 near Hot Creek Gorge). Initial reservoir block temperatures are also based on observed well data. It should be noted that it is not possible for the reservoir (or block) temperature to be reduced below the fluid injection temperature by this method. The injection temperatures used here are 80°C for Casa Diablo projects and 60°C for the Mammoth Chance projects. The division of the reservoir into blocks is shown in Figure 2-2. Boundary conditions and reservoir parameters are listed in Table 2-1.

Though this calculation does not predict a 30°C decline at Casa Diablo, commercial production would cease long before the reservoir temperature changed by this amount. This is due to power plant design constraints. Further, no financial institution or investor would invest in such a project if there were any reasonable likelihood of such declines occuring within the projected power plant life. Though some poorly planned geothermal projects have been cut back due to faulty analysis of intitial conditions none are known to have been reduced by temperature declines in the reservoir.

The results for only one power plant operating (MP-I) are given below.

MP-I ONLY

Predicted Reservoir Temperature Change (°C)

Area	After 10 yrs	20 yrs	30 yrs
Casa Diablo	- 1.8	-4.0	-6.1
Fish Hatchery	0	0	0
Hot Creek Gorge	0	0	0

MP-I and PLES-I

Predicted Reservoir Temperature Change (°C)

Area	After 10 yrs	20 yrs	30 yrs
Casa Diablo	-5.6	-10.7	-15.4
Fish Hatchery	0	0	0
Hot Creek Gorge	0	0	0

The results, shown graphically in Figure 2-3, indicate a temperature decline in the Casa Diablo area (Block 1) and no declines in the Fish Hatchery and Hot Creek Gorge areas due to the warmer recharge water (130 kg/s) moving laterally from west to east. If the recharge volume available is greater than existing surface discharge, as assumed, smaller declines will be predicted. However, it should be noted that the size of Block 1 allows flow to be induced from the entire volume toward the producing wells which is, in effect, a form of recharge. A similar model could be set up which allows a smaller reservoir volume from which producing wells can draw fluid but with greater recharge. Exisiting data from wells at Casa Diablo could support either approach and the "downstream" effects in the reservoir toward the Hatchery and Hot Creek Gorge areas would be the same as shown above.

The results for the Hatchery and Hot Creek Gorge areas show no change in temperature since no production, other than spring discharge occurs in these areas. The temperature of Blocks 2,3 and 4 are maintained by the continued recharge from Block 1 which remains a higher temperature than the others. This higher temperature recharge would cause a minor natural increase in temperature (<5°C) of those blocks were it not for surface conduction and spring discharge.

In summary, it is difficult to precisely predict the effects on surface thermal features resulting from production/injection operations at the proposed PLES I Project and the existing MP I Project. The simple model calculations described here indicate that, even assuming hydraulic communication exists, the potential for subsurface impacts to extend 3 to 5 miles to the Hot Creek Hatchery and Hot Creek Gorge areas is very low. It is possible that direct hydraulic communicaion does not exist in which case no impacts are likely to extend to areas beyond the graben in which the Casa Diablo area is located.

Subsurface effects can not be related directly to thermal springs. Special circumstances exist at each area, such as those at the Hatchery springs, where it is estimated that 2-3% of the average flow is thermal water. The temperature of the thermal fluid component of these springs is unknown. It has been estimated that a loss of the entire thermal component could result in a lowering of average spring temperature of 2° to 3° degrees Centigrade (Sorey, 1976). On this basis a 30°C geothermal reservoir temperature decline in the Hatchery area would be required before a 1 C change could be expected in the average Hatchery springs temperature (Sorey, 1988). This 30°C/ 1°C relationship cannot be considered a certainty, however. Only continued monitoring of springs and wells may allow cause and effect relationships to be established.

2.3.5 Monitoring Programs

Since a precise analysis of hydrologic effects due to increased geothermal development at Casa Diablo is not possible on the basis of current data, a closely controlled program of surface and subsurface fluid monitoring should be established. This program should include measurement of chemistry, flowrate and temperature of important surface features; temperature, pressure and chemistry of one or more observation wells; injection well pressure; temperature and rate and production well temperature, pressure, flowrate and chemistry. Continuous monitoring and periodic sampling of various features is already underway by the USGS and others (Farrar, et al, 1985, 1986).

A monitoring program has been prepared by PLES (Plan of Baseline Data Collection, PLES I - 10 MWe Binary Power Plant Project, 1987), and is also underway.

The PLES proposal includes a significant upgrade in the accuracy of downhole pressure measurement during testing and production of wells, which allows more accurate estimates of reservoir parameters than was previously available. This, along with other proposed monitoring, drilling and well testing should allow the construction of more detailed models than the simplified versions used for calculations presented above. Calculations may then be updated and improved, and potential adverse impacts to the reservoir and/or springs can be evaluated periodically. Any monitoring plan should allow some degree of flexibility. Future data may show a lack of response or reduced need to monitor one feature, while increased attention should be directed to another area. Any monitoring guidelines would have to be agreed to in advance by both the regulating body and the project operator.

It was previously recommended that a monitoring well be drilled at an accessible and permissable location chosen by an appropriate agency. Such a well (SF65-32) was drilled to a depth of 250 feet and pressure data has shown it to be in communication with the geothermal production zone of the proposed project. The primary function of the monitoring well is to serve as an early warning of potential changes in reservoir pressure or temperature which may propagate toward the east or southeast and which could potentially affect springs.

At present, the Casa Diablo area production zone pressure does not appear to respond directly to injection, since the pressure response calculations used above would predict an increase in pressure for the SF65-32 location. However, the actual measured pressure in Well SF65-32 showed a slight decrease in response to production of (approximately 1 psi) when MP-I wells were restarted after a brief shut-in. This is not surprising given the complex structure in the Casa Diablo area.

On a regional scale however, the pressure response calculations has been proven effective for analysis of pervasively fractured reservoirs and should effectively model pressure changes due to production and injection in the Casa Diablo area.

Background data collection should be continued to allow baseline values to be established and action levels (re: temperature, pressure and chemical constituents) to be agreed upon by appropriate government agencies. The data collected by the USGS and others thus far, presented by Farrar, et al (1985, 1986), should allow general guidelines to be established which could then be updated as new data is added. Additional data would be helpful in delineating more precisely to what extent pressure, temperature, chemical and flowrate changes can be attributed to natural causes (e.g. tectonic strain and seasonal precipitation amounts) and what changes, if any, may be attributed to PLES I power plant operations.

3.0 CUMULATIVE IMPACTS

Several other developments requiring geothermal fluid are proposed for the south caldera region in addition to the existing MP I and planned PLES I power plants. These include: 1) MP II and MP III, 10 MW power plants within the Casa Diablo area; 2) Mammoth/Chance I, 10 MW power plant, northwest of Hot Creek Hatchery. Proposed fresh water users include: 1) Mammoth Lakes Airport development (also referred to as the Doe Ridge project), near the airport southeast of Hot Creek Hatchery, 2) the Chance Ranch located near the Sheriff's substation and (3) the Town of Mammoth Lakes.

3.1 Surface Resources

The primary threat to surface freshwater resources is from potential spills of geothermal fluid, petroleum products and other chemical compounds which may be used on-site for construction, maintenance and drilling. The probability of contamination from spills or natural runoff from contaminated soils increases with each additional power plant installed or under construction but remains low. However, the chance of having an event such as a spill or well blowout occuring at more than one power plant at any given time is remote. Hence the effect of a single event would be similar to that described in Section 2.1.1.

3.2 Shallow Fresh Groundwater

The existing shallow groundwater well within the Casa Diablo area should be sufficient to supply the needs (primarily landscaping and fire protection) of the existing MP I plant and contribute to the needs of the proposed PLES I plant. No definite limits are known for the shallow fresh water aquifer at Casa Diablo and demand requirements have not been well defined for the proposed MP II and MP III or PLES I developments. Assuming the one existing and the three proposed power plants at Casa Diablo would each need approximately the same quantity of fresh water, four times as much as is currently produced would be required. No other users of this supply are known or anticipated. Increased production, possibly including a new well, could lower the fresh water table locally.

Other projects which pump fresh water may impact shallow groundwater resources but no significant cumulative impact is likely to result from the low level usage planned for projects in the Casa Diablo area. As mentioned in Chapters 1 and 2, the non-potable shallow groundwater at Casa Diablo is associated with shallow alluvial material that appears to thin out southeast of the area, and neither the alluvium nor a significant shallow fresh water resource is believed to be continuous down gradient toward the Chance Ranch, Mammoth/Chance or Doe Ridge projects or directly connected to aquifers in the Mammoth Lakes Areas. A greater thickness of alluvium, along with a larger freshwater aquifer, is believed to occur in those areas. Little effect on other aquifers can be anticipated from cold groundwater production within the Casa Diablo area

It is suggested that an entire study be dedicated to defining groundwater aquifers in the Mammoth Creek drainage basin for the purpose of evaluating cumulative impacts. The size, number and extent of aquifers and sub-basins in this area is poorly understood. The shallow cold groundwater supply in the Casa Diablo area is belived to be minor. Even with all proposed projects at Casa Diablo in place, shallow fresh groundwater use and impact on a regional scale is likely to be insignificant. However, much larger fresh groundwater uses are proposed outside the Casa Diablo area which may significantly affect groundwater resources on a regional scale. Any such study would require more data from groundwater aquifier testing, estimates of the depth of alluvium and basalt layers in the area and more precise definition of well locations and flow rates required for each project.

3.3 Hydrothermal Resources

The MP II and MP III Projects will be binary power plants, each with similar production/injection requirements to PLES I (i.e. approximately 5000 gpm each). For the purpose of this study, production is assumed to be from the same reservoir as MP I and PLES I. Pressure response calculations were performed under the same assumptions and for the same purpose as discussed in Chapter 2. The analysis method shows the potential effect of all proposed power plants on the geothermal reservoir. The results are given as predicted pressure changes in the subsurface reservoir at depth, in the area of the springs (see Figure 2-1).

	Predicted Reservoir Pressure Change (psi)		
Area	After 10 years	20 yrs	30 yrs
Casa Diablo	+5.53	+5.53	+5.53
Fish Hatchery	-1.88	-1.88	-1.88
Hot Creek Gorge	+.38	+.38	+.38

Includes MP-I, PLES-I, MP-II & III and M/C-I.

The results demonstrate that for a kh=500,00 md-ft the responses stabilize two years after the proposed power plants begin operating. This steady state occurs before the first 10 year interval listed above (see Figure 2-1 for effects before 10 years). The last project to start up is assumed to be MP III in 1992. The flat response is primarily due to 100% injection, which is proposed for all the projects. The final well locations are not yet known for the Mammoth Chance I project (M/C-I). The well locations assumed for this calculation are those shown in the Revised Mammoth Chance I EA (1987).

As expected, the pressure changes are greater than for the MP I and PLES I power plants operating together (see Chapter 2). At Casa Diablo, pressure declines are expected on the west side in the vicinity of the producing wells. Increases are expected on the eastern side. The pressure changes predicted are more than twice that calculated for MP I and PLES I only. However, these values are extremely low compared to what would be considered significant for exisiting geothermal projects in other areas.

The results for the Fish Hatchery area have reversed from the previous case (MP I and PLES I only). It no longer indicates a small pressure increase. Rather, a decrease is predicted, due to pumping at proposed well locations for Mammoth Chance I. The decline is low, equivalent to less than five feet of water head in a static well.

The calculated increase at Hot Creek Gorge is essentially insignificant and may be unmeasurable given the observed magnitude of background effects in pressure data taken from local wells (eg. CH-10).

Bulk Model Calculation

The results of the bulk model calculation, by the same method described in Section 2.3.3, for all five proposed power plants (MP I, PLES I, MP II & III, and M/CI) are shown below.

Distance of Thermal Front from Project Area

Casa Diablo			Mammoth/Chance		
After 10 yrs	20 ys	30yrs	After 10 yrs	20 yrs	30 yrs
980 ft	1390 ft	1700 ft	850 ft	1200 ft	1470 ft

The maximum calculated distance traveled from the project area is less than one third of a mile, which is not significant compared to the distance to the Fish Hatchery (3 miles) and Hot Creek Gorge (5 miles). The Mammoth Chance project thermal front is calculated to travel approximately 0.28 miles. The distance from the proposed Mammoth Chance injection wells to the Fish Hatchery and Hot Creek Gorge is approximately 1 mile and 3 miles respectively. Overall, by this method of calculation, the potential threat to springs is remote.

Heat Balance Calculation

The results of the heat balance calculation for the five power plants (MP I, MP II, MP III, PLES I and M/C I) is given below.

Predicted Temperature Change (°C)

	After 10 yrs	20 yrs	30 yrs
Casa Diablo	-11.4 C	-21.1 C	-29.4 C
Fish Hatchery	-7.6	-14.2	-19.8
Hot Creek Gorge	0	0	0

The same properties and parameters apply from Section 2.3.4 and are listed in Table 3.1. The only changes are to flowrates, allowing an additional 5000 gpm in Block 2 (Figure 2-2) for each MP II & III power plant and 10,000 gpm in Block 4 for the M/C I plant.

The results indicate a moderate temperature decline for the Fish Hatchery area (Block 3). This decline could potentially result in a 1 C reduction in spring temperature using rationale based on approximately 3% of spring flow having thermal origin (Sorey 1976, 1988).

In summary, the effect of the proposed PLES I geothermal power plant, on the thydrothermal resources, together with other proposed geothermal projects, is the major issue of concern. Calculations performed in an attempt to predict these effects were based on simple models using available data and are believed to simulate what effects would occur in the reservoir under extremely conservative circumstances. The calculations showed that no significant reduction in subsurface reservoir pressure near thermal springs in the Hatchery and Hot Creek Gorge areas is likely. Nor are reservoir temperature declines predicted to significantly effect springs. However, significant reservoir changes are predicted for the vicinity in which the proposed power plants are to operate. These changes may only be anticipated in the absence of significant subsurface recharge to the shallow (500-1000 ft deep) geothermal reservoir. Given the reservoir performance at the existing MP-I plant and the other data reviewed in this report, there is ample evidence to suggest that the volume of recharge available is greater than that which can be measured as discharge at the surface. The effect of such recharge would be to decrease changes predicted by the above calculations and possibly eliminate any potential threat to the springs at the Fish Hatchery or Hot Creek Gorge.

REFERENCES

Anderson, L.A., and C.R. Johnson, 1973. The application of the self-potential method in the exploration for geothermal energy in Long Valley, California (abstract). EOS, Vol. 54, p. 1212.

Anonymous, 1986, Accessible core hole in the Long Valley. Geothermal Resources Council Bulletin, August 1986, pp. 39-40.

Benoit, W.R., 1984. Initial results from drillholes PLV-1 and PLV-2 in the western moat of the Long Valley Caldera. Geothermal Resources Council Transactions, Vol. 8, pp. 397-402.

Blackwell, D.D., 1985. A transient model of the geothermal system of the Long Valley Caldera, California. Journal of Geophysical Research, Vol. 90, pp. 11229-11241.

California Department of Fish and Game (CDFG), IBLA #88-303, Statement of Reasons Pursuant to Notice of Appeal Dated March 9, 1988, Before the Department of the Interior Office of Hearing and Appeals, Board of Land Appeals.

California Department of Water Resources, 1967. Investigation of geothermal waters in the Long Valley area, Mono County. 141 pp.

California Department of Water Resources, 1973. Mammoth Basin water resources environmental study (final report), 70 p.

Campbell, D., Reservoir Engineer, Mesquite Group, Personal Communication - April 1987.

Eccles, L.A., 1976. Sources of arsenic in streams tributary to Lake Crowley, California. U.S. Geological Survey, Water Resources Investigations Report 76-36, 39 pp.

Farrar, C.D., M.L. Sorey, S.A. Rojstaczer, C.J. Janik, R.H. Mariner, T.L. Winnett, and M.D. Clark, 1985. Hydrologic and geochemical monitoring in Long Valley Caldera, Mono County, California, 1982-1984. U.S. Geological Survey Water Resources Investigations Report 85-4183, 137 pp.

Farrar, C.D., M.L. Sorey, S.A. Rojstaczer, C.J. Janik, T.L. Winnett, and M.D. Clark, 1985a. Hydrologic and geochemical monitoring in Long Valley Caldera, Mono County, California, 1985. U.S. Geological Survey Open File Report 86-xxxx. Not yet approved for publication. 74 pp.

Farrar, C.D., U.S. Geological Survey, 1987. Personal Communication - February 1987.

GeothermEx, Inc., 1986. Evaluation of the geothermal energy potential in the Casa Diablo area of Long Valley, California. 133 pp.

Goodwin, D., Mammoth Lakes Geothermal Resources Assessment Project, CEC Project No. 912-86-016, Submitted to the Town of Mammoth Lakes, April 1988.

Lachenbruch, A.H., M.L. Sorey, R.E. Lewis, and J.H. Sass, 1976. The near-surface hydrothermal regime of Long Valley caldera. Journal Geophysical Research, vol. 81, pp. 763-768.

Lawrence Berkeley Laboratory, 1984, Proceedings of the Workshop on Hydrologic and Geochemical Monitoring in the Long Valley Caldera, (LBL-20020).

Lewis, R.E., 1974. Data on wells, springs, and thermal springs in Long Valley, Mono County, California. U.S. Geological Survey Open File Report, 52 pp.

Mariner, R.H., and L.M. Willey, 1976. Geochemistry of thermal waters in Long Valley, Mono County, California. Journal of Geophysical Research, vol. 81, pp. 792-800.

Mesquite Group, Inc., MP I Injection Well Logs and Surveys, August 20-27, 1987 for PLES, Nov. 1987.

Mesquite Group, Inc., 1986. Final report on well SF 35-32, Casa Diablo Geothermal Field Exploration. 56 pp.

Mesquite Group, Inc., 1986a. Summary of observations supporting a multi-reservoir model of the Long Valley Caldera Hydrothermal System. 12 pp.

Mesquite Group, Inc., 1986b. Meeting summary; review of the data relative to the lateral continuity of the shallow Long Valley Caldera Hydrothermal System(s). 5 pp.

Pacific Lighting Energy Systems, 1986. Plans of operations development, injection and utilization PLES I 10 MWe (net) Binary Power Plant Project. 61 pp.

Pacific Lighting Energy Systems, 1987. Plan of Baseline Data Collection PLES I - 10 MWe (net) Binary Power Plant Project. 21 pp.

References, cont'd.

Pacific Resources Management, Inc., 1981. Engineering evaluation of selected leases, Casa Diablo Hot Springs, Mono County, California. pp. 1-11.

Pacific Resources Management, Inc., 1984. Testing and evaluation of geothermal wells, Casa Diablo Hot Springs, Mono County California. pp. 1-34.

Papadopulous, S.S. & Associates, Inc., Evaluation of Impacts of Geothermal Development within Long Valley, May 1988.

PLES, Drilling Testing and Initial Data, PLES Observation Well 65-32, Jan. 1988.

PLES, PLES-I Geothermal Development Project Emergency Spill Containment Plan, Revised June 1988.

Potter, R.W., Geochemist, Santa Fe Minerals, Inc., Personal Communication - April 1987.

Sass, J.H., A.H. Lachenbruch, and R.J. Munroe, 1974. Thermal data from heat-flow test wells near Long Valley, California. U.S. Geological Survey Open File Report, 43 pp.

Setmire, J.G., 1984. Water-quality appraisal of Mammoth Creek and Hot Creek, Mono County, California. U.S. Geological Survey Water Resources Investigation Report, 84-4060. 50 pp.

Shevenel, L., C.O. Grigsby, F. Goff, N.O. Jannik, and F. Phillips, 1986. Mixing and boiling of the thermal fluids in Long Valley Caldera, California. In press.

Smith, J.L., and R.W. Rex, 1977. Drilling results from the Eastern Long Valley Caldera. American Nucl. Society meeting 7/12/77. 12 pp.

Sorey, M.L., 1976. Potential effects of geothermal development on springs at the Hot Creek Fish Hatchery in Long Valley, Mono County, California. U.S. Geological Survey Open File Report 75-637. 8 pp.

Sorey, M.L., 1985. Evolution and present state of the hydrothermal system in Long Valley caldera. Journal of Geophysical Research, vol. 90, pp. 11219-11228.

Sorey, M.L. and P. Beilin, 1986. Hot spring flow and well discharge at Casa Diablo. U.S. Geological Survey, Long Valley Monthly Report, Nov. 1986, pp. 1-2.

References, cont'd.

Sorey, M.L. and M.D. Clark, 1981. Changes in the discharge characteristics of thermal springs and fumaroles in the Long Valley caldera, California, resulting from earthquakes on May 25-27, 1980. U.S. Geological Survey Open File Report 81-203, 22 pp.

Sorey, M.L., C.D. Farrar, and H.A. Wollenberg, 1984. Workshop on hydrologic and geochemical monitoring in the Long Valley caldera. LBL-20020, 82 pp.

Sorey, M.L., R.E. Lewis, and F.H. Olmstead, 1978. The hydrothermal system of Long Valley caldera, California. U.S. Geological Survey Professional Paper 1044-A, 60 pp.

Sorey, M.L., 1987. U.S. Geological Survey. Personal Communication - February 1987.

Sorey, M.L., 1988. Comments on "Evaluation of Geothermal Development within Long Valley", a report by S.S. Papadopulous & Associates.

USDA Forest Service, 1986. EIR/EA Mammoth/June Lake Airport Land Use Plan. 141 pp.

USFS, Drilling and Testing of a Deep Geothermal Test Will by Occidental Geothermal Corporation, no date.

Westec Services, Inc., 1987, Revised Mammoth Chance I EA/EIR.

Westec Services, Inc., 1986. Draft Environmental Impact Report Mammoth/Chance Geothermal Development Project. County of Mono, 158 pp.

Wollenberg, H.A., A.F. White, and S. Flexser, (Lawrence Berkeley Laboratory), and M.L. Sorey and C.D. Farrar (U.S. Geological Survey), and L.C. Bartel (Sandia National Laboratory). A Core Hole in the southwestern moat of the Long Valley Caldera: Early Results. EOS Transactions, in print.

Wollenberg, H.A., Staff Scientist, Lawrence Berkeley Laboratory. Personal Communication - February 1987.

Table 1-1

Creek Flowrates (cfs)

Location		Low	High	Average
Ephemeral tributary to Mammoth Creek at Casa Diablo (1)		0	40	N/A
Mammoth Creek Flume (MCF)(2)	June	14	191	82
	Sept	1.5	33	8
Hot Creek Flume (HCF)(2)	June	33	265	115
	Sept	26	86	41

(1) - from PLES I Plans of Operation (PLES, 1986)

(2) - Calculated from monthly flow totals 1932-1971 CDWR, 1973

Table 1-2

Summary of Selected Creek Flow Data

Mammoth/Hot Creeks, Mono Co., California

Location	Date	Flowrate (cfs)	Temp. °C	Specific Conductance u /mho per cm
1) MC 395	7/20/86	60.4	14.3	49.4
2) Mammoth Creek Flume (MCF)	9/25/81	-	10.4	135
	5/24/82	102	5.5	57
	7/20/86	62.8	14.4	65.4
3) Hot Creek above Hatchery	9/25/81	-	15.4	252
	5/24/82	96.1	18.0	106
	7/20/86	58.4	-	117
4) Hot Creek Flume (HCF)	9/25/81	-	30.8	470
	5/24/82	206	17.0	236
	7/20/86	109.5	25.1	307

From Setmire, 1984 and
C. Farrar, personal communication 1987.

Table 1-3 Chemical analyses of waters from selected springs and wells in the Long Valley area, Mono County, California (revised from Farrar, et al, 1985 & 1986) (Units are milligrams per litre)

Feature	Collection date	Temperature (°C)	pH	Ca	Mg	Na	K	ALK	SO_4	Cl	F	SiO_2	Dissolved Solids	As	B	Li	Hg
Casa Diablo area - springs in sections 15, 31, 32, 33, t.3S., R.28E.																	
Geyser (CDG)	11/19/83	92.0	9.4	1.5	0.53	389	40	469	152	269	10.1	341	1,212	2.5	12.7	3.7	-
	05/09/84	90.1	8.2	0.8	0.1	410	38	382	160	300	12.0	268	1,480	1.8	12	3.2	1.2
	09/04/84	90.8	8.2	1.3	<0.1	410	40	388	160	310	13.0	-	1,470	1.8	13.0	3.0	0.1
	05/28/85	92	9.1	2.2	0.06	458	44	395	137	298	13.7	300	1,326	1.9	13.5	3.8	<50
North Spring (CDNS)	03/15/83	88.5	6.7	-	-	-	-	-	-	270	9.8	-	-	2.0	13.0	-	-
	06/03/83	92.5	6.8	8.7	1.2	235	24	-	155	260	10.0	216	-	-	13.0	1.2	-
	08/18/83	91.5	6.7	-	-	-	-	-	160	260	9.6	130	-	2.1	12.0	-	-
	10/04/83	91.5	6.8	9.1	1.2	240	23	47	160	260	9.3	220	971	1.9	12.0	1.1	0.3
	12/15/83	89.5	7.1	10.0	1.5	240	22	45	170	270	12.0	210	1,010	1.6	12.0	1.1	-
	05/09/84	89.5	6.9	10.0	1.4	250	25	61	190	270	9.1	200	1,020	1.5	11.0	1.3	0.5
	09/04/84	92.8	7.2	10.0	1.4	240	26	58	160	280	9.2	220	1,010	1.5	-	1.2	0.5
	11/11/84	89.8	6.8	10.0	1.3	240	24	36	170	270	8.0	220	1,000	1.2	13.0	1.2	0.3
	02/06/85	86.1	6.3	11.0	1.4	230	21	43	180	260	8.9	260	1,020	1.9	11.0	1.0	0.2
	07/16/85	90.0	6.7	12.0	1.5	250	23	39	170	270	10.0	220	1,010	1.5	11.0	1.2	1.2
South Spring (CDSS)	08/27/82	93.0	8.4	11.0	2.2	290	27	186	150	260	8.1	210	1,090	1.5	11.0	-	-
	11/17/82	93.5	7.8	9.9	2.2	280	27	175	160	250	8.8	200	1,080	1.6	11.0	-	-
	01/14/83	86.0	-	-	-	-	-	-	-	250	-	-	-	1.5	-	1.7	0.2
	02/04/83	81.0	-	-	-	-	-	-	-	240	11.0	-	-	1.4	11.0	1.7	0.3
	03/15/83	80.0	6.6	-	-	-	-	-	-	240	8.5	-	-	1.5	11.0	1.8	0.1
	05/03/83	80.5	6.5	-	-	-	-	-	-	230	6.9	-	-	1.6	-	-	-
	06/03/83	84.0	6.7	23	3.3	320	31	281	225	205	8.2	200	-	-	9.6	1.8	-
Casa Diablo area - wells in sections 32, 33, T.3S., R.28E.																	
Endogenous (END-5)	05/19/72	94.0	9.2	0.9	0.1	390	45	368	130	280	12.0	340	1,217	2.2	14	2.8	-
IW-2	01/04/83	-	9.7	3.5	.008	401	10	464	118	132	23.7	91	1,072	0.18	10.8	0.22	-
MBP-1	01/04/83	-	8.8	5.1	0.04	431	47	405	132	300	12.1	63	1,248	0.21	10.6	3.48	-
	07/11/85	168	6.2	3.9	0.10	260	33	355	110	260	11.0	250	1,270	1.0	11.0	2.7	2.6
MBP-3	07/12/85	171	6.1	1.2	0.10	350	36	345	120	270	11.0	250	1,250	1.1	11.0	2.6	2.3
MBP-2	01/04/83	-	9.1	1.8	0.03	430	45	410	133	288	12.8	65	1,236	0.23	10.8	3.52	-
MBP-4	01/04/83	-	8.8	1.4	0.02	453	52	425	135	300	13.6	188	1,414	0.24	11.7	3.98	-
	10/13/85	173	6.0	1.8	0.10	340	35	360	110	270	10.5	240	1,270	1.2	11.0	2.6	1.9
MBP-5	01/04/83	-	9.2	2.6	0.02	435	34	389	172	267	14.7	75	1,248	0.20	10.3	3.98	-
	10/13/85	168	6.3	6.0	0.10	340	31	360	110	270	10.5	240	1,270	0.7	11.0	2.7	1.8

Table 1-3. Chemical analyses of waters from selected springs and wells in the Long Valley area, Mono County, California (continued-pg.2)
(revised from Farrar, et al, 1985 & 1986) (Units are milligrams per litre)

Feature	Collection date	Temperature (°C)	pH	Ca	Mg	Na	K	ALK	SO_4	Cl	F	SiO_2	Dissolved Solids	As	B	Li	Hg
Casa Diablo area - wells in sections 32, 33, T.3S., R.28E. (continued)																	
Union (M-1)	01/04/83	-	9.4	0.9	0.02	422	18	415	172	180	14.5	61	1,126	0.14	7.57	0.82	-
Colton Spring (CS)	08/26/82	93.0	9.1	1.4	0.20	390	25	354	140	270	12.0	240	1,310	1.6	12.	-	-
	12/04/82	95.0	8.4	1.2	0.07	370	25	367	140	250	11.0	240	1,290	1.5	12.	-	-
	01/14/83	93.0	-	-	-	-	-	-	-	260	-	-	-	1.7	-	2.9	0.1
	03/15/83	91.5	8.3	-	-	-	-	-	-	260	12.0	-	-	1.7	12.	2.9	0.2
	05/01/83	91.5	8.4	-	-	-	-	-	-	260	12.0	-	-	1.5	12.	-	-
	06/03/83	93.0	8.3	1.2	0.01	385	25	370	135	250	10.0	240	-	-	11.	2.8	-
	08/14/83	92.0	8.4	1.3	0.3	380	28	355	130	260	12.0	-	-	1.4	11.	-	<0.1
	10/06/83	91.5	8.3	1.3	-	370	24	355	140	260	11.0	240	1,280	1.6	11.	2.8	0.1
	12/15/83	89.1	8.4	1.7	<0.01	370	23	359	140	270	12.0	-	1,280	1.5	11.	2.9	0.5
	04/25/84	70.0	8.4	1.4	0.02	384	32	390	129	258	9.6	315	1,376	1.4	11.4	2.9	-
	05/09/84	91.4	8.3	1.3	<0.01	370	28	353	150	270	12.0	230	1,340	1.3	11.	3.3	0.3
	02/04/85	93.1	8.3	1.4	<0.01	360	26	335	130	270	11.0	300	1,320	1.7	11.	2.5	0.3
	05/26/85	93.8	8.7	2.0	0.05	408	27	365	133	260	10.7	250	1,266	1.5	11.6	3.5	<50
	12/18/85	92.9	8.5	1.4	<0.01	380	27	393	140	270	13.0	250	1,310	1.7	12.0	3.0	0.3
Meadow Spring (MS)	08/27/82	60.0	7.5	3.8	0.8	230	37	132	110	210	8.7	210	910	2.2	9.1	-	-
	12/05/82	61.0	5.9	3.5	0.6	220	39	134	120	200	8.0	200	894	2.2	9.4	-	-
	03/15/83	61.0	6.2	-	-	-	-	-	-	200	8.8	-	-	2.4	9.0	0.16	0.1
	05/01/83	61.0	6.6	-	-	-	-	-	-	180	8.3	-	-	2.0	8.1	-	-
	06/03/83	63.0	6.9	3.1	0.46	200	31	127	100	170	7.8	-	-	2.0	7.5	1.4	0.1
	08/14/83	62.3	6.4	3.2	0.53	200	39	135	100	180	7.6	180	-	2.1	7.8	1.4	0.9
	10/06/83	64.4	6.2	4.1	0.57	210	36	122	120	190	7.2	190	844	2.0	8.5	1.3	0.1
	12/15/83	56.0	6.2	4.4	0.60	200	32	119	120	190	7.5	180	824	1.8	8.0	1.4	0.2
	04/05/84	60.0	6.2	3.5	0.60	200	39	109	120	200	7.5	190	881	2.0	8.5	1.4	0.3
	05/10/84	63.3	6.3	3.4	0.60	210	39	115	120	200	7.7	190	865	1.8	8.6	1.5	0.3
	10/11/84	64.0	6.7	4.6	0.13	220	43	115	134	199	6.8	235	855	2.2	9.1	1.6	-
	05/26/85	62.5	6.2	4.2	0.65	241	36	106	122	212	7.9	189	768	2.1	9.3	.1.6	<50
SS-2	11/17/84	12.0	6.8	22.0	6.4	23	5.1	130	10	7.4	-	60	-	0.13	0.4	0.1	-
	07/16/85	20	6.9	13.0	5.8	32	5.3	91	11	15	0.4	53	182	0.05	0.4	0.1	0.2
Fish Hatchery area - springs in sections 34, 35, T.3S., R.28E.																	
AB Supply	07/26/73	14.5	7.3	10.0	8.4	21	4.8	91	12	6.5	0.3	56	175	0.05	0.3	-	-
	05/25/82	14.5	6.8	10.0	10.0	30	-	-	-	-	-	50	-	-	0.3	.07	-
	06/21/84	16.0	7.1	13.0	9.7	24	5.1	111	10	8.0	0.4	57	187	0.02	.37	.08	0.1
	04/12/85	15.5	6.5	-	11.	25	-	80	10	10.	-	50	125	0.02	0.4	-	1
	04/28/85	15.9	7.0	-	11.	27	5.9	110	13	11.	0.2	61	197	0.04	0.4	.94	<0.1
	05/30/85	15.7	6.7	12.4	8.4	23	5.2	96	10.5	12.1	0.3	56	190	<0.1	0.5	.07	<50
	10/31/85	16.8	7.2	-	9.	26	-	110	9	.11.	-	50	180	<0.01	0.2	-	<2

Table I-3. Chemical analyses of waters from selected springs and wells in the Long Valley area, Mono County, California (continued-pg.3)
(revised from Farrar, et al, 1985 & 1986) (Units are milligrams per litre)

Feature	Collection date	Temperature (°C)	pH	Ca	Mg	Na	K	ALK	SO_4	Cl	F	SiO_2	Dissolved Solids	As	B	Li	Hg
Fish Hatchery area - springs in sections 34, 35, T.3S., R.28E. (continued)																	
CD Supply	06/14/66	16.0	7.2	9	7	22	5	88.5	7	5	0.3	-	150	0.05	.17	-	-
	05/25/82	14.8	6.8	10	10	30	-	-	-	-	-	50	-	-	.3	.07	-
	06/21/84	14.0	7.1	11	8.1	20	4.2	97	9.7	3.7	0.4	53	155	0.03	.19	.06	0.1
	04/12/85	14.0	6.6	-	8	20	-	95	9	3	-	47	145	0.02	.2	-	1
	04/28/85	14.4	7.1	12	8.8	21	4.6	89	11	3.9	0.3	57	167	0.04	.2	.06	-
	10/31/85	14.1	7.0	-	8	21	-	95	8	4	-	47	170	0.01	.3	-	<2
H-I	06/14/66	12.0	7.5	11	6	19	5	83	7	4	0.3	-	135	0.03	.13	-	-
	05/25/82	13.0	6.8	10	7	10	-	-	-	-	-	50	-	-	.10	.05	-
	06/21/84	12.8	7.2	11	6.9	17	3.7	88	9.3	2.1	0.3	50	136	0.02	.13	.05	0.1
	04/28/85	12.9	7.2	11	6.8	18	4.0	81	11	2.1	0.3	51	143	0.04	.12	.05	
H-II, III	06/14/66	12.0	7.3	12	5	16	4	75	8	3	0.3	-	120	0.02	.08	-	-
	05/25/82	11.0	7.1	10	5	10	5	-	-	-	-	-	-	-	.1	.05	
	11/16/83	11.0	7.2	12.7	5.1	12	3.2	71	-	-	-	34	-	-	-	.04	-
	06/21/84	11.1	7.3	13.0	4.7	12	2.9	70	11	1.5	0.2	39	104	0.02	.09	.04	<0.1
	04/28/85	10.8	7.3	14	4.7	12	3.2	64	10	1.7	0.2	40	118	0.02	.08	.03	<0.1
Hot Bubbling Pool (HBP)	05/24/72	60.0	7.2	3.3	0.1	380	25	382	120	250	11.0	300	1,532	0.34	13	2.5	-
	02/04/83	56.0	8.1	7.6	0.21	368	22	374	120	250	9.2	-	-	1.5	11	2.8	0.6
	11/17/83	55.0	8.0	11	0.23	335	23	399	110	238	10.3	207	1,188	.248	10.8	3.4	-
	05/25/85	69.3	7.6	8	0.04	396	21	376	120	244	10.6	215	1,271	1.5	11.1	3.0	<50
Chance-2 Well (CW-2)	05/28/85	104	9.0	2.6	0.16	362	20	348	111	233	9.8	173	1,109	1.3	10.6	3.0	<50
	06/03/85	92.5	6.0	1.4	0.10	290	20	290	88	210	8.7	140	936	1.2	9.1	2.1	3.5
Hot Creek Gorge Area - springs in section 25, T.3S., R.28E.																	
Morning Glory Pool (HC-1)	08/29/73	90.0	6.6	1.6	0.1	400	24	-	100	225	9.6	150	-	-	10.5	2.3	-
	05/29/80	92.0	7.8	2.4	0.08	395	23	484	94	220	10.0	142	-	-	10	-	0.2
	06/03/83	94.0	8.2	1.3	0.09	390	23	461	92	215	10.0	140	-	-	10	2.6	
	12/13/83	73.3	6.8	1.4	0.29	380	22	495	110	230	9.5	140	1,210	0.9	11	2.5	0.3
Spring above bridge (HC-2)	05/29/80	92.0	8.2	1.5	0.1	370	21	433	92	210	9.6	133	-	-	9.6	-	-
	01/11/83	90.0	7.6				-	-	-	210	-	-	-	0.96	-	-	-
	05/01/83	79.0	7.2	-	-	-	-	-	-	220	8.1	-	-	0.6	10	-	-
	06/03/83	82.0	7.3	7.0	0.26	375	23	441	98	210	10.0	140	-	-	10	2.5	-
	08/19/83	82.0	7.2	6.6	0.29	370	24	449	99	220	9.2	140	1,150	1.3	10	2.4	1.1
	10/04/83	79.1	7.2	6.4	0.22	370	21	450	100	220	9.7	140	1,140	0.98	10	2.4	0.3
	12/13/83	76.3	7.3	13.0	0.43	360	17	439	98	220	9.1	140	1,130	0.9	9.6	2.4	0.2
	05/08/84	79.2	7.3	6.5	0.20	360	24	435	100	220	9.8	130	1,150	0.9	9.5	2.7	0.1
	09/03/84	78.7	7.4	6.7	0.20	360	26	430	100	220	9.4	140	1,160	0.9	9.9	2.6	<0.1
	02/04/85	76.2	7.6	6.0	0.20	350	21	405	100	220	9.5	180	1,130	0.98	9.5	2.3	<0.1
	07/16/85	78.5	7.4	-	-	-	-	-	-	230	-	140	-	-	10.	-	-

Table 1-3. Chemical analyses of waters from selected springs and wells in the Long Valley area, Mono County, California (continued-pg.4) (revised from Farrar, et al, 1985 & 1986) (Units are milligrams per litre)

Feature	Collection date	Temperature (°C)	pH	Ca	Mg	Na	K	ALK	SO_4	Cl	F	SiO_2	Dissolved Solids	As	B	Li	Hg
Hot Creek Gorge area - springs in section 25, T.3S., R.28E. (continued)																	
Geysers (HC-3)	03/16/83	89.0	8.4	3.6	0.30	380	23	475	95	220	11.0	-	-	0.99	11.	2.6	0.4
	05/01/83	90.0	7.9	-	-	-	-	-	-	230	10.0	-	-	0.8	11.	-	-
	08/19/83	91.5	8.0	2.4	0.22	380	24	473	96	230	9.9	140	1,180	1.1	10.	2.5	0.2
	11/18/83	90.0	8.2	2.9	0.22	353	23	475	105	176	6.9	165	1,131	1.6	9.8	2.8	
	12/13/83	88.3	8.2	3.7	0.20	380	24	471	94	230	10.0	140	1,150	0.9	11.	2.5	0.2
	05/08/84	91.4	8.1	2.3	0.20	380	24	490	96	230	10.0	130	1,190	0.9	9.8	2.9	0.2
	09/03/84	91.0	8.1	2.2	0.18	380	28	477	96	230	10.0	140	1,190	0.9	9.9	2.7	0.2
	11/12/84	90.2	-	-	-	-	-	-	-	220	10.0	-	-	-	10.	-	-
	02/04/85	92.0	8.1	2.5	0.20	380	23	474	98	230	13.0	180	1,170	0.9	9.9	2.4	0.2
	05/30/85	91.0	8.4	4.4	0.35	416	20	454	92	209	9.4	139	1,175	0.9	10.	2.9	<50
	07/26/85	92.8	7.8	4.4	0.20	410	22	457	98	220	9.7	140	1,190	1.1	10.	2.5	0.4
Hot Creek Gorge Area - wells in section 30, T.3S., R.29E.																	
CH-10	01/27/81	-	8.4	7.0	-	-	-	-	-	220	-	-	-	-	8.9	-	-
CH-10A	08/09/83	82.0	8.8	2.2	0.4	360	24	440	87	210	8.5	130	1,096	0.77	9.6	-	-
	11/09/84	93.3	7.2	-	0.4	340	21	463	93	200	8.4	230	1,120	0.62	9.9	2.3	0.2
CH-10B	08/16/83	83.0	8.4	6.7	0.3	360	22	435	90	200	9.5	130	1,090	1.2	9.	-	-
Shady Rest Well (preliminary analysis results)																	
SR Well	11/ /86	dh.		18	.35	388	48	-	-	260	-	105	-	-	9.9	.33	-
Laurel Spring (LS)	06/19/66	12.0	7.6	16	0	5	1.0	37	13	1	0.2	-	65	0.01	-	-	-
	06/03/83	12.0	8.6	16	0.6	5.9	1.3	40	18	0.5	0.1	-	-	.003	.02	.004	0.1
	11/17/83	10.0	8.8	14	0.6	5.3	1.2	37	17	0.4	-	20	-	.13	.05	-	-
	01/17/84	11.8	7.8	16	0.6	5.7	1.3	40	19	0.5	0.1	20	81	.004	.02	.005	0.1
	05/10/84	12.0	8.9	15	0.6	5.8	1.4	39	20	0.5	0.1	19	81	.004	.02	.006	0.1
	09/02/84	12.0	8.8	17	0.6	5.4	1.5	38	19	0.2	0.1	21	86	.003	.03	.005	<0.1
	02/02/85	12.0	8.9	17	0.6	6.2	1.3	38	19	0.6	0.2	22	85	.001	.02	.004	<0.1
	05/26/85	11.8	8.6	15.7	0.59	6.1	1.2	38	18.4	2.0	0.12	21	91	.2	.04	<.01	<50

Table 1-4

Stable Isotope Data from Springs & Wells
(From Farrar, et al, 1986)

Location	Date	δD	$\delta^{18}O$	
Casa Diablo Area				
Geyser (CDG)	6/26/83	-111.6	-13.5	
	11/18/83	-118	-13.2	boiled liquid
	6/29/84	-113.7	-13.6	
	9/ 4/84	-113	-13.5	
	5/29/85	-114	-13.5	
North Spring (CDWS)	6/26/83	-110.9	-12.8	
	12/15/83	-115	-14.3	
	5/ 9/84	-116	-14.3	
	9/ 4/84	-114	-14.2	
	2/ 6/85	-115	-14.0	
	7/16/85	-115	-14.1	
South Spring (CDSS)	2/ 4/83	-115	-14.3	
	3/15/83	-118.4	-14.7	
	6/ 3/83	-122	-14.8	
Well MPB-1	1/ 7/84	-114	-13.2	
	7/11/85	-128	-17.7	separated gas
	7/11/85	-116	-14.2	sep. liquid
	7/11/85	-117	-14.8	total flow liquid
Well IW-2	1/ 7/84	-128	-14.2	
MPB-5	1/ 5/84	-111	-13.4	
MPB-3	7/12/85	-116	-14.8	total flow liquid

Table 1-4, cont'd.

Location	Date	δD	$\delta^{18}O$	
Colton Spring Area				
Colton Spring	3/15/83	-112.5	-14.3	
	5/ 9/84	-115	-14.3	
	5/26/85	-115	-14.2	
Meadow Spring	3/15/83	-117.2	-15.1	
	5/10/84	-121	-15.1	
	5/26/85	-121	-13.7	
Well SS-2	11/17/83	-116	-15.1	
	7/16/85	-114	-15	
Fish Hatchery Area				
Springs 2,3	11/16/83	-128	-15.8	
	4/16/85	-124	-16.3	
	4/28/85	-123	-16.5	
Springs AB	4/28/85	-115	-15.2	
Springs CD	4/28/85	-118	-15.8	
Hot Bubbling Pool	6/26/83	-111.2	-12.4	
	6/28/84	-113.7	-13.1	
	5/28/85	-113	-13.2	
Well CW-2	5/28/85	-117	-14.3	sep. liquid
	5/28/85	-140	-18.9	separated gas
	5/28/85	-121	-15.2	total flow liquid

Table 1-4. cont'd.

Location	Date	δD	$\delta^{18}O$
Hot Creek Gorge Area			
Spring HC-1	6/ 3/83	-118.4	-14.9
	12/13/83	-118	-14.2
Spr. HC-2	6/ 3/83	-119.4	-14.2
	12/13/83	-117	-14.8
	7/16/85	-120	-14.7
Spr. HC-3	6/27/83	-120.6	-14.4
	9/ 3/84	-119	-14.8
	5//29/85	-121	-14.9
Laurel Spring (LS)	6/ 3/83	-123.7	-16.8
	9/ 2/84	-126	-16.9
	5/26/85	-127	-17.0

Table 2.1

Parameters Used for Heat Balance Calculation

Block	1	2	3	4
T_o (°C)	180	150	130	100
Volume (m^3)	$4.4 \times 10^9 m^3$	2.2×10^9	2.2×10^9	2.2×10^9
Q_{prod}	240 (1) 550 (2) 1170 (3)	-	- 620 (3)	-
Q_{inj}	240 (1) 550 (2) 1170 (3)	-	- 620 (3)	-
Q_{rech}	130 kg/s	-	-	-
T_{rech}	200 °C	-	-	-
Q_{spring}	-	-	30 kg/s	100 kg/s
T_{inj}	80°C	-	60°C	-

(1) MP I only
(2) MP I and PLES I case
(3) Cummulative case

General		
	Porosity	15%
	Rock Density	2600 kg/m^3
	Water Density	950 kg/m^3
	Rock Heat Capacity	240 cal/kg-°C
	Water Heat Capacity	100 cal/kg-°C

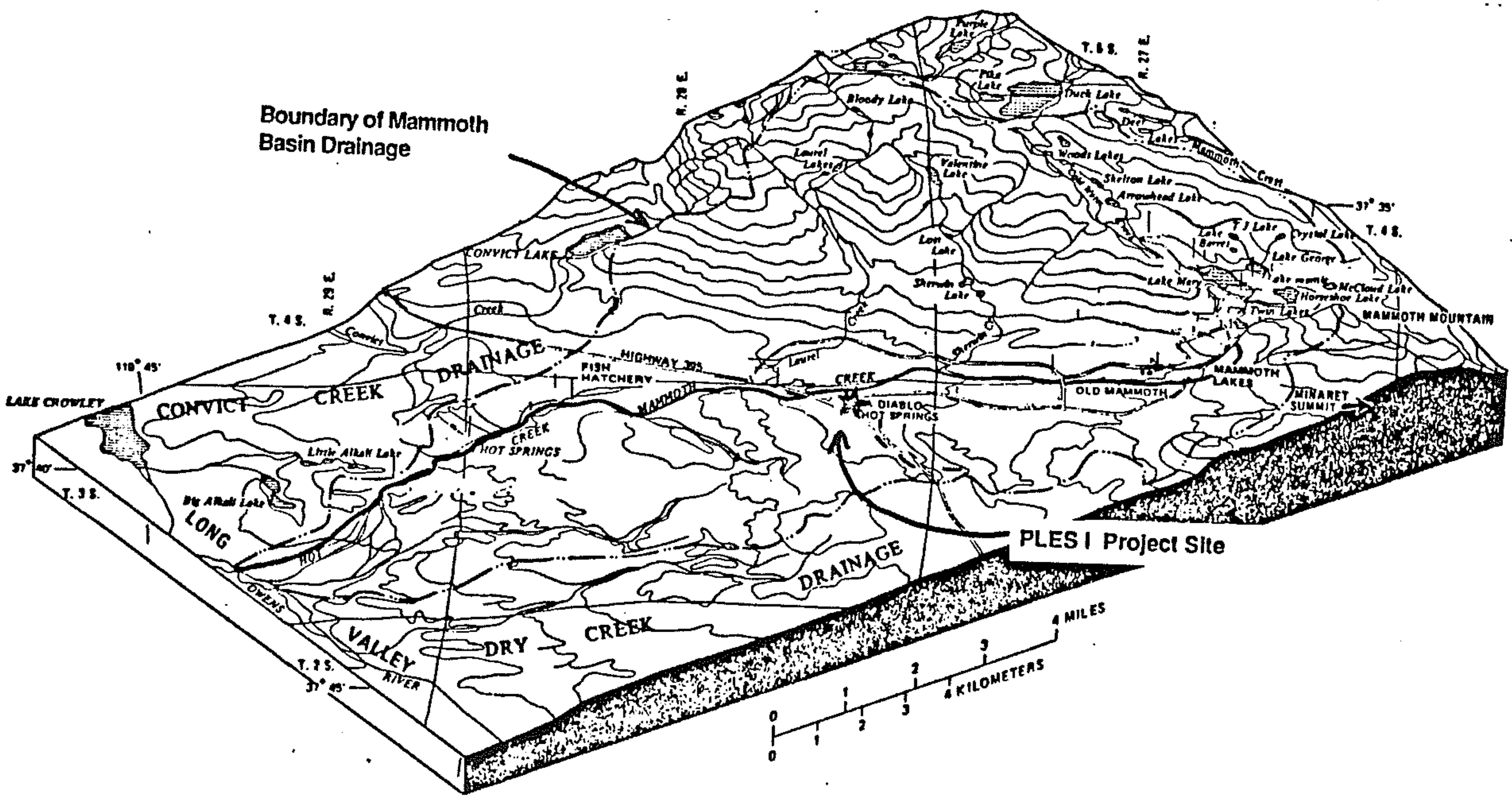


Figure 1-1 Surface Drainage Features of the Mammoth Creek Basin.

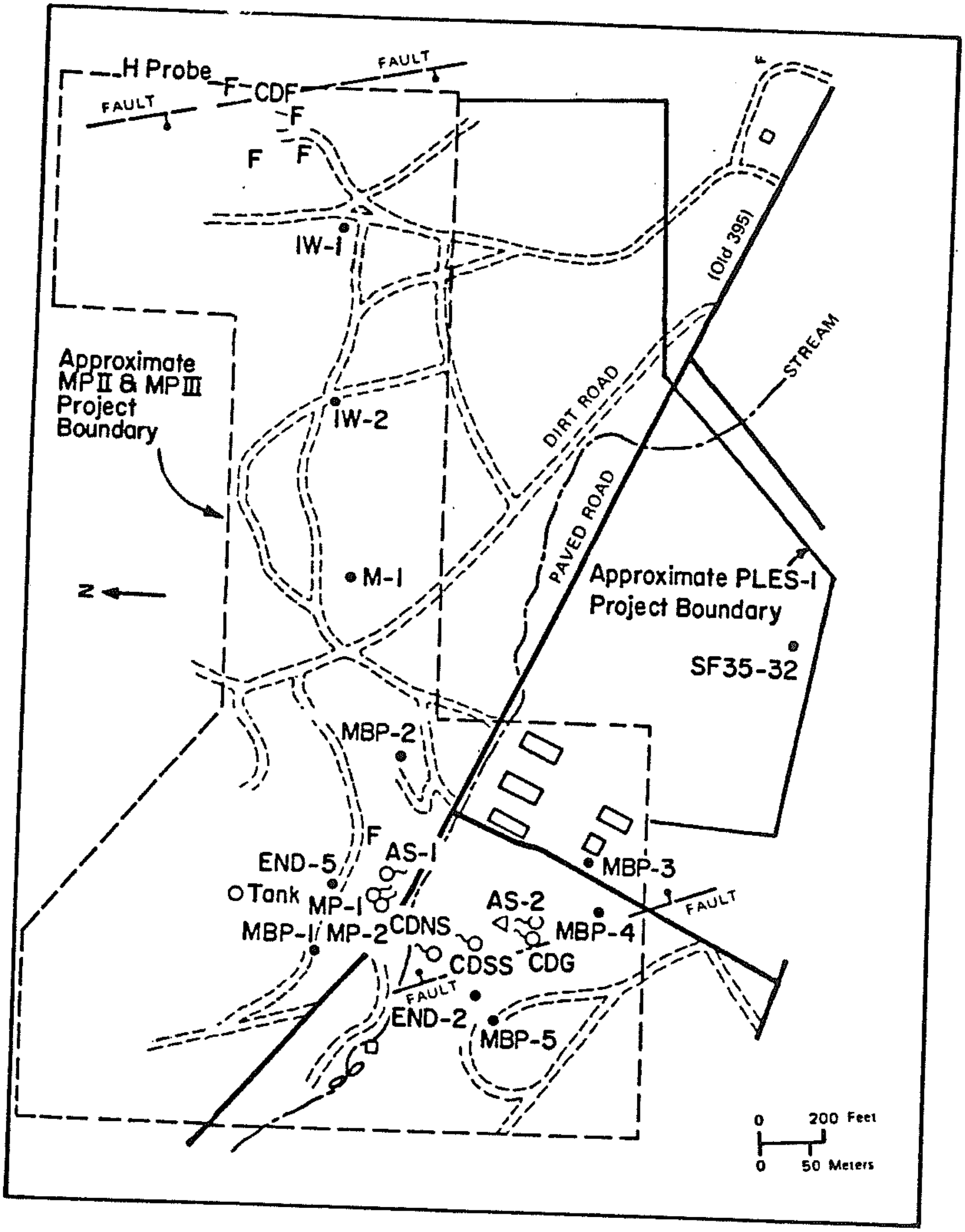
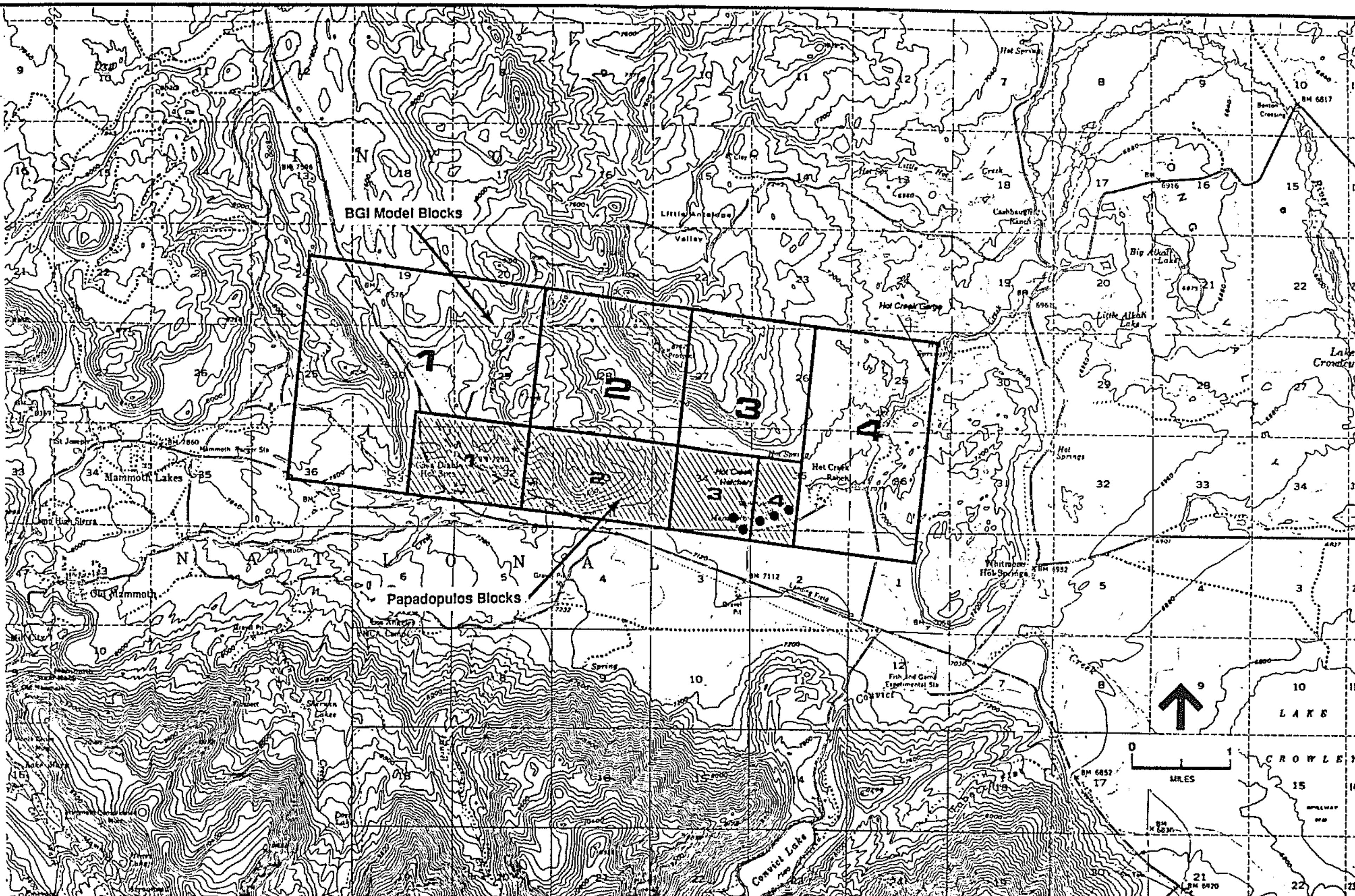


Figure 1-2. Map of the Casa Diablo Area showing the location of the proposed PLES I site, existing wells and springs.

(revised after Farrar et al, 1985)



● Location of Convective Discharge

FIGURE 2-2 Comparison of Reservoir Simulation Blocks Used in the Heat Balance Calculation.

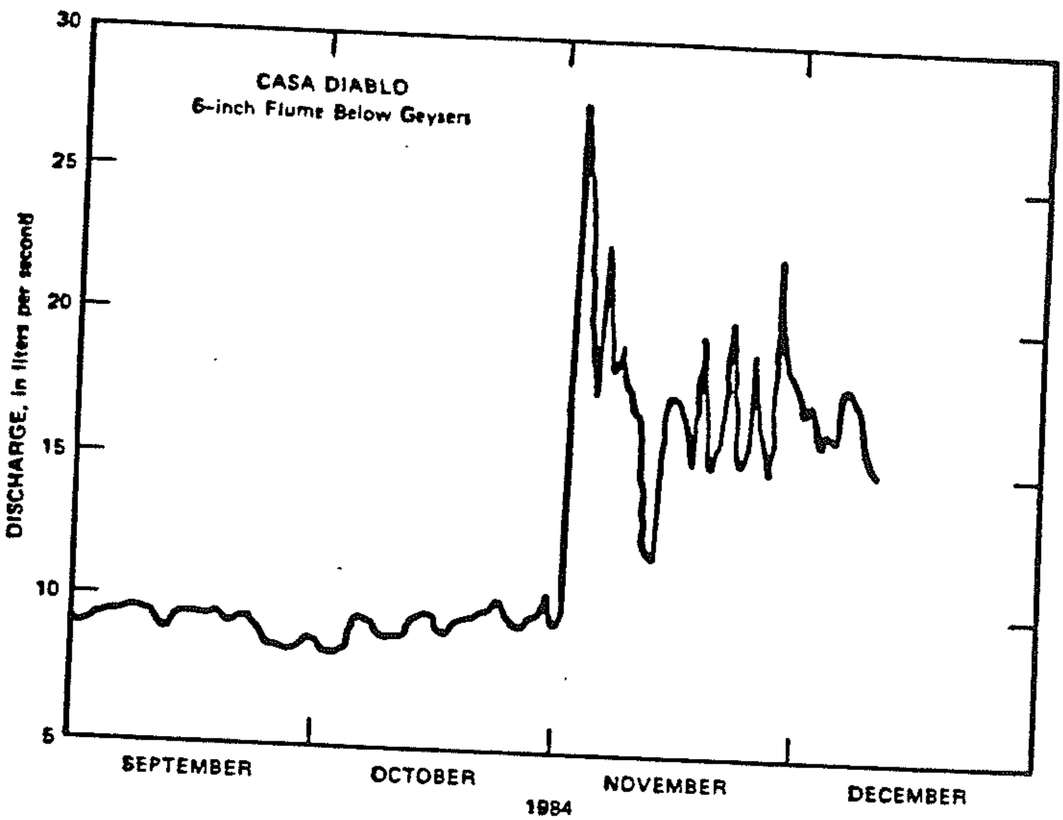


Figure 1-4. Flowrate of Casa Diablo Geyser (CDG) spring discharge, 1984.

(after Farrar et al, 1985)

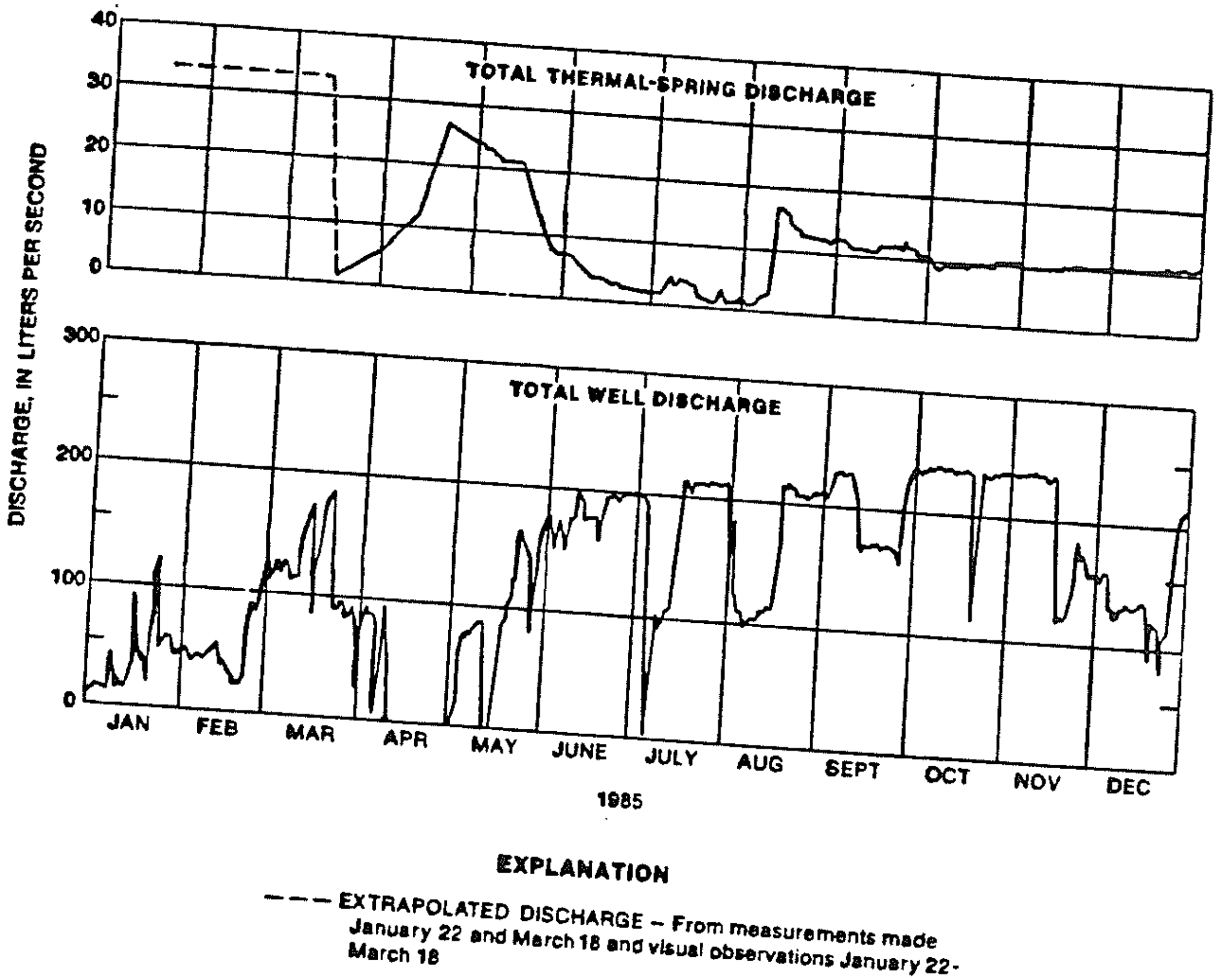


Figure 1-5. Flowrate of all Casa Diablo Springs during 1985.
(after Farrar et al, 1985)

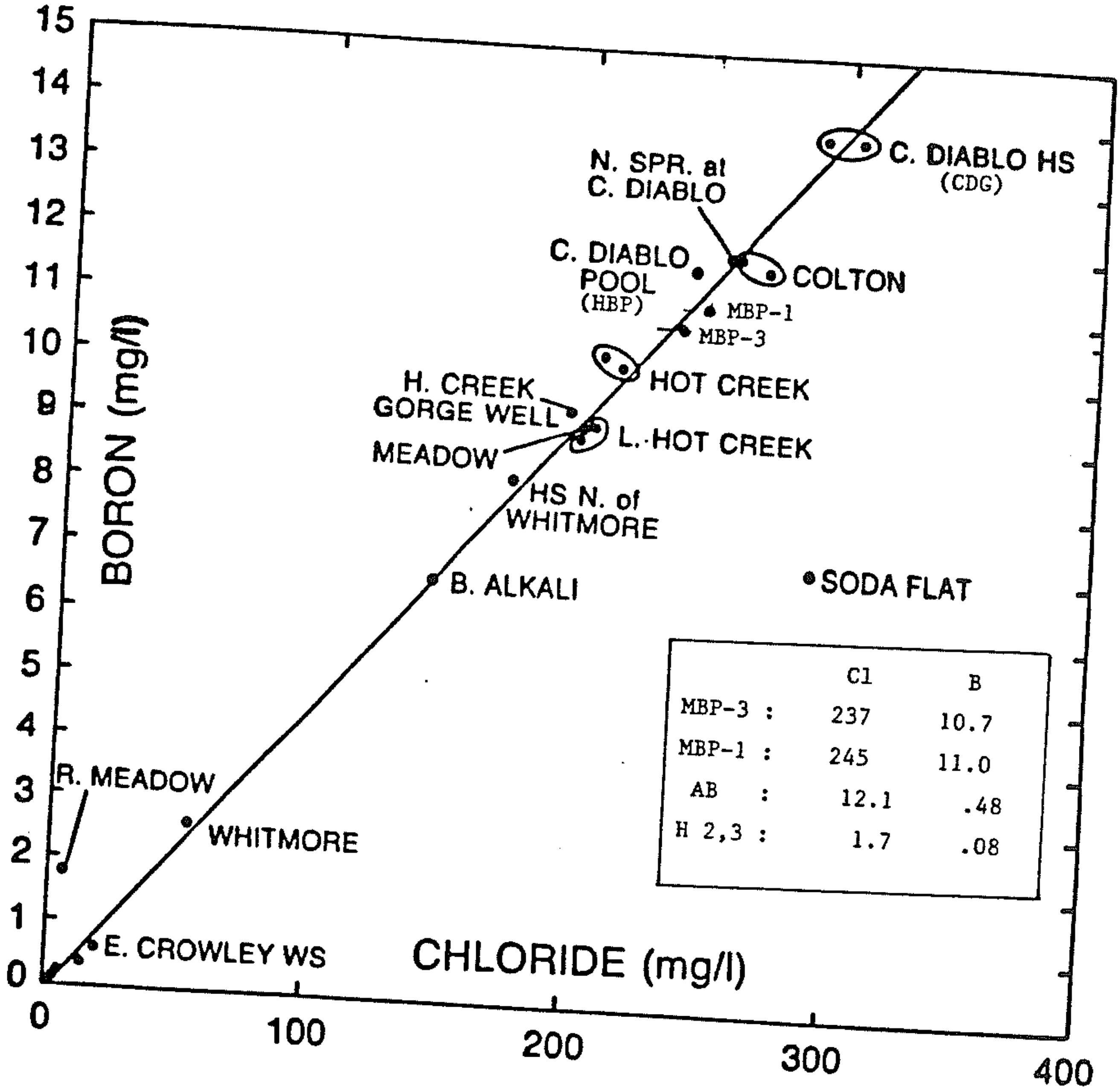


Figure 1-6. Plot of Boron vs. Chloride for selected spring and well waters.
(revised after Shevenell et al, in print)

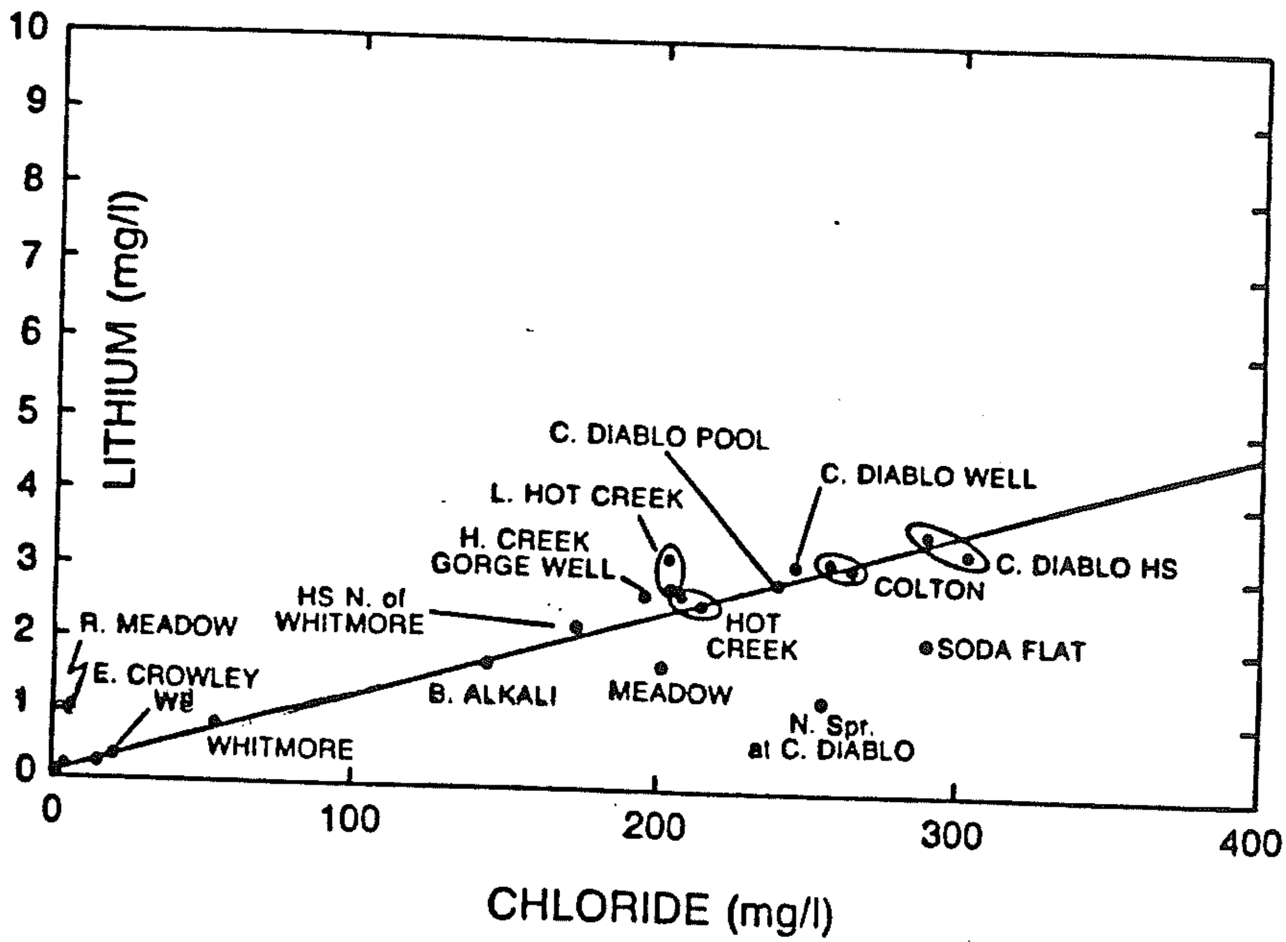


Figure 1-7. Plot of Lithium vs. Chloride for selected spring and well waters.

(after Shevenell et al, 1987, in print)

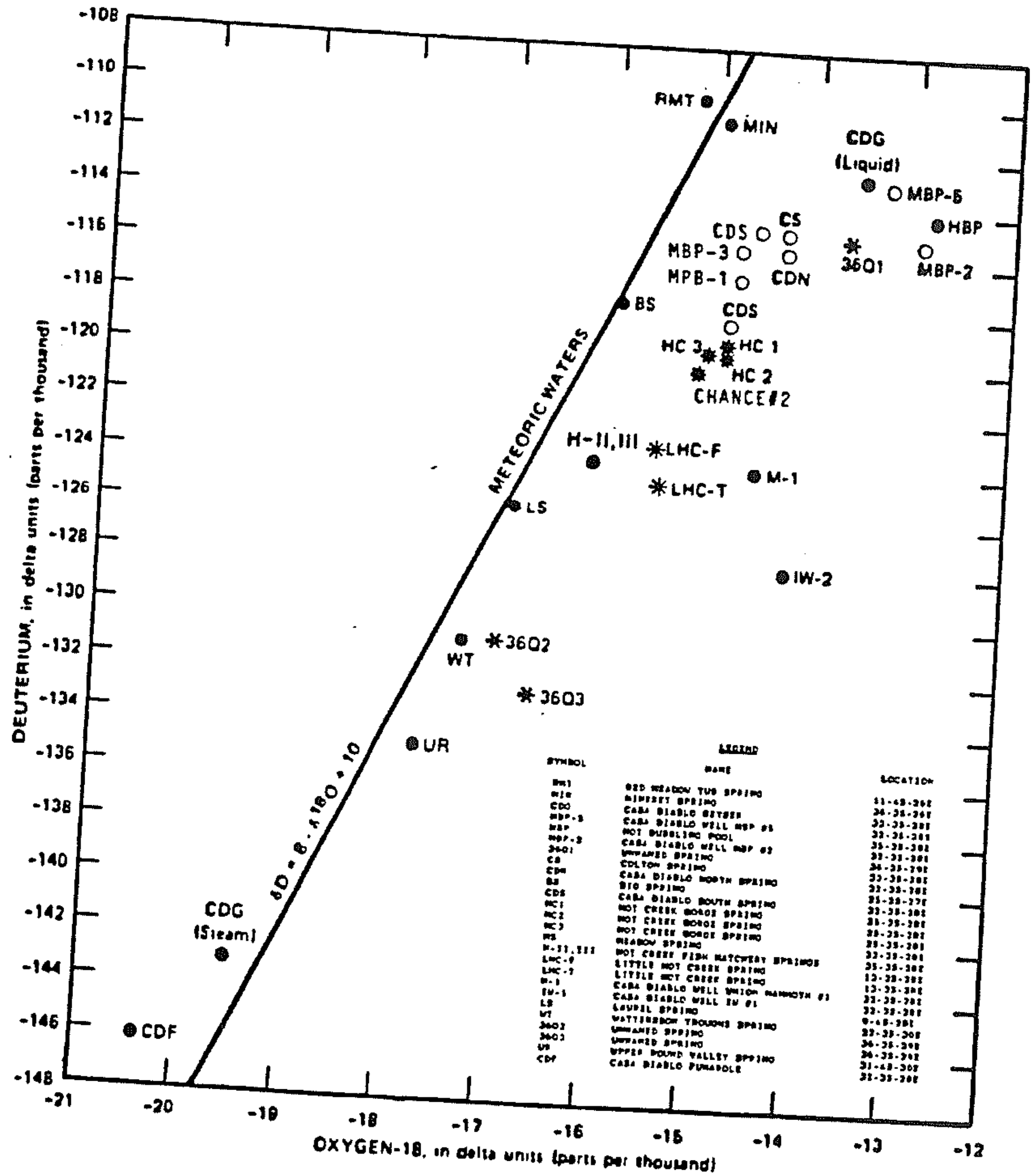


Figure 1-8. Plot of stable Hydrogen vs. Oxygen isotopes for selected spring and well waters.

(revised after Sorey et.al. 1984)

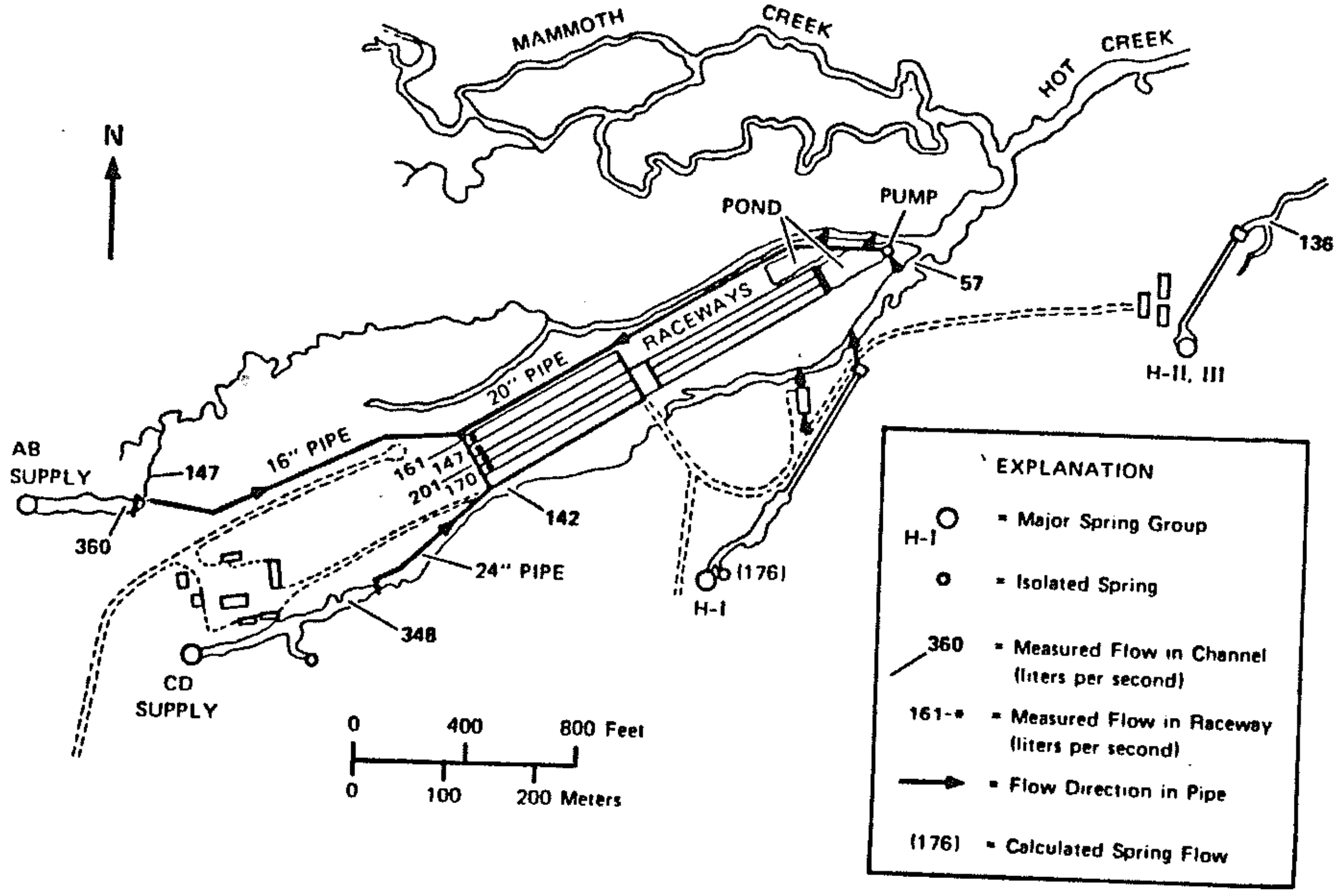


Figure 1-9. Map of the Hot Creek Fish Hatchery including the location of springs. (after Farrar et al, 1985)

FIGURE 1-10 Temperature of Fish Hatchery AB Spring.

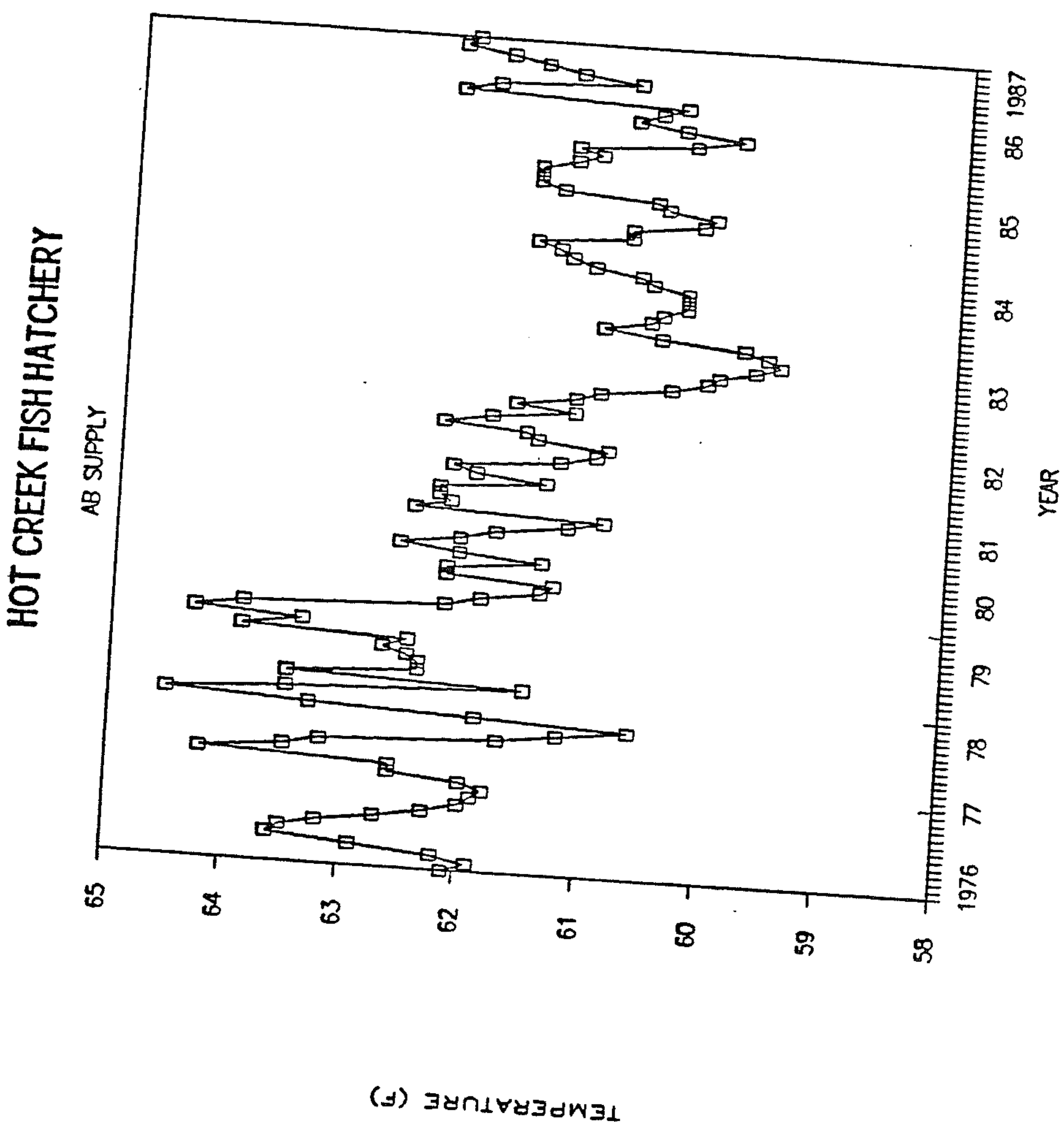


FIGURE 1-11 Temperature of Fish Hatchery CD Spring.

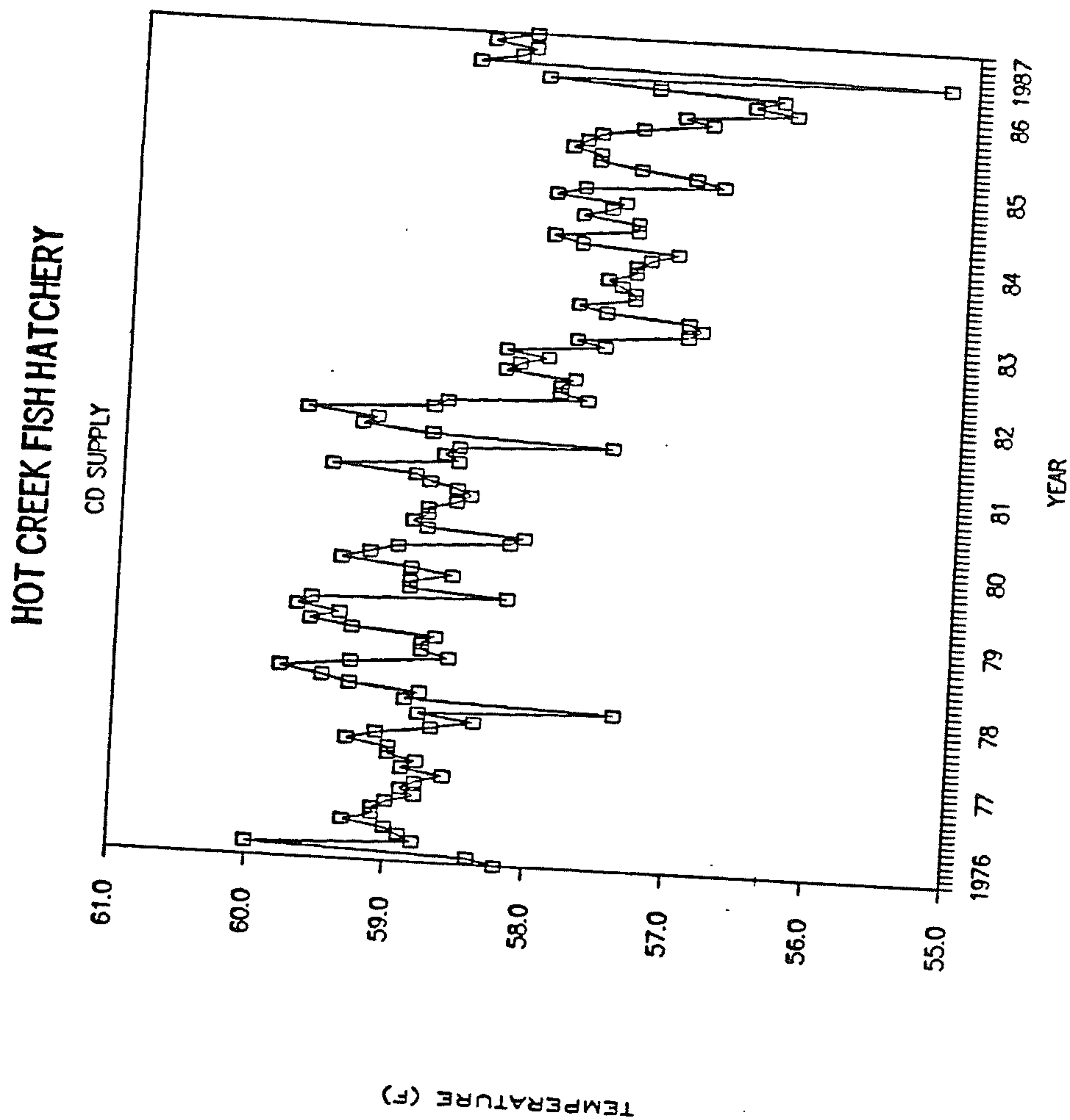


FIGURE 1-12 Temperature of Fish Hatchery I Spring.

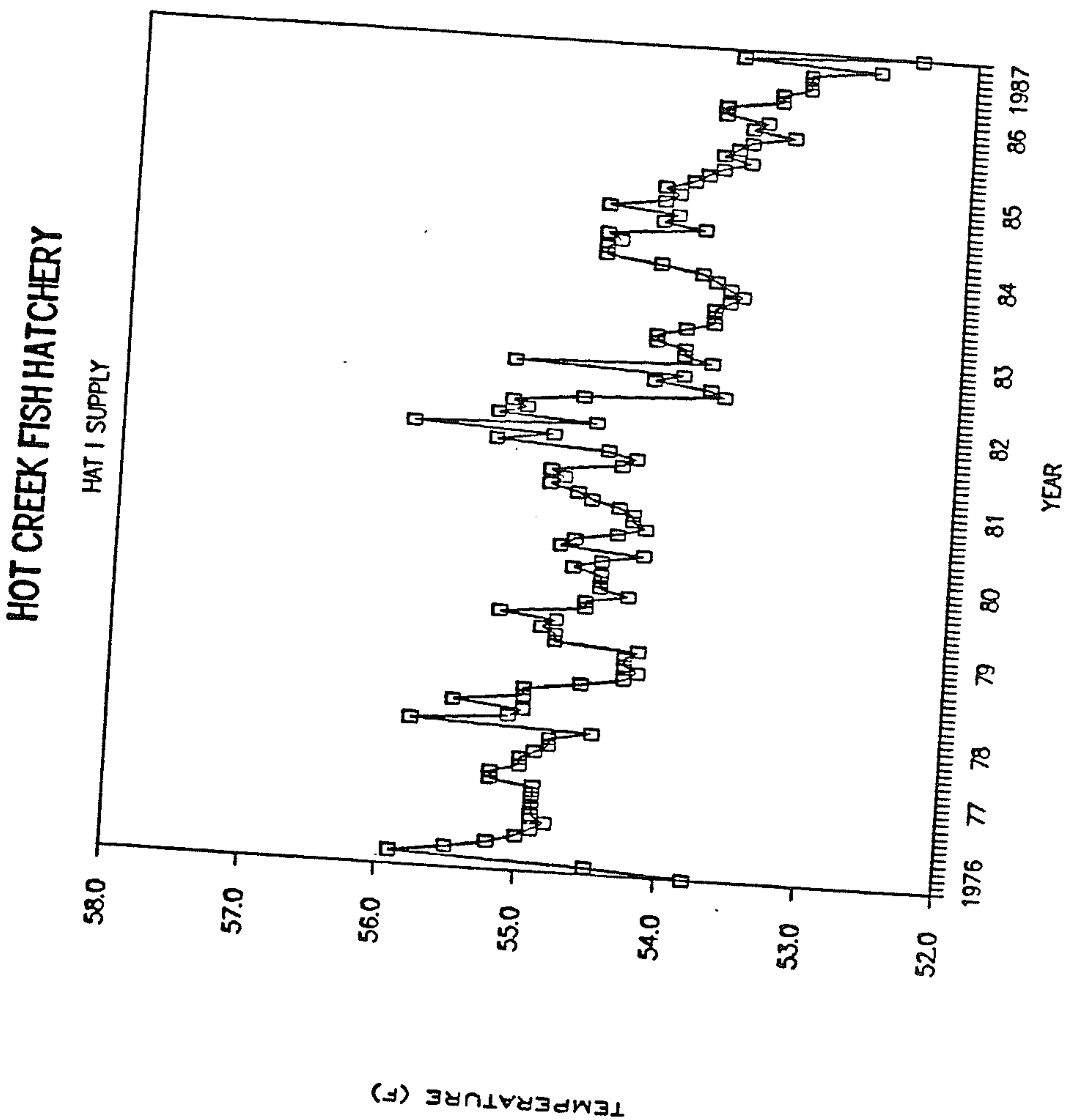


FIGURE 1-13 Temperature of Fish Hatchery II,III Spring.

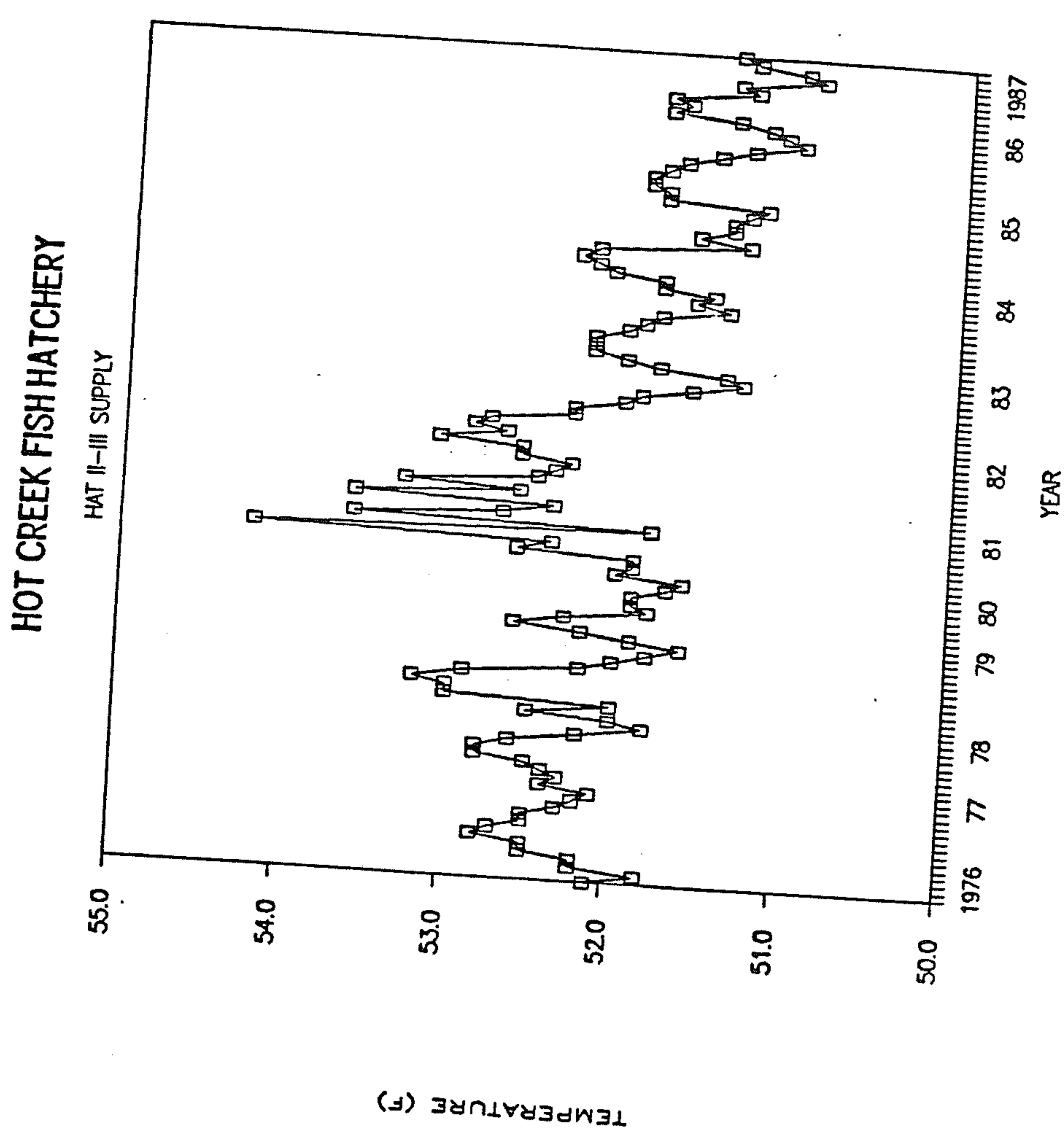
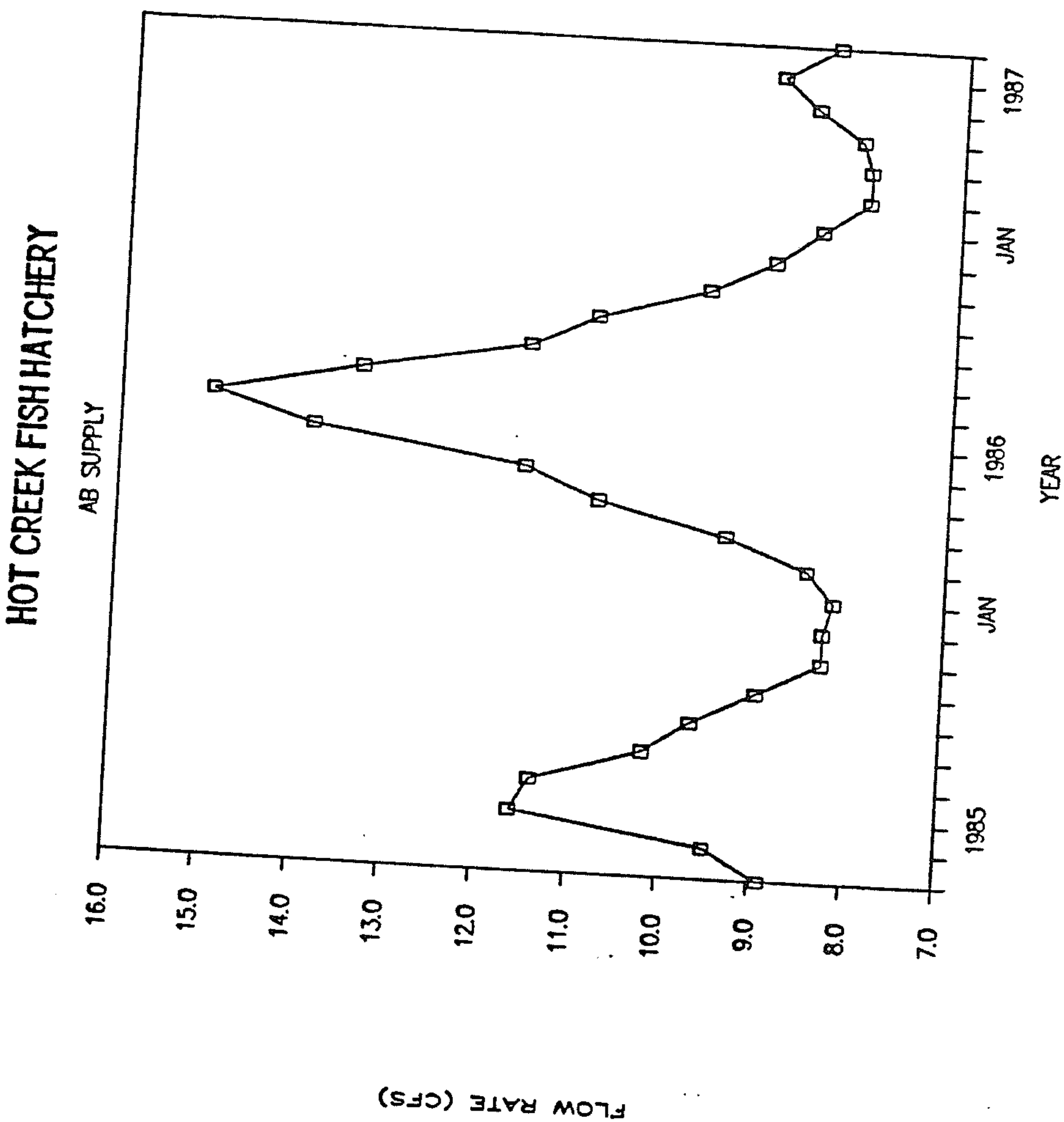


FIGURE 1-14 Flow rate of Fish Hatchery AB Spring.



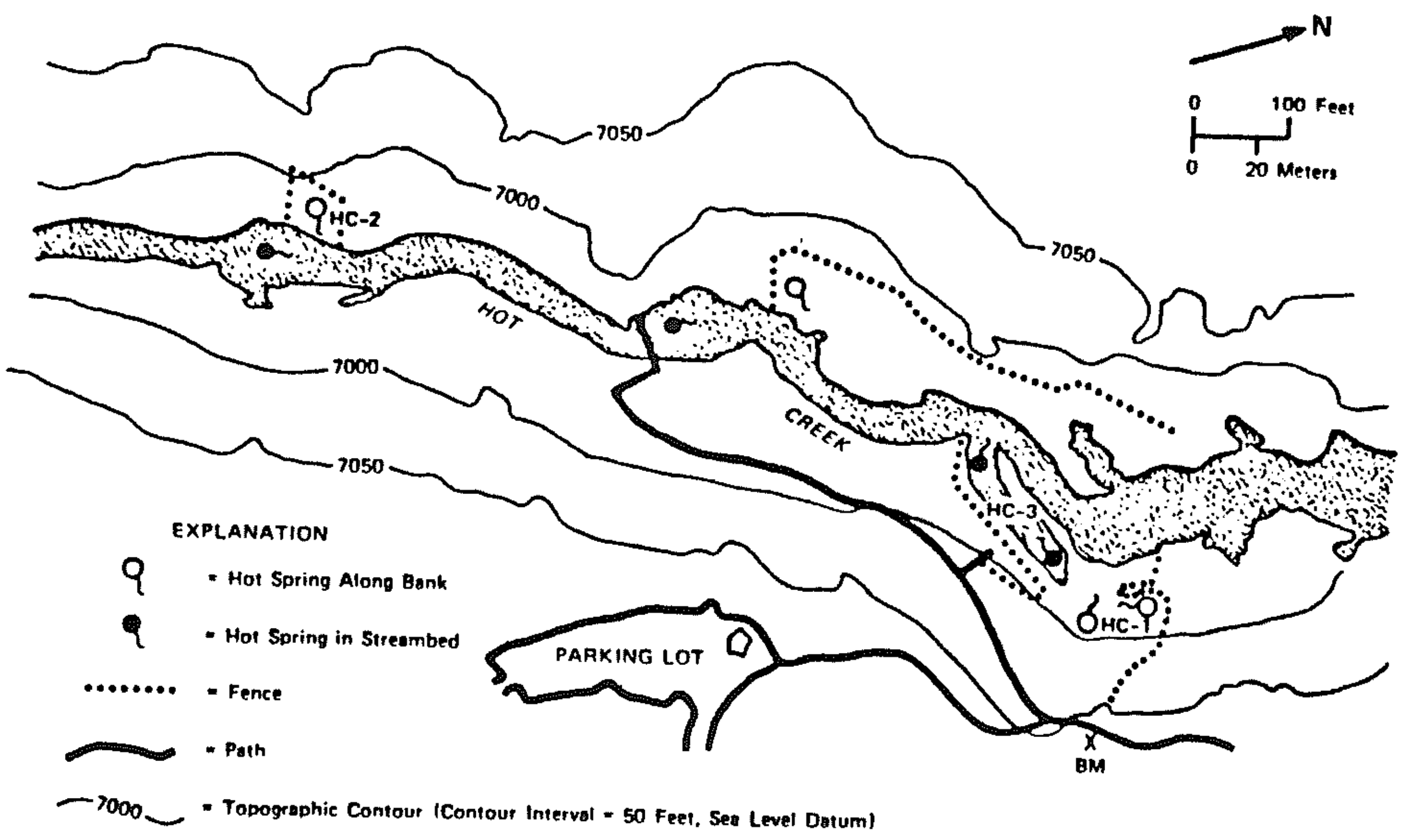


FIGURE 1-15 Map of a part of Hot Creek Gorge, including the location of springs.

(after Farrar et al, 1985)

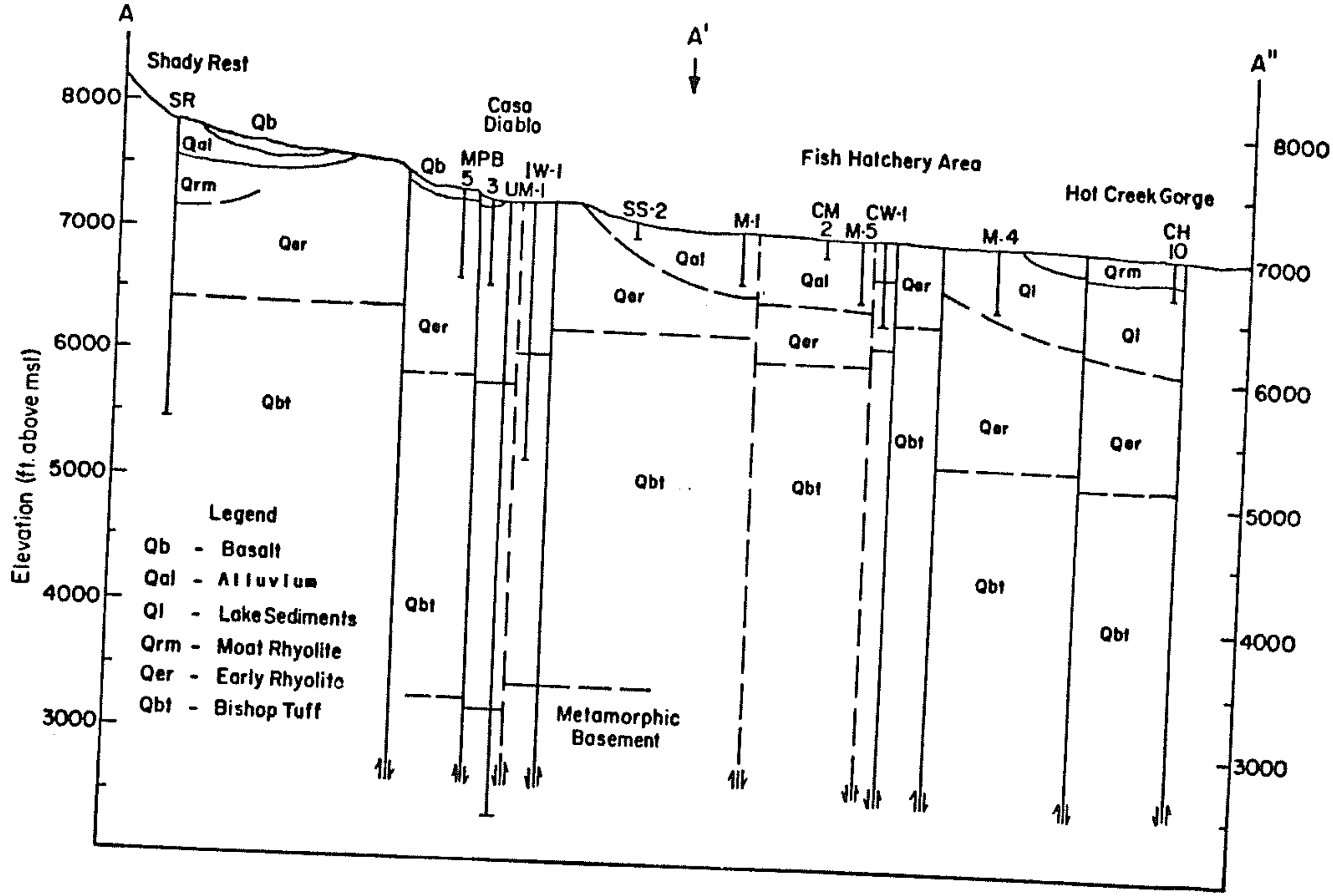


FIGURE 1-16 Geologic Cross-section along A -A'-A" from Figure 1-3, showing the location of selected wells.

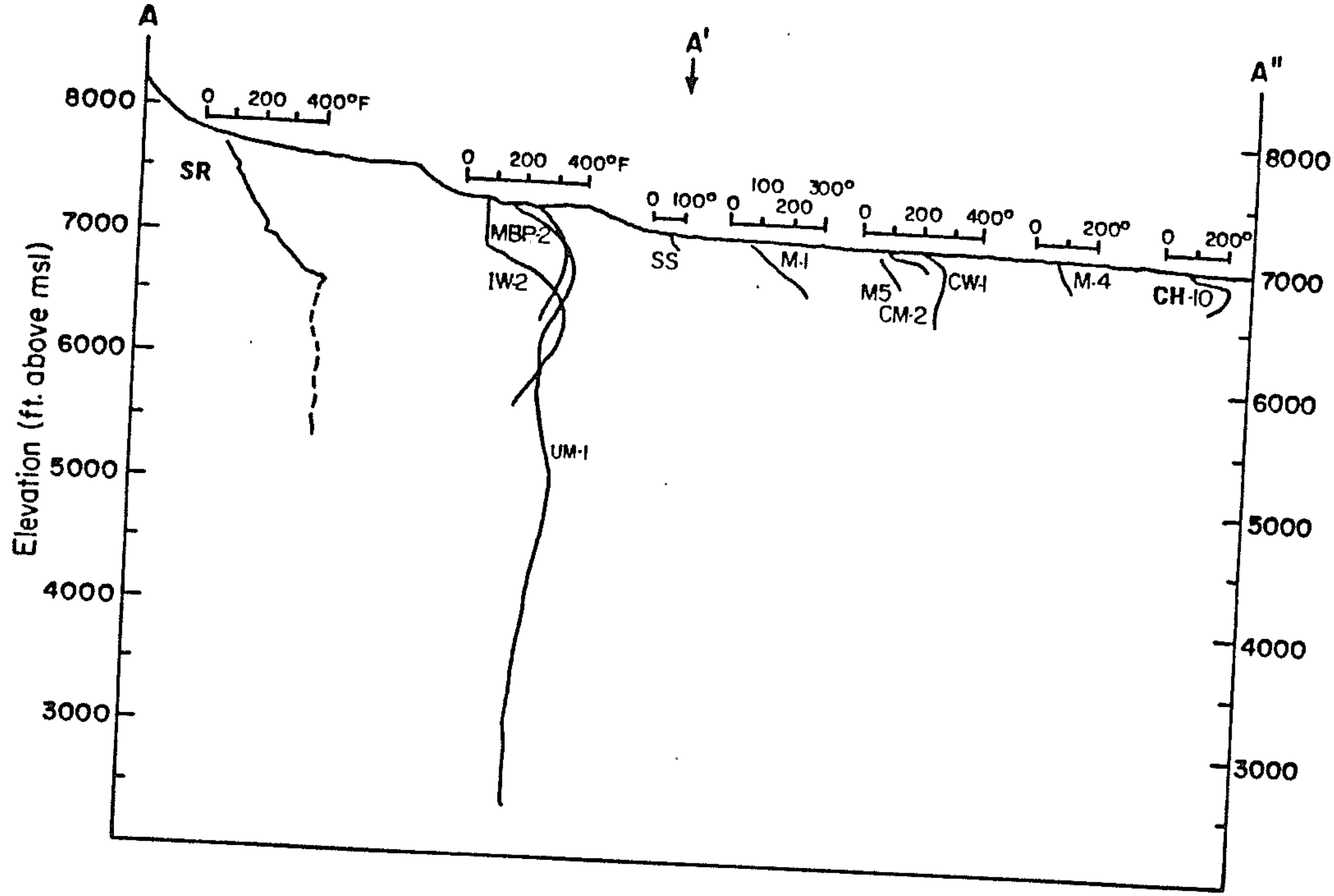


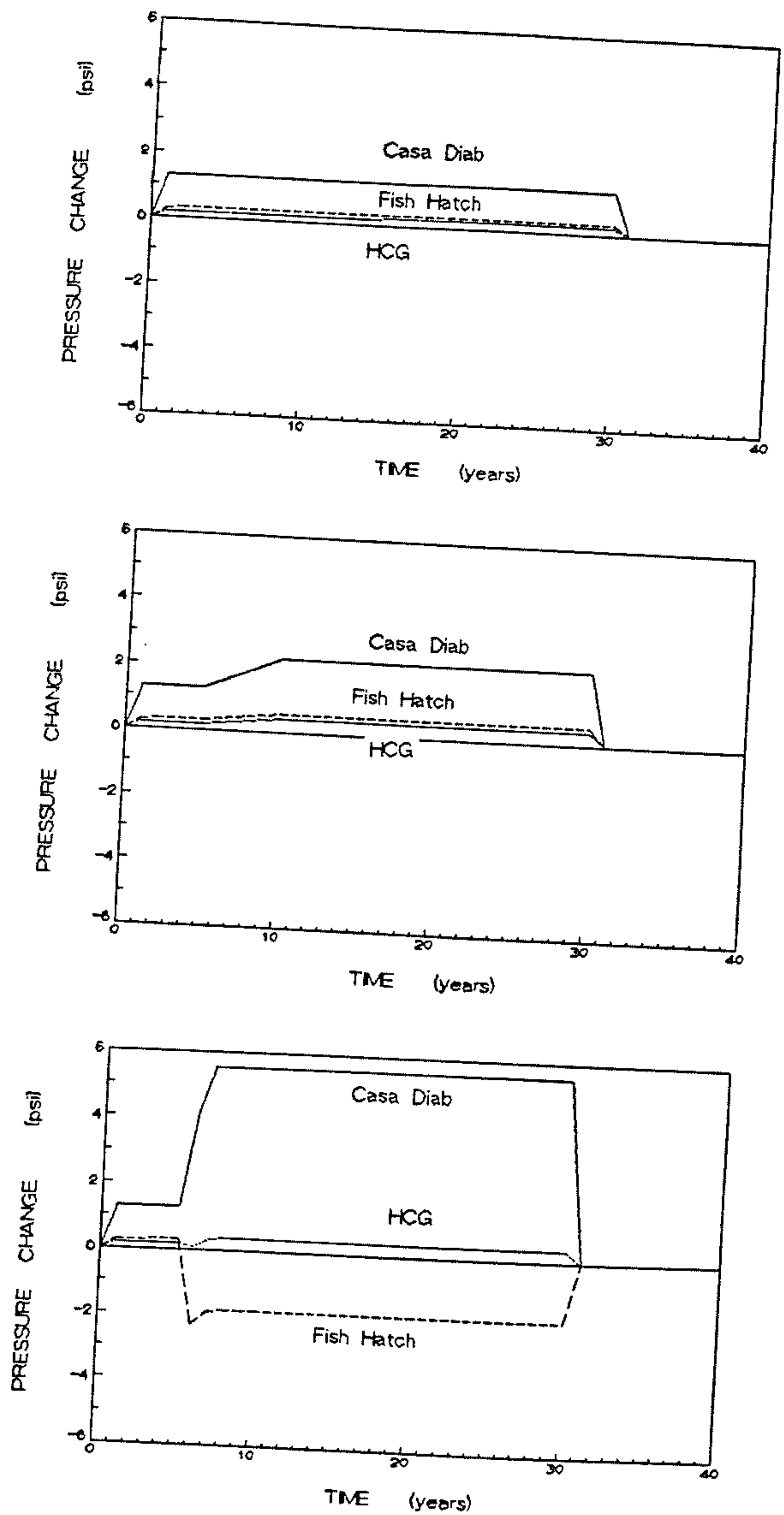
FIGURE 1-17 Cross-section along A-A'-A" from Figure 1-3, showing selected well temperature profiles.

FIGURE 2-1 Calculated Reservoir Pressure Response in the Casa Diablo, Hot Creek Gorge and Fish Hatchery Areas.

MP-I only

MP-I and PLES-I

Cumulative
MP-I,II,III,PLES-I and M/C-I



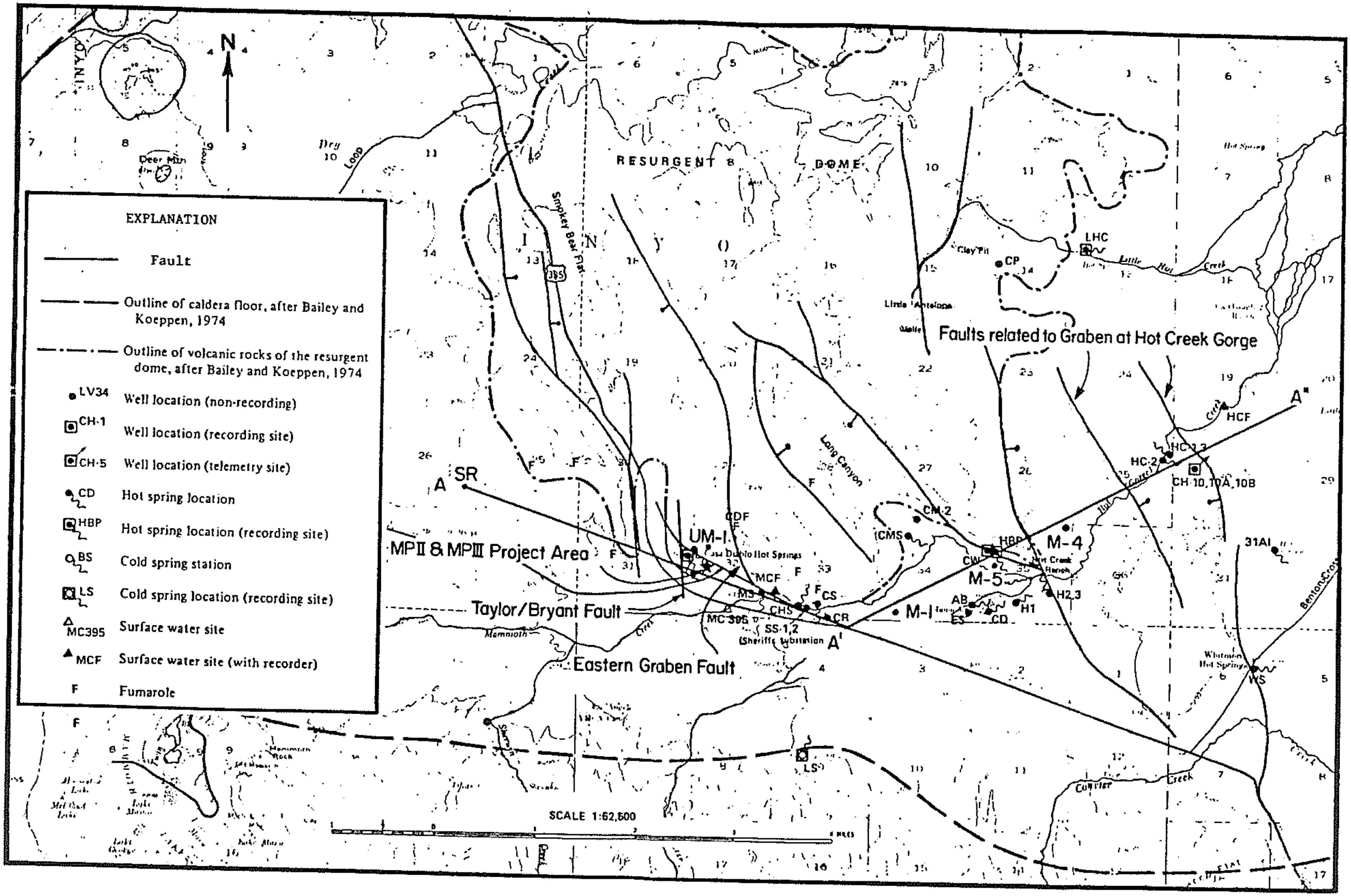
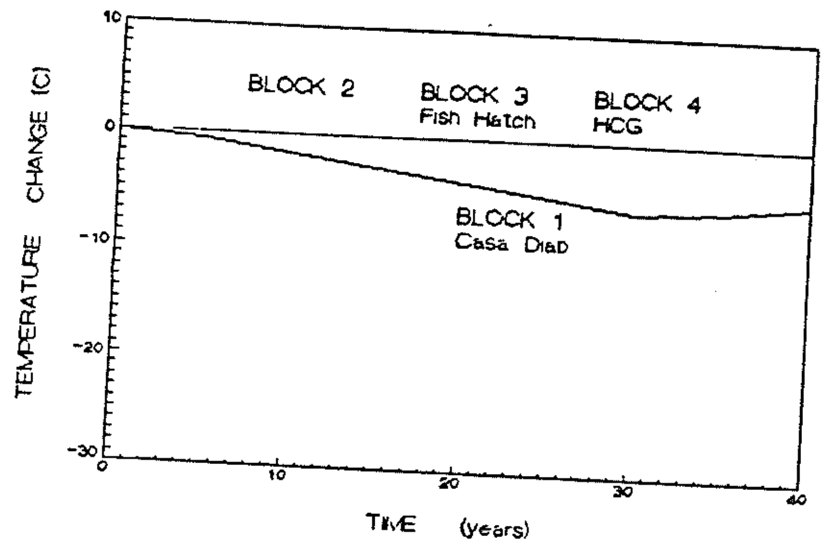


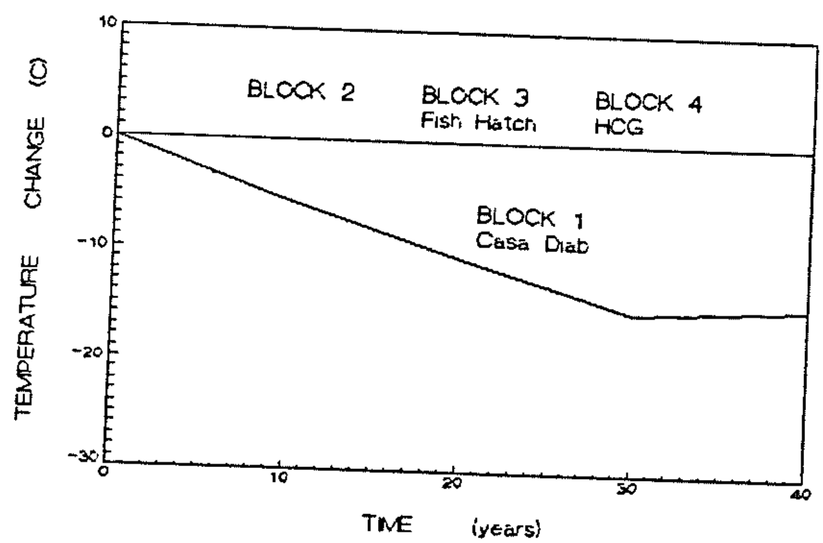
Figure 1-3. Map of the southern region of the Long Valley Caldera showing the location of the proposed MP II and MP III sites, faults, thermal features, wells and the trace of cross-section for Figures 1-11 and 1-12.

FIGURE 2-3 Calculated Reservoir Temperature Changes in the Casa Diablo, Hot Creek Gorge and Fish Hatchery areas.

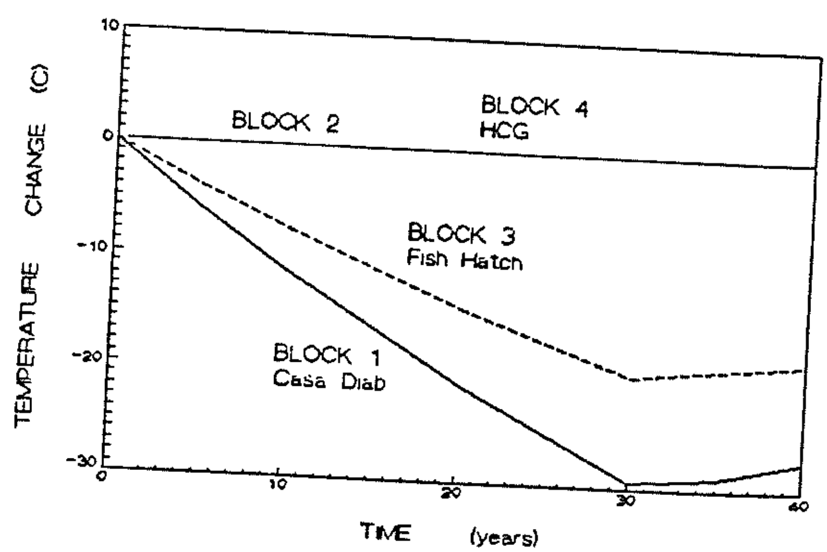
MP-I only



MP-I and PLES-I



Cumulative
MP-I,PLES-I,MP-II,
MP-III and M/C-I



APPENDIX D

BIOLOGICAL SURVEYS

BIOTIC ASSESSMENT FOR PROPOSED GEOTHERMAL ENERGY FACILITIES, CASA DIABLO HOT SPRINGS, MONO COUNTY, CALIFORNIA

Biotic Assessment
Casa Diablo Geothermal

Prepared By:

Dean Wm. Taylor
Richard Buckberg
BioSystems Analysis, Inc.
303 Potrero, Suite 29-203
Santa Cruz, CA 95060

Prepared For:

Environmental Management Associates, Inc.
405 S. State College Boulevard, Suite 211
Brea, CA 92621

Pacific Lighting Energy Systems
6055 East Washington Boulevard
Commerce, CA 90040

January 12, 1987

J-302

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report provides an inventory of biotic resources for the site of proposed geothermal energy resource developments near Casa Diablo Hot Springs in Mono County, California. This region is one of existing and proposed electrical generation facilities utilizing hot water derived from volcanic sources.

Environmental Management Associates, Inc., on behalf of Pacific Lighting Energy Systems (PLES) has subcontracted with BioSystems Analysis, Inc. (BSAI) to conduct a baseline biological inventory and assessment of the Casa Diablo Hot Springs area and vicinity. The results of this survey will be used as baseline information and background for biological impact assessment for environmental reports in relation to proposed geothermal development. This report presents the results of BSAI's inventory, characterization, and assessment of the biotic resources of the Casa Diablo Hot Spring area.

2.0 STUDY AREA DESCRIPTION

2.1 GEOGRAPHIC SETTING

The Casa Diablo Hot Spring study area consists of approximately 623 acres (252 ha). The exact boundary of the study area in which biological resources were studied is shown in Figure 1.

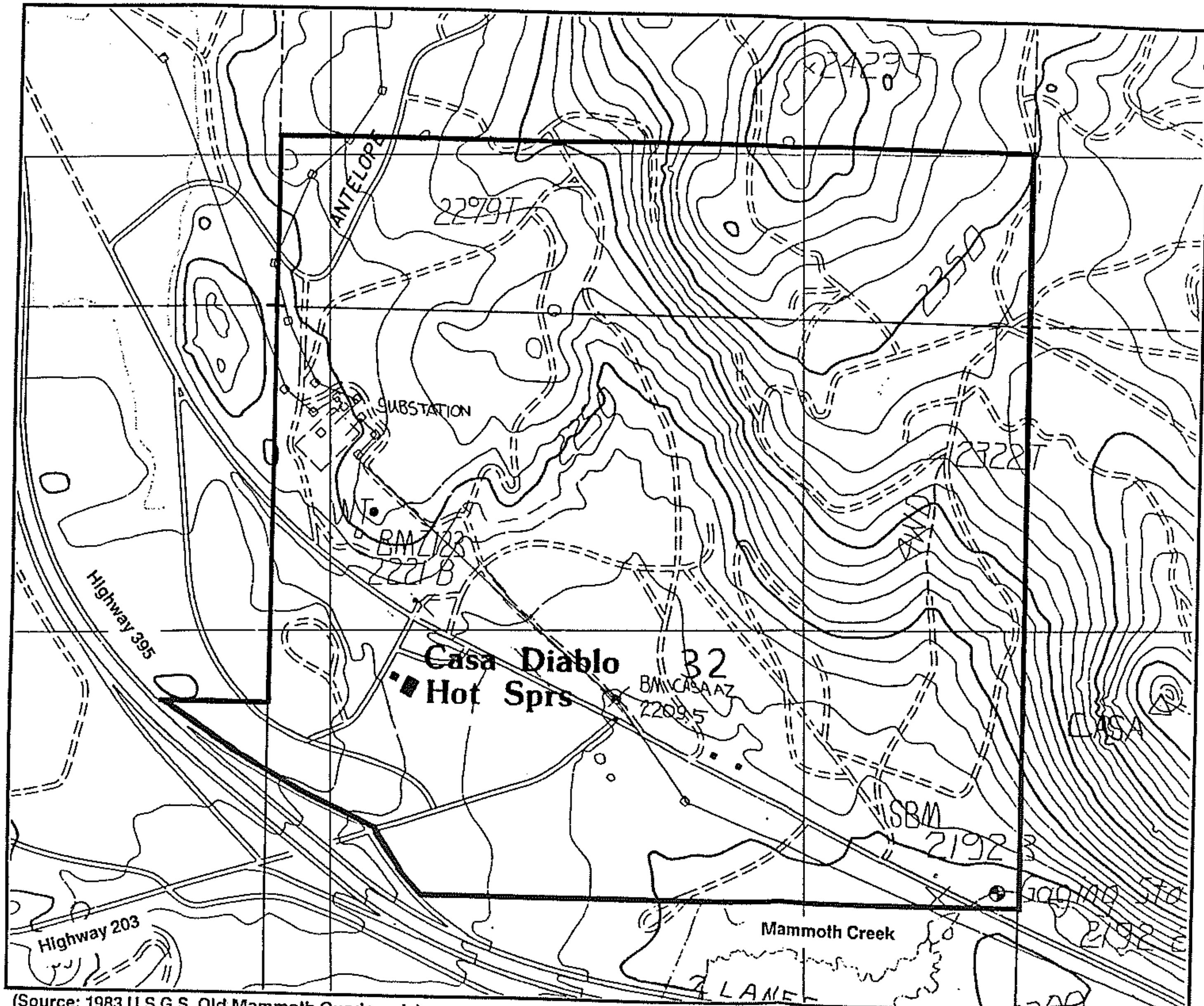
Location - The study area is located in Township 3 South, Range 28 East (Mount Diablo Base Line & Meridian) in portions of Section 28, Section 29, Section 32 and Section 33 (Figure 1).

Vicinity - Casa Diablo Hot Springs is located adjacent to and east of Highway 395 approximately 35 miles north of Bishop and 25 miles south of Lee Vining, situated near the junction with Highway 203. The site is about 4 miles east from the town of Mammoth Lakes.

Land Ownership - most lands adjacent to and within the study area are administered by the U.S. Department of Agriculture, Forest Service, being situated on the Mammoth District of the Inyo National Forest. Approximately 90 acres of the site are in private ownership under geothermal lease. The remaining federally administered area is leased for geothermal energy development, with administration of said leases under the direction of the Bureau of Land Management.

2.2 PHYSIOGRAPHY AND REGIONAL CLIMATE

The study area is located at the eastern base of the Sierra Nevada, bordering the boundary between the Sierra Nevada and Great Basin physiographic provinces. As situated, Casa Diablo Hot Springs and the Mammoth region in general is located in a portion of the Sierra where the crest is relatively low in elevation compared to areas directly to the north or south. As a consequence, the area to the north of Casa Diablo Hot Springs is heavily forested, contrasting markedly with the otherwise sagebrush dominated deserts to the east and south.



(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

Figure 1. Location Map

STUDY AREA BOUNDARY

SCALE 1:8,615

0 850 1700

FEET

N

Elevations within the study area range from 7200 feet to 7900 feet. Relief on the western and southern portions of the site is moderate, with hills and steeper slopes to the east (Figure 1).

The relatively mesic climate in the vicinity of Mammoth can be attributed largely to the low elevation of the Sierran crest to the east, allowing storms from the west to penetrate through the nearby passes (cf. Smith 1976). Winter climate at the vicinity of Casa Diablo Hot Springs is characterized by abundant snowfall and cold temperatures. Snow pack depth at maximum extent is about 3 feet in years of average precipitation. Annual precipitation in the vicinity of Casa Diablo Hot Springs is on the order of 25 inches. Winter temperatures are generally in the 10°F-30°F range, while summer temperatures are generally in the 40°F-70°F range.

2.3 GEOLOGY

The study area is situated in a region of active recent vulcanism (Bailey et al. 1976). Casa Diablo Hot Springs is located on the southwestern margin of the Long Valley caldera, a large volcanic depression at the headwaters of the Owens River in which present-day Crowley Lake is located. The source of energy driving the thermal features at Casa Diablo Hot Springs and elsewhere in the region is a residual magma deposit underlying the region at a fairly shallow depth (Miller 1985, Storey et al. 1978).

Surface rocks exposed within the study area consist largely of rhyolite, tuff and basalt deposits (Bailey and Koppen 1977). Small exposures of hydrothermally altered rocks occur about the area that are rich in clays, and small travertine deposits occur in association with the hot springs proper.

3.0 SURVEY METHODS

Selection of methodology appropriate for identification of biotic resources of the Casa Diablo study site was made after consultation with agency personnel. Unpublished information for this biotic assessment was gathered from files of appropriate government agencies. Table 1 provides an enumeration of agency personnel contacted during the biotic assessment process.

3.1 REVIEW OF LITERATURE AND DATA SOURCES

Publications and documents on the vegetation and wildlife of Mono County and specifically the Mammoth region were assembled and reviewed, and information was gathered from local agency experts prior to fieldwork. Previous environmental and planning documents for the region were reviewed, including the Mammoth-Mono Planning Unit Plan (U.S. Forest Service 1978), the draft Inyo National Forest Plan (1986), and U.S. Forest Service environmental assessments related to leasing of potential geothermal sites within the Long Valley caldera (USFS 1980, 1982).

Literature on the wildlife of the region, including status, habitat relationships, and management considerations was collected form various sources (cf. Remsen 1978, Laudenslayer and Grenfell 1983, Verner and Boss 1980). Specific consideration was given to obtaining information on species of special concern with potential occurrence within the study area. These include sensitive species (having special legal or management status): federally endangered or threatened, federal candidate species, California state threatened or endangered, California state fully protected, and Department of Fish and Game bird species of special concern. Species with commercial or local recreational importance can also be considered species of concern.

Wildlife habitat analysis was completed based on indicator species that represent guilds, or groups, of wildlife that depend on similar habitat for survival.

Table 1.

Enumeration of government agency personnel contacted during the Casa Diablo Hot Springs biotic assessment.

Agency	Contact
U.S. Forest Service	Clint McCarthy, Forest Wildlife Biologist
	Cristina Hargis, Mono Ranger District Biologist
California Department of Fish and Game	Edwin P. Pister, Fisheries Biologist
	Ron Thomas Wildlife Biologist
	Tom Blankenship, Wildlife Biologist

3.2 VEGETATION METHODS

The Casa Diablo Hot Springs vegetation survey was divided into three activities

- Preliminary literature and Data Base review
- On-site rare plant searches
- Habitat type mapping

Prior to conducting field work, a literature review was undertaken to gather and evaluate information on the rare plant species and sensitive habitats with known occurrences in the region. The basic working list for the rare plant survey was a list of all California Native Plant Society (CNPS) rare and endangered plants of California with occurrences in Mono County (Smith and York 1984). To develop a list of potential rare plants possibly occurring at the site, the working list was refined using geographic distribution and habitat information provided in standard floristic manuals (i.e., Munz and Keck 1968, Cronquist et al. 1972, 1977, 1984), location data printouts from the California Natural Diversity Data Base (CNDDB, Cochrane and Jensen 1984), and from unpublished rare plant status reports prepared for the CNPS (various authors).

Table 2 presents status, habitat, and distributional information for 12 CNPS rare or endangered plants with potential to occur in the vicinity of Casa Diablo Hot Springs. This table presents a refined working list for field surveys, based upon the data review described above.

Rare plant surveys were conducted on the site on 25 November 1986 and 26 November 1986. Potential habitat areas were surveyed for rare plant populations, and a vascular plant species list was compiled to aid in habitat characterization and sensitive habitat assessment.

Mapping of vegetation types within the study area was conducted using standard techniques (Avery 1968). Color aerial photography of the study area was used to map vegetation (source: 1984 U.S. Forest Service photos). Polygons of uniform habitat conditions were drawn on an overlay of the photography (scale ca. 1:8,000). The study area was then surveyed on foot and by vehicle to inspect vegetation conditions, and a preliminary map drawn. The map was then transferred to a topographic base map of the area (1983 Mammoth Quadrangle, U.S.G.S. interim edition) using a Bausch & Lomb Stereo Zoom Transfer scope with the aid of 1:16,000 aerial photography (source U.S. Forest Service, 1972 photography).

Table 2. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
<u>Astragalus</u> <u>monoensis</u> Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
<u>Astragalus</u> <u>johannis-howellii</u> Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
<u>Astragalus</u> <u>lentiginosus</u> var. <u>piscensis</u> / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
<u>Centaurium</u> <u>namophilum</u> Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
<u>Eriogonum</u> <u>ampullaceum</u> Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
<u>Fimbristylis</u> <u>spadicea</u> Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
<u>Lupinus</u> <u>duranii</u> Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
<u>Lupinus</u> <u>montigenus</u> Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
<u>Lupinus</u> <u>sublanatus</u> Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
Pedicularis crenulata var. candida / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
Sedum pinetorum Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
Sidalcea covillei Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   Category 2 = currently under review with extisting information insufficient to support listing.
   Category 3c = currently not under review, as taxon is more common than formerly thought.

4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.

3.3 FIELD SURVEYS FOR TERRESTRIAL WILDLIFE

Field surveys were conducted on foot and by vehicle on 19 and 20 November, 1986. Representative sections of different habitat types that occur on the project area were evaluated. Areas of unique habitat and wildlife potential were identified and mapped. Special emphasis was placed on determining habitat suitability for and occurrence of Species of Concern and indicator species.

For the purpose of this study, the survey area includes the private inholdings containing the existing geothermal powerplant and the hot water wells associated with the development, as well as the U. S. Forest Service land. The presence of a species was confirmed either by sighting of an individual animal, evaluating scat or tracks, or by the call of the animal. During the survey all wildlife observations were recorded in field notebooks. A species list was also prepared of all wildlife observed or expected to occur on the site (because of the dates of the survey, we were unable to document the breeding of any species on the site, as most of the birds that breed on site have already fledged young and many of the migratory birds had already departed). In general, behavior was less conspicuous at the season of the survey, making field observation more difficult.

No quantitative assessments of habitat parameters were measured on the study area. The field visits provided only qualitative assessments of habitat suitability. These qualitative assessments were then compared to quantitative data in the literature and a subjective assessment of habitat suitability was made for each species or guild of concern. The shortcomings of this subjective assessment are fully recognized; the scope of the study requested to date precludes more detailed analysis of the habitat.

4.0 RESULTS

4.1 FLORA

The Casa Diablo Hot Springs area is located on the boundary between the Californian and Great Basin biogeographic provinces. Consequently, the flora is composed of largely two distinct elements: mountain and desert plants. There is no specific local flora covering Mono County, and the eastern Sierra region is as yet poorly understood floristically. The plant checklists for the Owens Valley region compiled by Dedecker (1974, 1984) are the most valuable local source of floristic information. Other plant checklists have been published in grey-literature sources for several areas adjacent to the Casa Diablo region: Convict Creek basin (Major 1964), lower Convict Creek (Orr 1981), for a small area near Mammoth (Howald 1981), for nearby Indiana Summit Research Natural Area (Taylor 1980) and adjacent portions of Glass Mountain Ridge (Dedecker 1979), and for the Mono Basin (Taylor 1981).

A list of vascular plant species observed on the study area is presented in Appendix 1. Due to the dates of our survey (late November), most of the annuals and herbaceous perennials growing on the site were dormant and consequently were easy to overlook.

4.1.1 HABITAT TYPES AND VEGETATION MAPPING

A total of 10 major vegetation types were observed on the Casa Diablo Hot Springs study area:

- Jeffrey Pine Forest
- Jeffrey Pine-Pinyon Pine Woodland
- Pinyon-Juniper Woodland
- Sagebrush Scrub
- Black Sagebrush Scrub
- Rhyolite Buckwheat Scrub
- Thermal Marsh
- Yellow Willow Riparian Thicket
- Nebraska Sedge Meadow
- Ruderal & Disturbed Weed field

Figure 2 provides a map depicting the distribution of these major habitat types within the study area boundaries. The majority of the study site

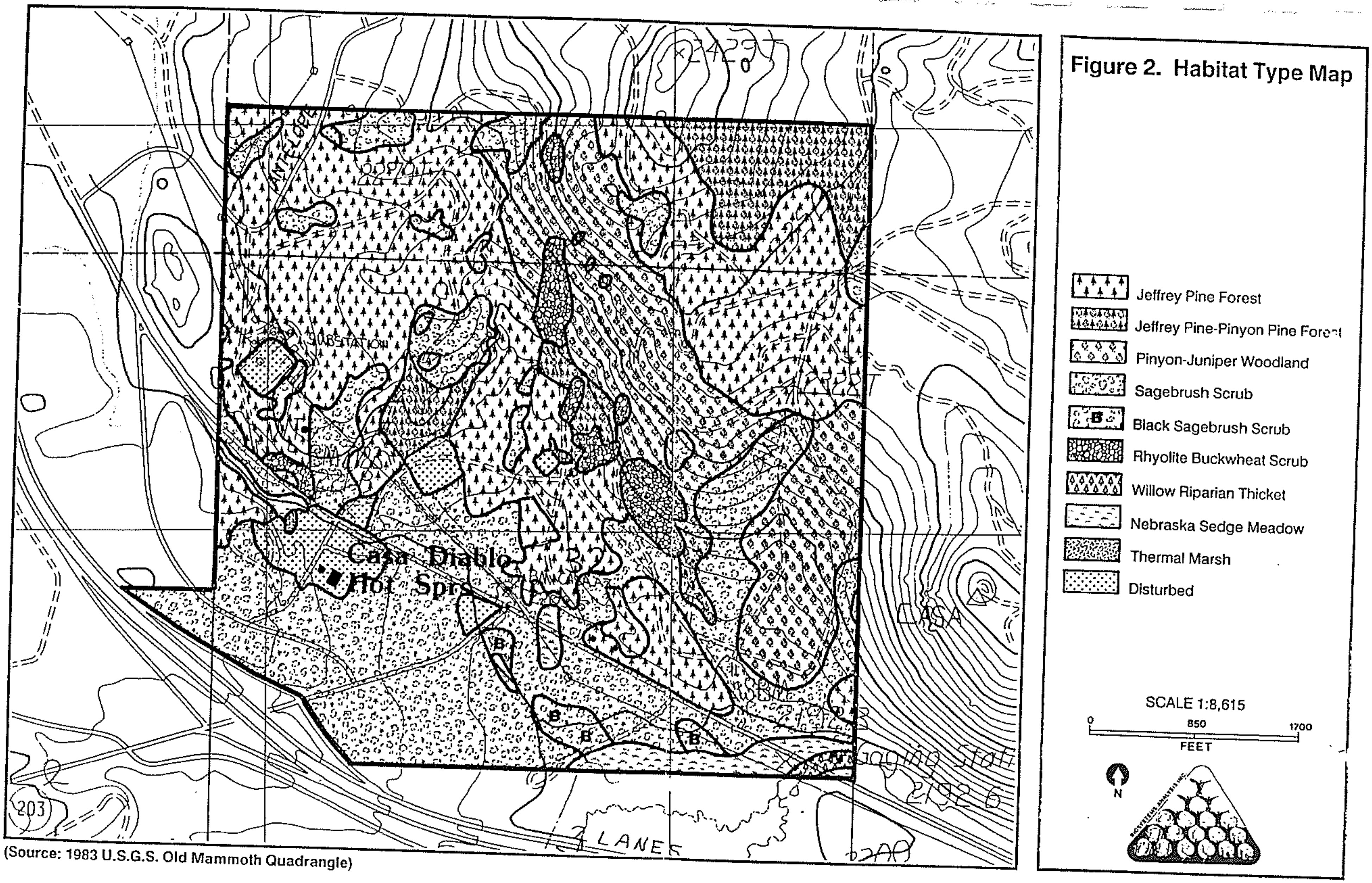
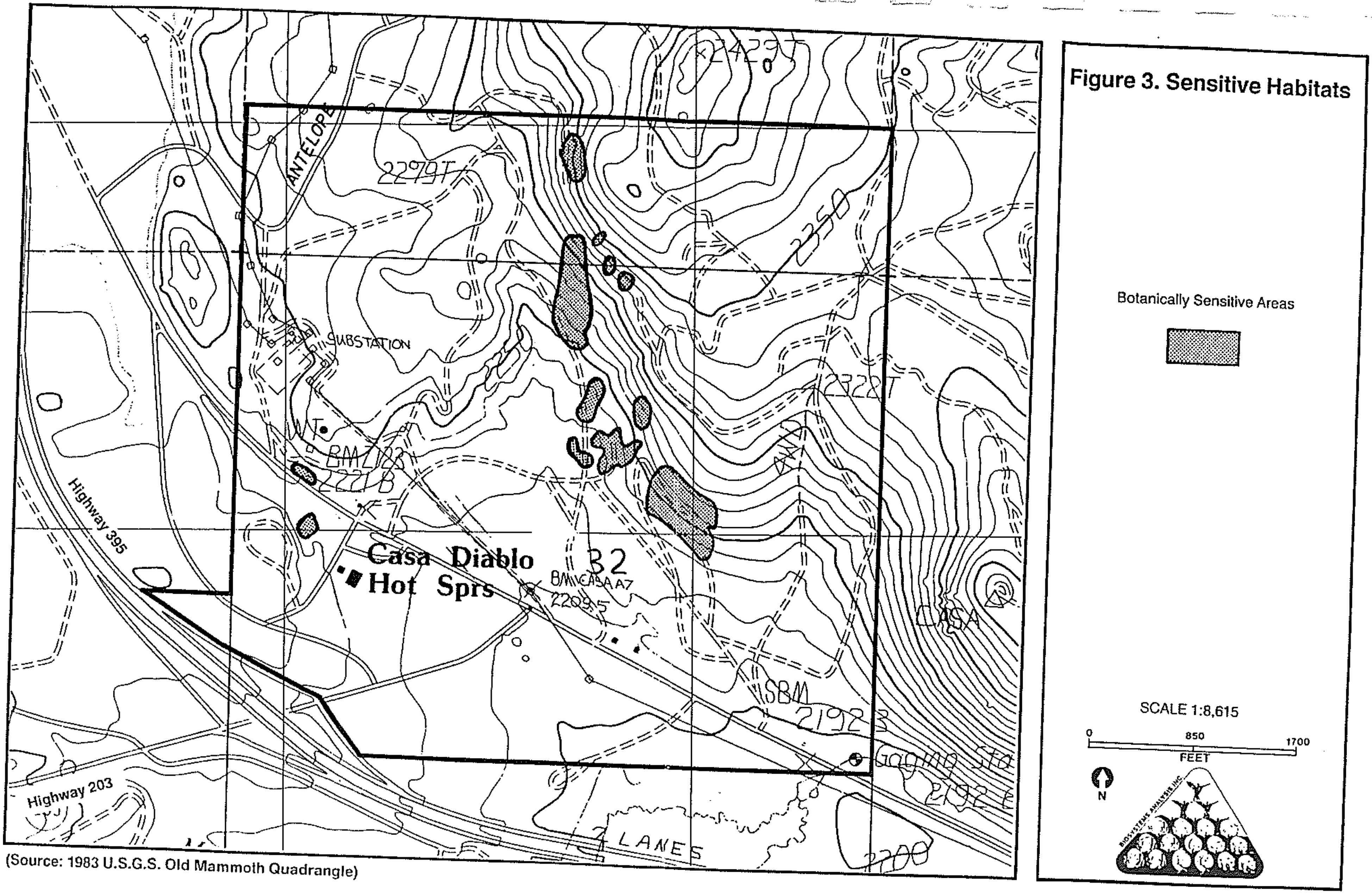


Figure 2. Habitat Type Map

(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

Figure 3. Sensitive Habitats



(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

consists of forest and woodland vegetation, with Jeffrey Pine (*Pinus jeffreyi*) and Pinyon Pine (*Pinus monophylla*) dominating. The second most important habitat-type on the site is scrub vegetation, with Sagebrush (*Artemisia tridentata* ssp. *vaseyana*) dominant. The remainder of the habitat types observed on the site cover but a small proportion of the landscape, but are nonetheless distinct and important components of the vegetation.

__Jeffrey Pine Forest__ - a moderately dense (30%-60% canopy cover) forest stand type, with a single overstory dominant, *Pinus jeffreyi*, covers much of the study site. This forest is variable in tree density and basal area over the study area, but in general most stands on the site are young and relatively open canopied. Subjective age estimates (cf. Taylor 1980) indicate most of the forest stands on the site are less than 80 years old, with the exception of the far northeastern corner of the site, where old-growth forest conditions (i.e., > 150 yr old stands) occur. Understory in Jeffrey Pine Forest consists of a dense to moderately open shrub layer composed of sagebrush and bitterbrush (*Purshia tridentata*), with some sites having tobacco bush (*Ceanothus velutinus*). Grass cover in this forest type is low, with squirrel tail (*Sitanion hystrix*) being most important.

__Jeffrey Pine - Pinyon Pine Woodland__ - this woodland is intermediate in composition and structure between Jeffrey Pine Forest and Pinyon-Juniper Woodland. The nature of this woodland is such that it represents a successional stage in forest development, where Jeffrey Pine stands become established within pinyon woodland, and will eventually dominate absent subsequent disturbance such as from wildfire.

__Pinyon-Juniper Woodland__ - steep slopes on the eastern portion of the study area are vegetated by a woodland (20%-40% canopy cover) dominated by pinyon pine (*Pinus monophylla*) with some Sierra juniper (*Juniperus occidentalis* ssp. *australis*). Canopy height in this woodland is generally less than 35 feet. Understory vegetation in this type is similar to Jeffrey Pine Forest, but with greater abundance of rabbitbrush (*Chrysothamnus nauseosus*) and a variety of forbs and grasses (including locally high cover of *Bromus tectorum*).

Sagebrush Scrub - the southwestern portion of the study area is vegetated by stands of sagebrush (*Artemisia tridentata* ssp. *vaseyana*) scrub. Shrub cover averages about 30%-50%, with moderate cover of cheatgrass (*Bromus tectorum*). Companion shrubs in this community include bitterbrush (*Purshia tridentata*), rabbitbrush, horsebush (*Tetradymia canescens*) and sulfur-flower (*Eriogonum umbellatum*). Canopy height in this vegetation ranges from 2 to 4 feet. In years of good spring rains, this community can support a diverse assemblage of annual herbs, few of which were in evidence on the site at the time of our survey.

Black Sagebrush Scrub - a distinct vegetation type in the eastern Sierra but relatively uncommon in the vicinity of the study area. Several patches of black sage (*Artemisia nova*) scrub occur on basaltic rocks in the extreme southwestern portion of the site. Canopy cover and associated flora in this vegetation is similar to Sagebrush Scrub, but canopy height is much less, averaging less than two feet.

Rhyolite Buckwheat Scrub - a distinct habitat of limited distribution in the eastern Sierra region. Vegetation cover at this type of site is low, with large clumps of Rhyolite Buckwheat (*Eriogonum kennedyi* var. *purpursii*) being conspicuous. Associated herbs are many, with Pussy-paws (*Calyptridium umbellatum*), locoweed (*Astragalus purshii*) and cheatgrass the most important. This community type is restricted to present or formerly thermally affected soils, and is essentially limited to the region.

Thermal Marsh - a marsh community composed of sedges (*Scirpus americanus*, *S. nevadensis*), rushes (*Juncus balticus*) and grasses (*Muhlenbergia asperifolia*, *Distichilis spicata*, *Hordeum jubatum*, *Poa juncifolia*) that is found about many of the thermal springs in the Mono Basin, Long Valley and Owens Valley region. Height of the graminoid canopy in this vegetation is less than 2 feet, while cover is high, except where excessive deposits of evaporites or open water limit vegetation development.

Yellow Willow Riparian - a riparian thicket that is a common and typical riparian vegetation type in the eastern Sierra (Taylor 1982) occurs on the southern boundary of the study area along Mammoth creek. Vegetation in this habitat type is dominated by yellow willow (*Salix lutea*) sandbar willow (*S. exigua*) and Great Basin wild rose (*Rosa woodsii* var. *ultramontana*), with a lush and diverse herbaceous understory. At the time of our survey of the site, most of the understory species of this vegetation were dormant, or were so heavily grazed, that their identification was difficult. The most important graminoid in this community that we observed was *Carex nebrascensis*.

<u>Nebraska Sedge Meadow</u> - a large wet meadow occurs just at the southern boundary of the study area. The vegetation of this meadow is dominated by Nebraska Sedge (*Carex nebrascensis*), with Great Basin Iris (*Iris missouriensis*) and rush (*Juncus balticus*) important codominants. A marginal scrub community typical of such meadows in the Long Valley region occurs at the dry margin of the meadow dominated by *Artemisia cana* ssp. *bolanderi* and *Chrysothamnus nauseosus*.

<u>Ruderal and Disturbed Weed field</u> - areas of recent or frequent surface soil disturbance at the study site are very sparsely vegetated. Where soil disturbance allows any plants whatsoever to grow, three species predominate: cheatgrass, dandelion (*Taraxacum officinale*) and peppergrass (*Lepidium perfoliatum*). This vegetation occurs along highway shoulders, and on the site of old buildings about Casa Diablo Hot Springs proper. Crested wheatgrass (*Agropyron cristatum*) has been planted along roadcuts of the present-day alignment of Highway 395. Floristic elements of this habitat are the initial colonists of sites where revegetation has been attempted at Casa Diablo geothermal developments.

4.1.2 RARE PLANTS

No rare or endangered vascular plant species were observed on the study area during our survey. It should be noted that field work for this survey was conducted at a time of year when most potential sensitive plants species would have been dormant and consequently difficult to detect.

Our inspection of habitat features of the study area indicated that it is unlikely that sensitive plant species occur on the site. Since, however, knowledge of the flora of the region is still rudimentary, we can not make an unequivocal negative declaration that no rare plants occur on the site.

Based on the array of species and habitats of rare plants known for the eastern Sierra region (Table 2), we can offer two lines of evidence why we feel occurrence of specific species on the Casa Diablo Hot Springs study site would not be expected given current information.

History of Botanical Collecting - the site, located adjacent to a highway, has often been visited by botanists passing through the eastern Sierra region. The first collecting of which we are aware (through personal communications and herbarium research) was in the 1930's, when John Thomas Howell and Alice Eastwood, and Frank Peirson collected along Highway 395 and in the Mammoth Area. Eastwood and Howell visited Casa Diablo Hot Springs, but found no rare species there. The Eastwood and Howell collecting trips were effective explorations, as several previously unknown species were discovered (including *Lupinus duranii*, *Astragalus monoensis*, and *A. joahnnis-howellii*). Peirson's collecting in the Long Valley region was also thorough, for example, he discovered *Pedicularis crenulata* var. *candida* growing at Convict Creek.

Other botanists, including Dean Taylor and Mary Dedecker, have also collected at the site in the past, without noting rare plants.

Array of Habitats and Geography - the availability of habitats for rare plants on the site are seemingly such that potential habitat for several candidate species in Table 2 is absent. The Mono milkvetch (*Astragalus monoensis*) is known to occur about 1 mile to the north of the Casa Diablo area, but we did not observe this species on the study area. At the time of our survey, *A. monoensis* plants, although dormant, were evident and easily recognized (as observed at nearby populations), indicating that we would have detected any populations on the site. The habitat for this plant, sterile pumice soils with moderate to low sagebrush cover, occurs on the northern portion of the site, but *A. monoensis* is apparently absent there.

Others of the species listed in Table 2 are typical of hot springs or alkaline meadow areas in the Eastern Sierra. Occurrence of these species on the Casa Diablo Hot Springs site was not documented in this survey, nor have there been historical reports of these taxa from the site.

Two species occurring in the Mammoth region for which detailed habitat information is lacking, Mammoth Lupine (*Lupinus sublanatus*), last seen in 1935 and known only from the type collection, and Pine City stonecrop (*Sedum pinetorum*), last seen in 1913 and also known only from the type collection, are unlikely to occur on the site. The Mammoth Lupine is known from a single collection near the "Earthquake fault" along Highway 203, while the sedum was collected in the montane forests west of Old Mammoth (the sedum was once thought to occur only in Mexico, but this supposition is erroneous).

4.1.3 BOTANICALLY SENSITIVE AREAS

Figure 3 depicts the location of botanically sensitive habitats occurring on the Casa Diablo study site. Two habitats occurring in the study area can to be considered sensitive habitats (using California Department of Fish and Game, Data Base Criteria, cf. Holland 1986): Thermal marsh and Rhyolite Buckwheat scrub.

Thermal marsh vegetation occurs at the immediate outflow of Casa Diablo Hot Springs. In its present condition, this habitat type has been influenced by past recreational, commercial and geothermal activities. Portions of the marsh have been eliminated by filling and construction of a berm surrounding the largest marsh area.

The study area supports an unusual example of hydrothermal control of vegetation pattern and structure of significance. Several areas of unusual soils produced by intermittent hydrothermal activity occur on the eastern portion of the site, producing openings in otherwise forested terrain. These sites are characterized by the Rhyolite Buckwheat habitat-type. During the 1983 magmatic dome uplift in the Casa Diablo area, soil surface temperatures bordering these openings became sufficient to kill pinyon pines (anecdotal observations of a soil temperature of 145°F at 3 inches depth were made by BSAI botanist Dean Taylor at this site in July of 1983).

4.2 FAUNA

4.2.1 Aquatic Habitats

Aquatic habitats of the Casa Diablo Hot Springs study area are of limited size and extent. A thermal marsh area occurs at the outflow of the several hot springs proper.

The site also contains several brine ponds of geothermal powerplant effluent. The brine ponds have fluctuating water levels and are generally less than 1 acre in size. These ponds do not support emergent vegetation or riparian associated vegetation at this time, limiting their present value to wildlife.

A small stream about 2 to 6 feet in width transects the southwestern corner of the study area. Little riparian vegetation is associated with this stream, and no salmonid fishery is expected. Flow in this stream is derived from two sources: from artificial drainage of the former Casa Diablo Lake (situated 0.5 miles northwest of the hot springs) necessitated by highway alignments, and from discharge of the hot springs. Although the stream is tributary to Mammoth-Hot Creek, it is small and sufficiently ephemeral that it is unlikely that it supports a significant salmonid fishery.

4.2.2 Terrestrial Habitats

From a standpoint of providing wildlife habitat, the study area contains two principal habitats. Much of the site is dominated by pine forest, specifically Jeffrey Pine (*Pinus jeffreyi*), with singleleaf pinyon pine (*Pinus monophylla*) as an associated secondary species. The forested habitat is interspersed with sagebrush (*Artemisia tridentata*) shrub habitat. Flat areas of lower elevation at the south and west sides of the study area contain minor amounts of meadow vegetation. Occasional rock outcrops are associated with the ridgeline in the east half of the study area. Areas of geothermally altered soil can be found on the site where vegetation patterns are controlled thermal and chemical changes in the soil caused by hot spring activity. Herbaceous vegetation tolerant of the altered soil conditions has replaced the trees previously found on such site.

Cones of both pine species present provide seed for mammals and birds, an important food source for many animals. Nesting opportunities are provided in cavities and branches of the conifer species. The forest stands of the study area are relatively young, subjectively estimated at 40-80 years (based on diameter and site index of *P. jeffreyi* in the area, cf. Taylor 1980), and from 8-20 inches diameter. The density of snags on the site is low compared to the potential for these cover types (i.e. at nearby Indiana Summit Research Natural Area) and may represent a limiting factor for cavity dependent species. Snag density on the site is probably low due to past wildfire, and to woodcutting, but it also may be naturally lower in general as the study area is located in an area on the geographic boundary between sagebrush and forest. Dead and down woody materials are also relatively scarce (due principally to wood gathering), limiting foraging, denning, nesting, and "look-out" opportunities for some species of birds and mammals.

The northeast portion of the study area contains Jeffrey pine forest with north and northeast aspects. Greater basal area, higher snag density, greater canopy cover, and more dead and down woody materials are found in these stands. Understory vegetation dominated by tobacco bush (*Ceanothus velutinus*) and other mesophytic species relative to the sagebrush of the drier microsites are found. The tobacco bush provides a dense understory and ample forage opportunities for many favored wildlife taxa.

Several buildings, geothermal wells, many dirt and paved roads, power lines, and an electric substation are found on the site. These areas of substantially altered habitat are mostly devoid of vegetation and are of little or no value to wildlife. Because of its location, the site serves as a deer staging area during spring migration to higher elevation summer range (T. Kucera, personal communication, 1986). Proximity to several passes west of the site allow access to the western Sierra through passes well vegetated with forage. Migrating deer use winter range in the Owens Valley and Round Valley areas, several miles south.

4.2.3 Species Of Special Concern

Consultation with U. S. Forest Service biologists and literature review has identified a list of 8 Species of Special Concern that are potential users of the Casa Diablo Hot Springs study site as either migrants or residents. Species were selected because of their legal or management status, or as indicator species of a particular habitat type. These indicator species were selected to represent foraging guilds important in eastern Sierra ecosystems. For indicator species, it is assumed if habitat requirements for this species were met then the habitat requirements for other species using the same habitat would also be met (McCarthy and Hargis 1984).

Federally endangered species selected for discussion are: bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*). Fully protected species are: Northern goshawk (*Accipiter gentilis*), pygmy nuthatch (*Sitta pygmaea*), Williamson's sapsucker (*Sphyrapicus thyroideus*), and the hairy woodpecker (*Picoides villosus*). Commercially important species are mule deer (*Odocoileus hemionus*) and sage grouse (*Centrocercus urophasianus*).

<u>Peregrine falcon</u> (*Falco peregrinus*). The study area contains cliff faces 30-50 feet in height with very few if any ledges that would be suitable for nesting sites. The area is at least 5 miles from the nearest major river, lake, or marsh. Project time constraints did not allow for a quantitative prey base assessment. Disturbance, distance to open water, lack of suitable cliff habitat, and the high elevation of the site contribute to low suitability of this site for peregrines. Peregrines have been reintroduced in Mono county each year from 1982 to 1985 at a site approximately 22 miles away. A reintroduction of captive bred peregrines to a site 8 miles away is planned

for 1987. Juvenile peregrines or wandering adults may visit the site looking for foraging opportunities.

<u>Bald eagle</u> (*Haliaeetus leucocephalus*). A bald eagle was observed from the project site soaring to the east at an estimated distance of around one mile. Bald eagles are known to winter in the Owens Valley and Lake Crowley areas approximately 8 miles south and east of the site, and at the June Lake area 10 miles north. Habitat at the Casa Diablo Hot Springs site is of low suitability for bald eagles for the following reasons: 1) early successional stage of Jeffrey pine cover type, 2) dominant conifers of less than 28" dbh, 3) less than 2 to 3 spike top or snag trees within one-quarter mile of suitable nest trees, 4) lack of fish and/or waterfowl as food supply, 5) greater than 1 mile to major river, lake, or marsh, and 6) frequent foot, vehicular, and industrial traffic within one-half mile of most of the site. Bald eagles may use the site occasionally as a migration or dispersion route.

<u>Northern goshawk</u> (*Accipiter gentilis*). The goshawk may be only an occasional visitor to the study area (C. McCarthy pers. comm. 1986). Goshawks are birds of mature forest characterized by a relatively closed overstory and a dense understory of seedlings of non-uniform height (Call 1978). The Jeffrey pine forest at the site is relatively young, with only a very sparse understory of occasional pinyon pine. The habitat within the Casa Diablo Hot Springs study area is judged to be largely unsuitable for goshawks.

<u>Cavity nesting species</u>: Pygmy nuthatch (*Sitta pygmaea*), hairy woodpecker (*Picoides villosus*), and Williamson's sapsucker (*Sphyrapicus thyroideus*). Parameters for optimum habitat for each of the above species is provided in Table 1 of McCarthy and Hargis (1984). Optimal habitat components for these species were developed for a timber compartment in the Mono Lake Ranger District, Inyo National Forest, located in the Glass Mountains approximately 10 miles east of the study site.

Based on the criteria of McCarthy and Hargis (1984), habitat within the Casa Diablo study area is inadequate for the Williamson's sapsucker due to lack of lodgepole pine cover type, stand basal area <38 m^2/ha, and fewer than 3.7 snags greater than 30 cm dbh per hectare.

Habitat on the study site is of secondary value for pygmy nuthatches and Hairy woodpeckers. The habitat parameters at the study site are within those suggested by McCarthy and Hargis (op. cit.) except for snag density. There are some areas on site of snag density meeting or exceeding those recommended. However, overall snag density does not provide optimum (primary) habitat, so that the forest habitat on the Casa Diablo study site can be characterized as of intermediate importance to this guild.

Sage grouse (*Centrocercus urophasianus*). Sage grouse are dependent on sagebrush stands for nesting, thermal and hiding cover, and feeding during fall and winter (Call and Maser 1985). Wet meadows and other grassland habitats are used for feeding when succulent vegetation and seeds are available. The interspersion of open grassland less than 275 m in circumference with areas of tall and short sagebrush with 20 to 40 percent canopy closure provides good sage grouse habitat for feeding, nesting, and breeding activity (Rogers 1964, Wallestad and Pyrah 1974, Klebenow 1969). The need for free water likely depends on the availability of succulent vegetation and the timing of the curing of herbaceous vegetation in the summer (Call and Maser 1985). The study area provides limited amounts of moderately suitable sage grouse habitat on the west, south, and central portions of the area. Most of the rest of the study area does not contain enough sagebrush cover type.

Pine Marten (*Martes americana*). Martens use red fir and lodgepole pine forests, alpine zones, talus, and open meadow habitat in the Sierra Nevada (Harris 1982). Dense coniferous forests provide cavities and down logs for denning and nesting and foraging opportunities among the upper branches (Ingles 1965). Cavities are limiting on the site and may not provide denning opportunities. Martens may use the denser stands of Jeffrey pine to the north area of the site for foraging. Forest stands on the Casa Diablo site may be used for travel to more suitable habitats in the Glass Mountain range to the east.

Mule deer (*Odocoileus hemionus*). The site must be evaluated as a staging area for deer migration as well as an area where deer feed and rest. Herds of deer winter in Long Valley, Little Round Valley, Round Valley, and the Owens Valley. In spring, deer move through the study site, crossing Highways 395 and 203, staging in the area for their migrations to the crest of the Sierra through either Deadman Pass, Mammoth Pass, at San Joaquin Mtn., Solitude Creek, Mammoth Rock, or at other sites west of the study area. Other staging areas in close proximity are located in the Sherwin Creek and Laurel Creek areas.

Habitat within the study site is of moderate value for mule deer. Thermal cover is of moderate value because crown closure is in general less than 75% in some of the study site. There is sufficient area (>0.8 ha) of shrubs of adequate height (>1.5 m) (Leckenby et al. 1982). Relative to the valley floor of low sagebrush and grassland habitat, the project area provides good thermal cover and will likely be favored in times of thermal stress (too hot or too cold).

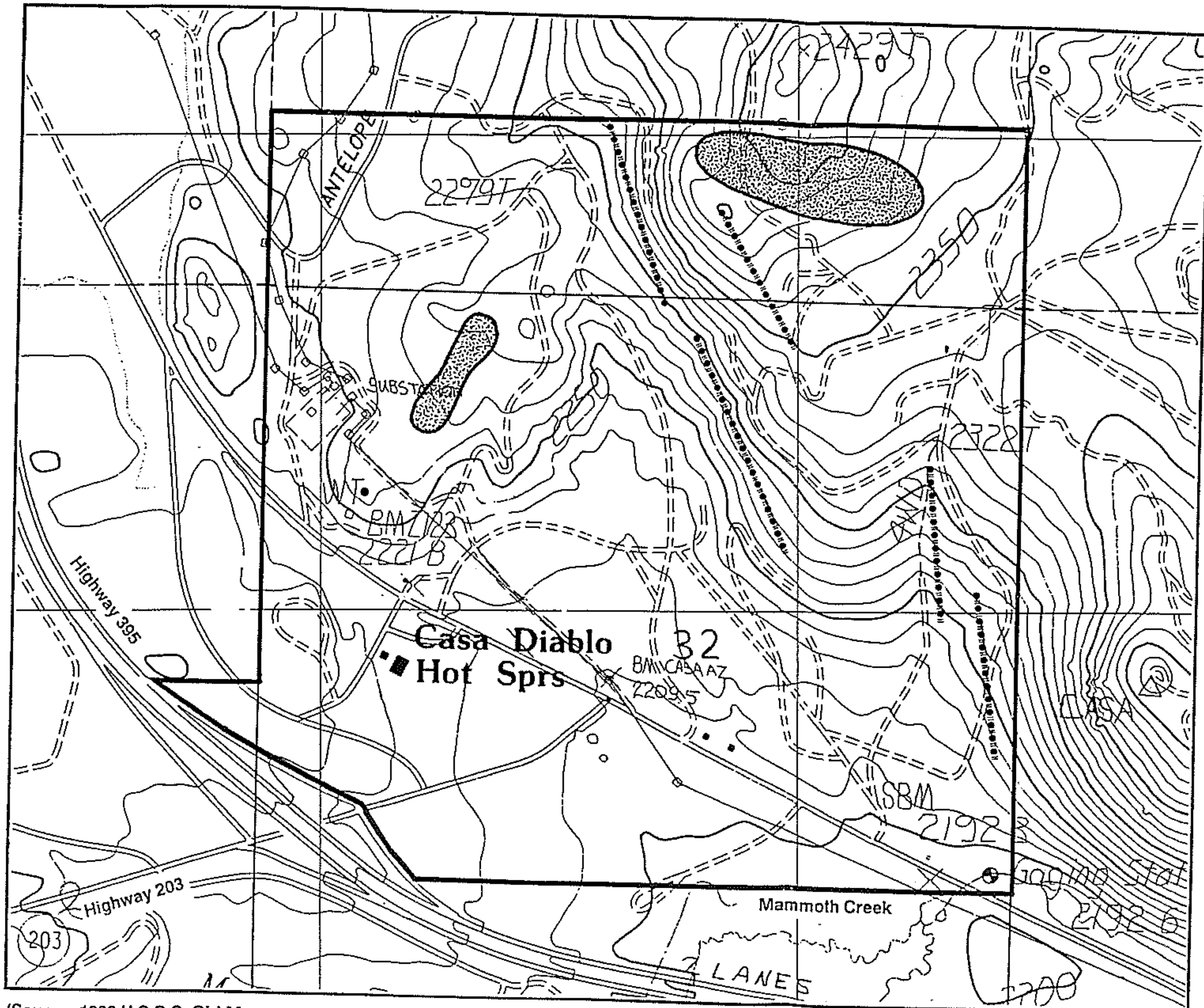
Adequate hiding cover can be found throughout much of the site. Hiding cover may be defined as vegetation that hides 90% of a bedded deer from view at a distance of 45 meters or less (Thomas et al. 1979).

Mule deer will utilize grass, forbs, and browse plants for forage at different times of the year. Browse and cured grass were observed on site; and it can be safely assumed forbs are present during the spring and summer. No quantitative assessment can be made in this report of the adequacy of forage availability on the site. Cursory examination did not reveal a severely overbrowsed or overgrazed range, except in the southwestern portion of the site accessible to cattle. Deer utilization of bitterbrush on the site (as judged by leader use) was moderate.

Fawning habitat should have available a mix of thermal and hiding cover, open water, a canopy closure of at least 40%, and a slope less than 30%. Succulent vegetation should be readily available through June. On the site, marginal cover reduces suitability of the Casa Diablo geothermal site as fawning habitat. November field visits negate an analysis of the site's suitability for forage during the fawning period.

Figure 4 provides a map depicting concentrations of observed deer sign on the Casa Diablo Study site. The map is based only on observations conducted during November, 1986 but may nonetheless reflect to some degree actual deer use patterns on site. Deer trails observed on the site are generally long-lived features, accumulating over months or years of deer use. Therefore, concentrations of deer trails are likely to reflect actual movement routes through the area to a large degree. Lack of observed deer trails on portions of the study site should not be taken to indicate lower deer usage, as deer trails are probably not persistent features due to physiographic differences.

Of the two major habitat types on the study area, forested vegetation is of value to deer for escape and thermal cover. Sagebrush vegetation is of value principally for forage production and staging during migration. Segments of the eastern and northern portions of the site could be of importance to some animals as fawning habitat



(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

Figure 4. Deer Observations

Deer Sign

Trails

Yarding

SCALE 1:8,615

0 850 1700
FEET

N

5.0 DISCUSSION OF SITE BIOLOGICAL SENSITIVITIES

5.1 FLORA AND VEGETATION

Potential direct impacts to flora and vegetation include: direct removal of native vegetation due to construction activities, creation of ruderal and disturbed habitat for weeds, and direct impacts to sensitive habitats and possibly to sensitive plant species.

Construction and development activities at the Casa Diablo geothermal site could result in significant losses of native vegetation cover only if appropriate design, construction and rehabilitation measures are not strictly utilized.

Existing development of geothermal resources at Casa Diablo Hot Springs has resulted in several classes of impacts to vegetation. At present, the significance of these impacts are minimal to moderate. Development of additional generation facilities will require that planning, design and construction include measures to minimize potential impacts to vegetation, thus minimizing the possibility that vegetation impacts would reach a significant level (thus requiring mitigation).

At present, construction of well pads, pipelines, electrical transmission lines and roads have removed native vegetation from a small but noticeable proportion of the site. In many areas of past disturbance, habitat rehabilitation measures have been instituted, but have met with varying degrees of success. Jeffrey Pine saplings have been planted at several localities, with acceptable survival rates. Areas of soil disturbance have in some instances been recountoured, allowing for either natural revegetation or artificially aided revegetation. We observed that recent seeding to limit erosion has apparently been undertaken in some instances. Little actual establishment had occurred on these sites at the time of our visit, and we were unable to determine the elapsed time since these activities.

Natural successional patterns of vegetation in this region are relatively uniform and thus can be used to plan for and manage potential vegetation impacts associated with direct surface impacts. Within two growing seasons following clearing, cheatgrass stands usually becomes fully established. During this successional stage, significant cover of native annual herbs can develop, particularly where natural topsoil (and thus soil seedbanks) has been preserved. Often within 5 years following disturbance, shrubs have begun to establish. Rabbitbrush is usually the initial colonist, followed later by sagebrush and then bitterbrush and other shrubs. Conifer seedlings may not become naturally established until several decades following cessation of disturbance, as they have higher natural survivorship in dense shrub stands (where shrubs act as 'nurse-plants'). The shrub species common in the Casa Diablo study area have light, wind dispersed seeds. Thus, given several years, they should be expected to become naturally established on disturbed sites. Active revegetation efforts can incorporate introduction of shrub seed on to disturbed sites, thus facilitating and enhancing natural successional change.

Revegetation efforts in the Casa Diablo Hot Springs area will be complicated by edaphic controls on vegetation and successional patterns. In areas where the sterile and xeric deposits of hydrothermally altered substrates (ie. kalonitic clays and travertine) need revegetation, expensive and often only partially successful techniques utilizing fertilizing and irrigation may be necessary.

Limiting the degree and intensity of surface disturbance during construction and operation will reduce the need for active revegetation efforts. Pipelines traversing steep slopes should be avoided where possible. In the vicinity of the study area, slopes with grades greater than about 25% can become subject to erosion problems if appropriate construction and revegetation methodology is not utilized.

Active revegetation efforts on the Casa Diablo site should utilize techniques appropriate to arid, cold steppe sagebrush environments (i.e., methods appropriate to the Great Basin-Intermountain region). Planting of grass to establish cover should utilize species native to the site, such as Great Basin wildrye, rather than employing exotic, non-native taxa. Conifers planted on site should be limited to locally collected seed for maximum likelihood of success.

Operation and management of the site as an energy development can be compatible with maintenance of natural habitat values if careful planning and supervision is exercised. It is recommended that a qualified botanist and landscape architect be utilized in the planning and design process.

A significant detrimental impact to the Casa Diablo site has resulted from historic uncontrolled grazing. We recommend that consideration be given to the grazing management for the site. Reduction of overgrazing would help improve vegetation conditions on the developed portion of the site, thereby minimizing the potential significance of vegetation losses associated with project construction becoming significant. Grazing management would serve to compensate for disturbance to native vegetation that invariably will be associated with future energy development of the site. We would recommend that a grazing management plan be formulated for the site.

Ancillary Vegetation Impacts - presently, the study area is subject to a variety of threats to vegetation which are essentially an indirect product of development. Roads accessing the site are unrestricted, allowing travel at will. Much of the road network on the site is probably unnecessary for access to the site for operational purposes. The density of roads on the site has resulted in loss of vegetation due to vehicular traffic. Easy access to the site has also allowed significant impacts resulting from woodcutting.

Woodcutting in the past three years has resulted in removal of trees killed by the recent series of incipient volcanic events caused by a upwelling within the magma chamber underlying the Long Valley caldera. Illegal felling of standing, dead pinyon and Jeffrey pines is largely related to ease of access to the site.

Since our survey did not locate rare or sensitive plants on the study area, no recommendations are given to consider regarding impacts to rare plants. Past activity associated with geothermal activity has resulted in loss of sensitive habitats from the site. The thermal marsh area surrounding the outflow to Casa Diablo Hot Springs has been influenced to varying degrees by filling and diking. It is our recommendation that these areas be avoided in future construction, and that consideration be given to removal of the dike surrounding the marsh area. Removal of the proposed well pads from the southern margin of the marsh is seemingly not feasible, but we do recommend no further encroachment on the marsh area.

Placement of roads and small well pads within the Rhyolite Buckwheat scrub areas has resulted in modification or elimination of a small proportion of this habitat from the site. We recommend that no additional roads, well pads or other construction requiring surface soil disturbance be proposed for this habitat. We also recommend that existing roads to well pads within this sensitive habitat type be closed to all vehicle traffic.

5.2 WILDLIFE

Possible construction and operational impacts to wildlife include: loss of native habitat to roads, buildings, pipelines, and well pads; disturbance to wildlife at various stages of its life cycle but especially nesting; the construction of utility transmission lines; vehicle traffic, and the possible disruption of deer from their regular migration routes.

The Mammoth Lakes area is expected to support new development in the recreation and geothermal industries and grow in population over the next several years. The cumulative effects of the proposed developments on wildlife habitats and populations will be much greater than the impacts being discussed here. Though evaluating the kinds and amounts of impacts that will occur as a result of expected developments are not within the scope of this biotic assessment, they require mention. It becomes especially critical in considering the effects this project may have on deer migration patterns.

This discussion assumes that most of the proposed construction will take place in the Jeffrey pine forest of the northwestern portion of the site, and on the sagebrush flats of the western portion of the project area. Minor amounts of forest land will be affected by the placement of well pads. A proposed pad (Well pad MP 22A-32) will occupy a sagebrush flat midslope above the present powerplant, displacing wildlife use from that particular stand of sagebrush. The juxtaposition of this stand surrounded by Jeffrey pine forest creates an area of higher biological diversity relative to the surrounding habitat. Habitat edge is created, providing foraging opportunities in close proximity to thermal and hiding cover. This particular site is evidently an area heavily used by deer, as judged by density of pellet-groups and severity of browsing of bitterbrush.

Animals that would be expected to be most affected by habitat losses are those restricted to particular habitats, microhabitats, or small home ranges, such as smaller mammals. Most of the wildlife species in the areas of construction will avoid direct losses by moving to adjacent similar or suboptimal habitat. Overcrowding and competitive exclusion in those areas could result in mortality to many displaced individuals. Any net loss of habitat would result in a proportional decrease in overall carrying capacity and associated wildlife populations.

Loss could be compounded for wildlife species whose reproductive periods coincide with construction, if nesting and nursery areas are destroyed and disturbed. Such a potential impact would be highest in the spring and summer months.

Pipelines to carry hot water from the well pads to the powerplants will cross through Jeffrey pine and sagebrush habitat. If the pipelines are too low to the ground at their lowest point, or too high above the ground at their highest point, they may provide a physical barrier to movement by wildlife.

Significant edge can be created when a narrow strip of vegetation is cleared or altered to an earlier successional stage for powerline or pipeline right-of-

-ways. This edge effect often increases biological diversity within otherwise structurally simple habitats. Pipeline distances of less than one-half mile and right-of-ways following roads would minimize this beneficial effect.

The operation of the well pads and especially the powerplants will generate constant, loud, high frequency noise. Little is known about the effects of loud noise on wildlife. It should be assumed, however, that loud and lingering noise can disrupt some wildlife life cycle patterns and could produce organic hearing deficits with continuous exposure. For deer, noise is often not associated with exclusion from an area, as the animals may habituate.

Increased vehicle traffic associated with construction and operation of the well pads and powerplant will increase the likelihood of wildlife losses due to collisions with cars and trucks.

Well pads and pipelines carrying hot water can rupture and leak in the event of an equipment failure. Hot water of several hundred degrees would be fatal to any animal that came in direct contact with the water or steam. Hot water running down a slope or pooling would drown any nests or burrows under the water, and increase the temperature of any burrows or ground nests in the area. An accident of this type, however improbable from an engineering standpoint, may not prove fatal to affected wildlife but at very least will provide a disruption to the life cycle of the affected animals.

5.2.1 Potential Specific Wildlife Impacts

Peregrine falcon. Conversion of natural areas to energy development may reduce the area's potential for foraging habitat. Reintroduced peregrine falcons may use the area for occasional foraging and as dispersal routes for juveniles. However, the lack of open water on the site and the relative scarcity of waterfowl, columbids, and other favored avian prey species minimizes the potential impacts of this project on foraging habitat. However, future development off-site in the wet meadows and marshes to the south may reduce the value of those habitats for foraging. In the aggregate, there may be a greater future impacts related to increased development and population in the Mammoth-Long Valley area. Geothermal development at Casa Diablo Hot Springs is incrementally part of this aggregate potential impact. Impacts on breeding of peregrines will be low due to the relative suitability of the area for peregrine falcon nesting habitat, however.

Bald eagle. Habitat at the project site is of low suitability for bald eagles. Habitat losses as a result of this project are expected to have low impact on the eagle. Bald eagles may have made greater use of the site in past years prior to the draining of Casa Diablo Lake.

Design of electrical transmission lines for future projects in the Casa Diablo area should incorporate methodology to avoid the potential for raptor electrocutions. Design specifications for implementations of raptor protection measures should be undertaken in conjunction with a qualified raptor biologist.

Sage grouse. Loss of sagebrush habitat to development can reduce the available nesting, wintering, and roosting habitat. The presence of human disturbances at the site may interfere with downslope movement to foraging habitat in the wet meadows of the valley. If leks are present near the site human disturbance may disrupt breeding and courtship activities. Further development in the region may reduce available habitat. Overall impacts to sage grouse may be moderate. Our survey of the study area indicates that the site is probably not used by sage grouse, due to past and present levels of human activity. Specifically, heavy vehicle traffic along Highways 395 and 203 would likely be sufficient to exclude sage grouse from the meadows near their junction. Additionally, these same meadows are heavily grazed and in poor range condition, a situation also not conducive to persistance of grouse populations.

Northern goshawk. Construction of well pads and buildings in sagebrush habitat should not have an impact on goshawks in the region. Construction activity in the Jeffrey pine forests on the site should not have an immediate impact on the goshawk due to the unsuitability of the habitat for goshawks given the present successional stage of forest development in the vicinity. The loss of Jeffrey pine forest to construction and development may have an impact in the future as the potential for mature forest with a well developed understory is lost. Overall impacts are expected to be slight.

Williamson's sapsucker. Habitat is not suitable for the Williamson's sapsucker. Any sighting on the site would be regarded as an accidental observation. Overall impacts of the project on this species can expected to be slight.

Pygmy nuthatch. Loss of forested habitat will reduce the number of available cavities for use by cavity dependent species. This project may affect small amounts of forest land which is suitable habitat for the pygmy nuthatch. However, the loss of any forest land will delay development of mature forest structure, possibly impacting the pygmy nuthatch guild. Disturbance by construction activities may disrupt birds attempting to nest. Overall impacts can be expected to be slight.

Hairy woodpecker. Any loss of forested habitat would reduce the number of available cavities for use by this and other cavity dependent species. The projects proposed for the site may affect small amounts of forest land. At present, forests at the site are suitable habitat for hairy woodpeckers. However, any loss of potential mature forest land typified by high snag densities would impact this species. Disturbance by construction activities may disrupt birds attempting to nest. Overall, impacts can be expected to be slight.

Pine Marten. Martens are not tolerant of human encroachment and disturbance. Though not common, most marten sightings are in isolated areas far from human presence. Construction and operation of well sites and geothermal plants would most likely preclude the marten from using areas within a close radius of the activity. The status of the marten in this region is uncertain, but operation of this project could affect movement patterns of this species. Loss of forested habitat reduces the availability of favored tall trees for the arboreal activities of this mammal. This site does not constitute favored habitat for this species. Overall impacts could be expected to be slight.

Mule deer. Construction of roads, well pads, and buildings on the site most likely will affect staging areas for the spring migration of mule deer of the Sherwin-Buttermilk deer herd. An estimated 3,000 to 4,000 deer stage within 5 miles of the site before migrating. Loss of sagebrush habitat used extensively during spring would reduce available forage and cover. Loss of the conifer forest and sagebrush edge would further reduce forage that is in close proximity to thermal cover. Increased activity at the construction site may increase the chances of deer being struck by vehicles and may disturb deer as they await spring thaw in the passes. Loss of forested habitat would reduce available thermal and hiding cover on the site. Cumulative effects of geothermal, industrial, and residential development in the Mammoth Lakes area have the potential to seriously alter deer migration patterns for the herds in the area. The proposed Sherwin ski area might place construction activity and habitat loss in the Solitude Creek migration corridor, used by many of the deer that stage in this project site. Further study is needed to fully appreciate the effect this project and others in the area will have on the deer herds. Overall cumulative impacts to deer could be expected to be moderate to high without appropriate mitigation. Careful consideration should be given to siting the power plant in a site that does not interfere with normal deer yarding and migration patterns. At least the eastern and northern portions of the study site appear to be heavily used by deer relative to the surrounding area, and consequently requires careful evaluation in planning location of facilities, roads and pipelines.

Control of ancillary disturbance levels on the site, such as from unrestricted vehicle traffic, woodcutting etc. would serve to reduce the aggregate wildlife impacts of energy development in the project vicinity.

6.0 LITERATURE CITED

Avery, T. E. 1968. Interpretation of Aerial Photographs. Burgess Publishing, Minneapolis, MN. [2nd edition].

Bailey, R. A. and R. P. Koppen 1977. Preliminary geologic map of Long Valley Caldera, Mono County, California. U.S.G.S. Open File Map.

Bailey, R. A., G. B. Dalrymple and M. A. Lanphere. 1976. Volcanism, structure and geochronology of the Long Valley caldera, Mono County, California. Journal Geophysical Research 81:725-744.

Call, M. W. and C. Maser. 1985. Sage grouse. in: Wildlife Habitats in managed rangelands - the Great Basin of southeastern Oregon. U.S. Forest Service General Technical Report PNW-187.

Call, M. W. 1978. Nesting habitats and surveying techniques for common western raptors. U.S. Department of the Interior, Bureau of Land Management, Technical Note TN-316.

Cochrane, S. and D. B. Jensen. 1984. The Natural Diversity Data Base. pp. ix in: Smith, J, P. Jr. and R. York. Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1 [3rd edition].

Cronquist, A., A. Holmgren, N. Holmgren and J. L. Reveal. 1972. Intermountain Flora. Volume 1. Hafner Publishing Co., New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1977. Intermountain Flora. Volume 6. Columbia University Press, New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1984. Intermountain Flora. Volume 4. New York Botanical Garden, Bronx, NY.

Dedecker, M. 1974. Plant checklist for the Owens Valley. Final Environmental impact report, increased groundwater pumping in the Owens Valley. City of Los Angeles, Department of Water and Power.

Dedecker, M. 1979. Report on the flora of Glass Mountain Ridge. unpublished administrative report, Inyo National Forest, Bishop, CA.

Dedecker, M. 1984. Flora of the Northern Mojave Desert, California. California Native Plant Society, Special Publication No. 7.

Harris, J. H. 1982. Mammals of Mono Lake - Tioga Pass region. Kutsavi Books, Lee Vining, CA.

Howald, A. 1981. A Flora of Valentine Eastern Sierra Reserve. Part I. Valentine Camp. Herbarium, University of California, Santa Barbara.

Holland, R. F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. Department of Fish and Game, Sacramento, CA.

Ingles, L. G. 1965. Mammals of the Pacific States. Stanford University Press, Stanford, CA.

Klebenow, D. A. 1969. Sage grouse nesting and brood habitat in Idaho. Journal of Wildlife Management 33:649-662.

Laudenslayer, W. F. and W. E. Grenfell. 1983. Wildlife habitat relationships Program - species notes. California Department of Fish and Game, Sacramento.

Leckenby, D. A., et al. 1982. Mule Deer. in: Wildlife Habitats in Managed Rangelands - the Great Basin of southeastern Oregon. U.S. Forest Service General Technical Report PNW-139.

Major, J. 1964. Plant checklist for the Convict Creek basin, Mono County, California. Botany herbarium, University of California, Davis.

McCarthy, C. and C. Hargis. 1984. Analyzing wildlife habitats at the project level: an evaluation method. California-Nevada Wildlife Transactions 1984:73-80.

Miller, C. D. 1985. Holocene eruptions in the Inyo volcanic chain, California -- implications for possible eruptions in Long Valley caldera. Geology.

Munz, P. A. and D. D. Keck. A California Flora. University of California Press, Berkeley.

Munz, P. A. Supplement to A California Flora. University of California Press, Berkeley.

Orr, B. 1981. A Flora of Valentine Eastern Sierra Reserve. Part II. Sierra Nevada Aquatic Research Laboratory. Herbarium, University of California, Santa Barbara.

Remsen, V. 1978. Bird species of special concern in California. California Department of Fish and Game, Sacramento.

Rogers, G. E. 1964. Sage grouse investigations in Colorado. Technical Publication 16, Colorado Game and Fish Department, Denver.

Storey, M. L., R. E. Lewis and F. H. Olmsted. 1978. The hydrothermal system of Long Valley Caldera, California. U.S.G.S. Professional Paper 1044-A.

Smith, G. 1976. Mammoth Lakes Sierra. [Revised edition]. Genny Smith Books, Palo Alto, CA.

Smith, J. P. Jr. and R. York. 1984. Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1 [3rd edition].

Taylor, D. W. 1980. Ecological survey of the vegetation of the Indiana Summit Research Natural Area, Mono County, California. U.S. Forest Service, Pacific Southwest Forest and Range Experiment Station administrative report.

Taylor, D. W. 1981. Plant Checklist for the Mono Basin, California. unpublished.

Taylor, D. W. 1982. Eastern Sierra riparian vegetation: ecological effects of stream diversions. U.S. Forest Service, Inyo National Forest, administrative report.

Thomas, J. W., H. Black, R. J. Scherzinger and R. J. Pederson. 1979. Deer and Elk. pp. 104-127 in: Wildlife Habitats in Managed Forests - the Blue Mountains of Oregon and Washington. U.S.D.A. Agriculture Handbook 553.

Wallestad, R. O. and D. B. Pyrah. 1974. Movement and nesting of sage grouse hens in central Montana. Journal of Wildlife Management 38:630-633.

U.S. Forest Service. 1979. Final environmental statement for land management alternatives for the Mammoth-Mono Planning Unit. Inyo National Forest, Bishop, CA.

U.S. Forest Service. 1980. Environmental Assessment - Leasing of National Forest lands for geothermal exploration in the Long Valley caldera. Inyo National Forest, Bishop, CA.

U.S. Forest Service. 1982. Environmental Assessment, geothermal leasing of National Forest System lands in the Mono-Long Valley Known geothermal resource area, second lease block. Inyo National Forest, Bishop, CA.

U.S. Forest Service. 1986. Draft Forest Plan, Inyo National Forest, Bishop, CA.

Verner, J. and A. S. Boss. 1980. California Wildlife and Their Habitats: Western Sierra Nevada. U.S. Forest Service General Technical Report PSW-37.

APPENDIX 1
PLANT SPECIES LIST

Checklist of Vascular Plants
Observed at Casa Diablo Hot Springs,
Mono County, California

25-26 November, 1986

Apiaceae
Pteryxia terebinthina

Asteraceae
Artemisia cana ssp. *bolanderi*
Artemisia nova
Artemisia tridentata ssp. *vaseyana*
Chaenactis douglasii
Chrysothamnus nauseosus ssp. *albicaulis*
Cirsium drummondii
Conyza canadensis
Haplopappus bloomeri
Lepidium perfoliatum
Lygodesmia spinosa
Machaeranthera canescens
Taraxacum officionale
Tetradymia cansecens
Wyethia mollis

Boraginaceae
Amsinckia tesellata
Cryptantha confertiflora

Brassicaceae
Caulanthus pilosus
Descurania californica
Lepidium virginicum
Rorippa nasturtium-aquaticum
Sisymbrium altissimum
Streptanthus tortuosus var. *orbiculatus*

Chenopodiaceae
Salsola australis

Cupressaceae
Juniperus occidentalis var. *australis*

Cyperaceae
Carex douglasii
Carex nebrascensis
Carex rossii
Eleocharis acicularis
Eleocharis palustris
Scirpus americanus
Scirpus nevadensis

Fabaceae
Astragalus purshii var. *lectulus*
Lupinus caudatus

Gentianaceae
Frasera puberulenta

Geraniaceae
Erodium cicutarium

Iridaceae
Iris missouriensis

Juncaceae
Juncus balticus

Lemnaceae
Lemna minima

Liliaceae
Calochortus sp. (cf. *leichtlinii, bruneaunis*)
Fritillaria pinetorum

Loranthaceae
Phorodendron juniperinum

Onagraceae
Oenothera xylocarpa

Papaveraceae
Argemone munita ssp. *rotundata*

Poaceae
Agrostis exarata
Agropyron cristatum
Agropyron trachycaulum
Bromus tectorum
Distichilis spicata var. *stricta*
Elymus cinereus
Hordeum jubatum
Muhlenbergia asperifolia
Oryzopsis hymenoides
Poa juncifolia
Poa pratensis
Polypogon monspeliensis
Puccinellia lemmonii
Sitanion hystrix
Stipa comata
Stipa speciosa

Polemoniaceae
Eriastrum wilcoxii
Gilia sp. (annual)
Leptodactylon pungens ssp. *pulchriflorum*
Linanthastrum pachyphyllus

Polygonaceae
Eriogonum baileyi
Eriogonum kennedyi var. *purpursii*
Eriogonum umbellatum var. *dichrocephalum*
Polygonum aviculare
Rumex crispus

Portulacaceae
Lewisia rediviva

Pinaceae
Pinus jeffreyi
Pinus monophylla

Ranunculaceae
Ranunculus aquatilis
Ranunculus cymbalaria var. *saximontana*

Rhamnaceae
Ceanothus velutinus

Rosaceae
Amelanchier utahensis
Holodiscus microphyllus
Potentilla biennis
Prunus andersonii
Purshia tridentata
Rosa woodsii var. *ultramontana*

Rupiaceae
Ruppia marina

Salicaceae
Salix exigua
Salix lutea

Scrophulariaceae
Castilleja applegatei
Mimulus coccineus
Mimulus guttatus
Penstemon speciosus
Verbascum thapsus

Solanaceae
Nicotiana attenuata

July 6, 1988
BioSystems Analysis, Inc.

SCOPE-OF-WORK

Casa Diablo Geothermal Biological Studies

BioSystems Analysis, Inc. will conduct a field biological inventory of the 280-acre Casa Diablo geothermal site, Mono County, California. The purpose of the inventory is to provide base-line data on vegetation, rare plants, birds and small mammals. Inventory methods will be systematic and quantitative, facilitating re-sampling to assess the nature of any post-project impacts.

1. Rare Plant Surveys

The entire study area will be surveyed for rare, endangered or sensitive plants. Emphasis will be placed on floristic characterization of those habitats most likely to support rare plant populations. Species considered for survey will include: 1) species listed under the Endangered Species Act of 1973 (as amended); 2) Federal candidate species and BLM sensitive species; 3) U.S.Forest Service sensitive species; 4) species on List 1B, List 2 or List 3 or List 4 of the California Native Plant Society Inventory. Table 1 enumerates species with the potential to occur in the vicinity of the Study Area (based on known geographic range and habitat requirements).

Methodology of the survey will follow Nelson (1987) and California Department of Fish and Game, Nongame Heritage Program (1984) guidelines. Using these methods, the entire flora of the site is inventoried. All plant species encountered along roving "meander-transects" by botanists on foot are noted. Survey of the site will be conducted between June and August, 1988.

2. Fumarole Vegetation Characterization

BioSystems botanists will conduct focused, quantitative vegetation inventory of selected fumarole areas (Figure 1). Three types of information will be provided for each fumarole site: 1) quantitative vegetation characterization; 2) detailed vegetation map; 3) photographic characterization. At each site characterized, grid-lines will be established. Grid size will be adjusted to accommodate the size of the site, and will range from approximately 1 by 1 meter to 10 by 10 meters. Location to nearby landmarks will be recorded for relocation. Where necessary, permanent stakes will be installed to facilitate relocation of the grid.

Table 1. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
Astragalus monoensis Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
Astragalus johannis-howellii Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
Astragalus lentiginosus var. piscensis / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
Centaurium namophilum Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
Eriogonum ampullaceum Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
Fimbristylis spadicea Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
Lupinus duranii Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
Lupinus montigenus Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
Lupinus sublanatus Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

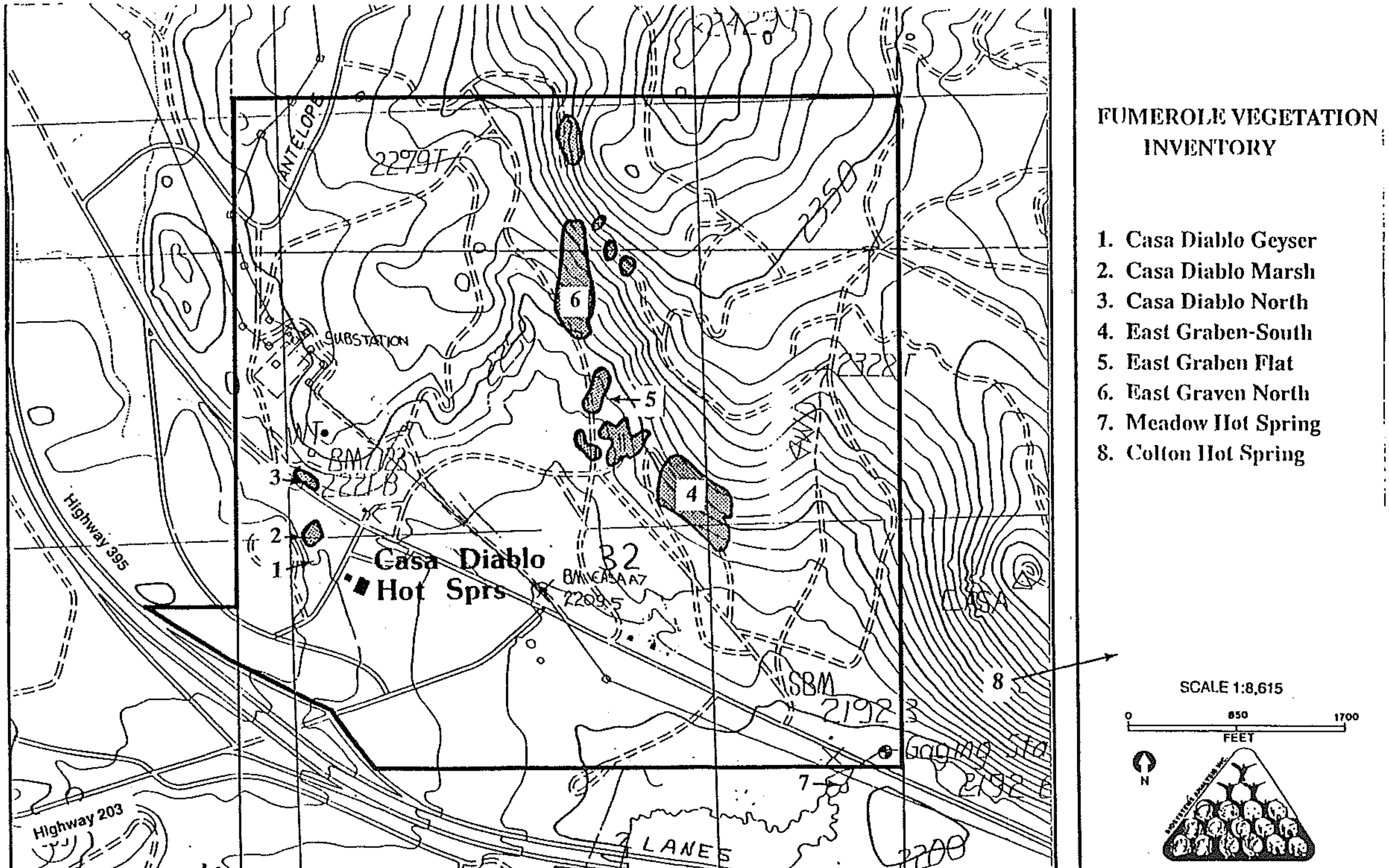
Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
<u>Pedicularis</u> <u>crenulata</u> var. <u>candida</u> / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
<u>Sedum</u> <u>pinetorum</u> Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
<u>Sidalcea</u> <u>covillei</u> Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   Category 2 = currently under review with extisting information insufficient to support listing.
   Category 3c = currently not under review, as taxon is more common than formerly thought.

4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.



(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

Quantitative vegetation characterization of each site will be accomplished by quadrat sampling. Quadrat sampling protocol will follow standard synecological vegetation inventory methods (Mueller-Dombois and Ellenberg 1974). Quadrat size will be adjusted to suit the size of a particular area under study, but in all cases will range from 0.2 dm by 0.5 dm to 1 by 1 m.

Data will be summarized in summary tables and graphics. Raw data from each sampling site will be provided in both hard-copy and electronic form (any MS-DOS format).

3. Breeding Bird Census. A combination of circular plots and linear transects will be used to determine the composition and relative abundance of the avifauna present on site. Five circular plot centers will be established in representative areas of the habitats present on site: pinyon-juniper woodland, Jeffrey pine forest, Jeffrey pine-pinyon pine forest, sagebrush scrub, and a Nebraska sedge meadow-Jeffrey pine forest-sagebrush scrub ecotone. In addition, data will be collected along linear transects established between the circular plot centers. Species, number of birds, sex, activity, method of detection, distance and azimuth, and time were recorded for each sighting.

Sampling will take place for five consecutive days during the breeding season. Each plot will be sampled twice daily; within one hour of sunrise and within one hour of sunset. Data analysis will provide information on species occurrence, relative density, and relative abundance. Plot centers will be marked with permanent posts so that the identical sites may be sampled during and after construction. The data will be useful in comparing any changes in composition, density, or abundance before and after construction.

4. Small mammal trapping. Baseline data on the small mammal community composition will be collected during 4 consecutive nights of live-trapping. Traps will be placed in representative areas of the major habitat types in approximate proportion to the amount of that habitat on site. In addition to the major habitat types mentioned above, traps will be also be placed in unique or potentially critical habitat areas: rhyolite buckwheat scrub (East Graben); hydrothermally altered areas (Casa Diablo marsh, Meadow Hot spring, and Colton hot spring). Traps will also be placed at the sites of the MP-1 and PLES-1 powerplants.

Traps will be set and baited at dusk and checked at dawn. They will remain closed during the day to avoid heat stress to any animal. Species, sex, physical condition, breeding condition, and trap location will be recorded. Locations and diagrams of the trapping grids or transects will be mapped so that they may be duplicated during or after construction. Trapping results will be analyzed for species composition and relative abundance.

x.x Rare Plant Survey

x.1 INFORMATION REVIEW

Selection of methodology appropriate for conducting a rare plant survey of the study area was made after consultation with U.S.F.S personnel (Christina Hargis, Inyo National Forest, pers. communication). Field work was conducted under the guidelines of the California Department of Fish and Game (1984), and those of Nelson (1984, 1987).

Species targeted for survey were those identified by Taylor and Buckberg (1986) via: 1] review of published and unpublished literature, including relevant environmental documents from the vicinity of the study region; 2] information from the Natural Diversity Data Base of the Natural Heritage Section, California Department of Fish and Game (Shevock and Hennessy 1987); and 3] communication with botanists with expertise with the local flora or particular taxonomic groups. Since the information assembled by Taylor and Buckberg (1986) considered current, no new data source review was conducted for the 1988 surveys.

Table 1 provides an enumeration of those rare plants with the potential to occur in the study area - basically any plants listed or considered for listing as rare, threatened, sensitive, or endangered by: *1)* the U.S. Fish and Wildlife Service (50 CFR Part 17, USFWS 1985) under the Endangered Species Act of 1973, as amended; *2)* the U.S. Forest Service (USFS 1984, cf. Smith 1987); *3)* the Bureau of Land Management (those taxa listed in USFWS 1985, cf. Hastey 1987); *4)* the California Fish and Game Commission under both the Native Plant Protection Act (Chapter 10, Section 1900, Fish and Game Code, Cochrane 1987) and the California Endangered Species Act (Sections 2050-2098, Fish and Game Code) or species that qualify for listing under the California Environmental Quality Act (Section 15380); *5)*; the California Native Plant Society (Smith and York 1984).

x.2 FIELD METHODS

Table 1 presents status, habitat, and distributional information for 12 CNPS rare or endangered plants with potential to occur in the vicinity of Casa Diablo Hot Springs. This table presents a refined working list for field surveys, based upon the data review described above. Known populations of many of these species in the eastern Sierra region were visited during the course of our surveys to ascertain phenology and microsite requirements for particular taxa.

Rare plant surveys were conducted on 7 June 1986 and again on 29-30 June 1988. All potential habitat for the 12 potential rare plants listed in Table 1 was visited. Field survey of the study area used the meander method of Nelson (1987). Two botanists walked in a meandering fashion through the survey area, recording each plant species encountered. The surveys were conducted at the peak of the growing and flowering season for the area, at the appropriate stage of phenology to identify any plant species encountered.

Table 1. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
Astragalus monoensis Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
Astragalus johannis-howellii Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
Astragalus lentiginosus var. piscensis / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
Centaurium namophilum Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
Eriogonum ampullaceum Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
Fimbristylis spadicea Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
Lupinus duranii Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
Lupinus montigenus Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
Lupinus sublanatus Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
Pedicularis crenulata var. candida / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
Sedum pinetorum Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
Sidalcea covillei Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   - Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   - Category 2 = currently under review with extisting information insufficient to support listing.
   - Category 3c = currently not under review, as taxon is more common than formerly thought.

4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.

x.x Results

x.1 RARE PLANTS

No rare or endangered vascular plant species were observed on the study area during our survey. Inspection of habitat features of the site confirmed our previous assumption (Taylor and Buckberg 1986) that sensitive plant populations were not likely for the Casa Diablo Hot Springs site, based on 1) habitat features, and 2) a long history of local plant collection along Highway 395 in the general region.

Appendix A provides a list of vascular plant species observed on the study site. A comparison with the species list compiled during our previous survey, conducted in the winter of 1986, indicates a considerably more diverse flora for the Casa Diablo Hot Springs site. In 1986, 90 taxa of vascular plants were seen. Our surveys during the summer of 1988 added 66 plant taxa to the species list, for a total of 166 taxa comprising 40 families of vascular plants. The majority of additions to the species list were plants growing in meadow vegetation along Mammoth Creek, and in the outflow marshes from Casa Diablo Hot Spring, Meadow Hot Spring and Colton Hot Spring. Relatively few species occurring in upland habitats (i.e., Jeffrey Pine Forest or hydrothermally altered areas) went undetected in our previous survey.

x.0 LITERATURE CITED

California Department of Fish And Game. 1984. Guidelines for assessing effects of proposed developments on rare and endangered plants and plant communities. Resource Agency, State of California 4 May 1984.

Cochrane, S.A. 1987. Endangered Plants and California State Laws. pp. 33-38 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Cronquist, A., A. Holmgren, N. Holmgren and J. L. Reveal. 1972. Intermountain Flora. Volume 1. Hafner Publishing Co., New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1977. Intermountain Flora. Volume 6. Columbia University Press, New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1984. Intermountain Flora. Volume 4. New York Botanical Garden, Bronx, NY.

Dedecker, M. 1984. Flora of the Northern Mojave Desert, California. California Native Plant Society, Special Publication No. 7.

Dedecker, M. 1979. Report on the flora of Glass Mountain Ridge. unpublished administrative report, Inyo National Forest, Bishop, CA.

Dedecker, M. 1974. Plant checklist for the Owens Valley. Final Environmental impact report, increased groundwater pumping in the Owens Valley. City of Los Angeles, Department of Water and Power.

Hastey, E.L. 1987. Conservation of rare plants on Public Lands in California. pp. 51-60 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Howald, A. 1981. A Flora of Valentine Eastern Sierra Reserve. Part I. Valentine Camp. Herbarium, University of California, Santa Barbara.

Munz, P. A. Supplement to A California Flora. University of California Press, Berkeley.

Munz, P. A. and D. D. Keck. A California Flora. University of California Press, Berkeley.

Nelson. J. R. 1984. Rare plant field survey guidelines. pp. vi-vii in: J.P. Smith and R. York [Eds.], Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society, Special Publication No. 1 [3rd edition].

Nelson, J.R. 1987. Rare Plant Surveys: Techniques for Impact Assessment. pp. 159-166 in: T. Elias [Ed.], Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Sacramento, CA.

Shevock, J.R., and L.L. Hennessy. 1987. The California Natural Diversity Data Base - a common denominator. pp. 181-184 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Smith, Z.G., Jr. 1987. Sensitive plant management on the National Forests in California. pp. 61-66 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants. Federal Register 50(188):39526-39527.

U.S. Forest Service 1984. Master List - Region Five Sensitive Plant Species. U.S. Forest Service, San Francisco, CA.

Orr, B. 1981. A Flora of Valentine Eastern Sierra Reserve. Part II. Sierra Nevada Aquatic Research Laboratory. Herbarium, University of California, Santa Barbara.

Smith, J. P. Jr. and R. York. 1984. Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1 [3rd edition].

Taylor, D. W. 1981. Plant Checklist for the Mono Basin, California. Mono Basin Research Group, Mono Lake Committee, Lee Vining, CA.

Taylor, D.W. and R. Buckberg. 1986. Biotic assessment for proposed geothermal energy facilities, Casa Diablo Hot Springs, Mono County, California. Unpublished report to Environmental Management Associates, Inc., Brea, CA.

July 12, 1988

Checklist of Vascular Plants Observed at Casa Diablo Hot Springs, Mono County, California

Dean Wm. Taylor & Glenn L. Clifton
BioSystems Analysis, Inc.

This checklist covers the general vicinity of Casa Diablo Hot Springs, including a 620 acre area surveyed in 1986 (Taylor and Buckberg 1986), and a smaller (±280 acres) surveyed in the summer, 1988. The list is is based on four visits: 25-26 November, 1986; 30 April 1987; 7 June 1988 and 29 June 1988. Nomenclature generally corresonds to Munz and Keck (1959), except where superceeded by more recent monographic treatment for a given taxon, or by the appropriate edition of the Intermountain Flora (Cronquist et al. 1972, 1977, 1985). This list corrects several epithets applied to dried remains of plants observed during a winter visit in 1986 (November 25-26).

Alliaceae
Muilla transmontana Greene

Apiaceae
Pteryxia terebinthina (Hooker) Coulter & Rose var. *californica* (Coulter & Rose) Mathias

Asteraceae
Achillea millefolium L. var. *borealis* (Bong) Farw.
Anisocoma acaulis Torrey & Gray
Artemisia cana Pursh ssp. *bolanderi* (Gray) G.H. Ward
Artemisia ludoviciana Nuttall ssp. *ludoviciana*
Artemisia nova A. Nelson
Artemisia tridentata Nuttall ssp. *vaseyana* (Rydberg) Beetle
Chaenactis douglasii (Hooker) Hooker & Arnott var. *rubricaulis* (Rydb.) Ferris
Chrysothamnus nauseosus (Pallas) Britton ssp. *albicaulis* (Nuttall) Hall & Clements
Cirsium drummondii Torrey & Gray
Conyza canadensis L.
Ericameria bloomeri (Hooker) J.F. MacBride var. *bloomeri*
Erigeron divergens Torrey & Gray
Erigeron loncophyllus Hooker var. *loncophyllus*
Layia glandulosa (Hooker) Hooker & Arnott
Machaeranthera canescens (Pursh) Gray ssp. *cansecens*
Malacothrix clevlandii Gray
Pyrrocoma lanceolatus (Hooker) Greene
Senecio vulgaris L.
Stephanomeria spinosa (Nuttall) S. Tomb
Taraxacum officionale L.
Tetradymia cansecens DC.
Wyethia mollis Gray

Betulaceae

Alnus incana (L.) Moenc. ssp. *tenuifolia* (Nuttall) Breitung

Boraginaceae

Amsinckia tesellata Gray
Greeneocharis circumscissa (Hooker & Arnott) Rydberg var. *hispdiula* (MacBride)
Lappula redwoskii (Hornem.) Greene
Oreocarya confertiflora Greene
Plagiobothrys kingii (Watson) Gray var. *harkensii* (Greene) Jepson
Tiquilia plicata (Torrey) A. Richards

Brassicaceae

Caulanthus pilosus Watson
Descurania californica (Gray) O.E. Schultz
Descurania sophia (L.) Webb. ex. Prantl.
Lepidium perfoliatum L.
Lepidium virginicum L. var. *pubescens* (Greene) C.L. Hitchcock
Nasturtium officionale R. Br.
Rorippa teres (Michaux) R. Stuckey
Sisymbrium altissimum L.
Streptanthus tortuosus Kellogg var. *orbiculatus* (Greene) Hall

Caryophyllaceae

Cerastium vulgatum L.
Stellaria longipes Goldie

Chenopodiaceae

Salsola iberica Sennen & Pau

Cupressaceae

Juniperus occidentalis Hooker ssp. *australis* Vasek

Cyperaceae

Carex athrostachya Olney
Carex aquatilis Wahlenb.
Carex douglasii Boott
Carex nebrascensis Dewey
Carex rossii Boott ex Hooker
Carex simulata Mackenzie
Eleocharis acicularis (L.) Roemer & Schultes
Eleocharis bolanderi Gray
Eleocharis palustris (L.) Roemer & Schultes
Scirpus americanus Pers.
Scirpus nevadensis Watson

Equisetaceae

Equisetum arvense L.
Equisetum laevigatum A. Braun

Fabaceae

Astragalus purshii Douglas ex Hooker var. *lectulus* (Watson) Jones
Lupinus caudatus Kellogg
Lupinus polyphyllus Lindley ssp. *superbus* (Heller) Munz
Lupinus sellulus Kellogg ssp. *sellulus*
Trifolium longipes Nuttall
Trifolium wormskjoldii Lehm.
Trifolium repens L.

Gentianaceae

Frasera puberulenta A. Davidson

Geraniaceae

Erodium cicutarium (L.) L'Her

Hydrophyllaceae

Phacelia ramosissima Douglas ex. Lehm.

Iridaceae

Iris missouriensis Nuttall
Sisyrinchium idahoense Bicknell var. *occidentale* (Bicknell) Henderson

Juncaceae

Juncus balticus L.

Lamiaceae

Marrubium vulgare L.

Lemnaceae

Lemna minuta HBK.

Liliaceae

Calochortus bruneaunis Nelson & MacBride
Fritillaria atropurpurea Nuttall

Loasaceae

Mentzelia dispersa Watson

Loranthaceae

Arceuthobium camplypodium Engelmann
Phorodendron juniperinum Engelmann ex Gray var. *juniperunium*

Malvaceae

Sidelcea oregana (Nuttall ex. Torrey & Gray) Gray ssp. *spicata* (Regel) C.L. Hitchcock

Nyctaginaceae

Abronia pogonantha Hiemerl

Onagraceae

Epilobium ciliatum Raf. ssp. *ciliatum*
Gayophytum diffusum Torrey & Gray ssp. *parviflorumm* Lewis & Szweykowski
Oenothera caespitosa Nuttall. ssp. *marginatus*
Oenothera xylocarpa Coville

Papaveraceae

Argemone munita Durand & Hilgard ssp. *rotundata* (Rydb) G. Ownbey

Poaceae

Alopecurus aequalis Sobol
Agrostis exarata Trin. var. *pacifica* Vasey
Agrostis filiculmis M.E. Jones
Agrostis stolonifera L. var. *major* (Gaudin) Farw.
Agrostis variabilis Rydberg
Agropyron pectiniforme Roemer & Schultes
Agropyron trachycaulum (Link) Malte.
Bromus tectorum L.
Distichilis spicata (L.) Greene var. *stolonifera* Beetle
Distichilis spicata (L.) Greene var. *stricta* (Torrey)Beetle
Elymus cinereus Scribner & Merrill var. *cinereus*
Hordeum brachyantherum Nevski
Hordeum jubatum L. ssp. *jubatum*
Muhlenbergia asperifolia (Nees & Meyer) Parodi
Muhlenbergia richardsonis (Trin.) Rydberg
Oryzopsis hymenoides (Roemer & Schultes) Ricker var. *hymenoides*
Phleum pratense L. var. *pratense*
Poa compressa L.
Poa incurva Scribner & Williams
Poa nevadensis Vasey ex Scribner var. *juncifolia* (Scribner) Beetle
Poa pratensis L.
Polypogon monspeliensis (L.) Desf.
Puccinellia nuttalliana (Schultes) A.S. Hitchcock
Sitanion hystrix (Nuttall) J.G. Smith
Stipa comata Trin. & Rupr.
Stipa coronata Thurber var. *depauperata*
Stipa speciosa Trin & Rupr.
Vulpia bromoides (L.) S.F. Gray

Polemoniaceae

Eriastrum wilcoxii (A. Nelson) Mason
Gilia sp. (annual)
Leptodactylon pungens Torrey ssp. *pulchriflorum* (Brand) Mason
Linanthas pachyphyllus R. Patterson
Phlox stansburyi (Torrey) Heller

Polygonaceae

Bistorta bistortoides (Pursh) Small
Eriogonum kennedyi (Porter ex Watson) var. *purpursii* (K. Brandegee) Reveal
Eriogonum umbellatum Torrey var. *dichrocephalum* Gandog.
Eriogonum watsonii Torrey & Gray
Eriogonum wrightii Torrey ex Bentham var. *subscaposum* Watson
Polygonum aviculare L.
Rumex crispus L.
Rumex salicifolius Weinm.

Portulacaceae

Calyptridium monospermum Greene
Lewisia rediviva Pursh ssp. *minor* (Rydberg) N. Holmgren

Pinaceae

Pinus jeffreyi Grev. & Balf.
Pinus monophylla Torrey & Fremont

Ranunculaceae

Ranunculus aquatilis L.
Ranunculus cymbalaria Pursh var. *saximontanus* Fernald

Rhamnaceae

Ceanothus velutinus Douglas ex Hooker var. *velutinus*

Rosaceae

Amelanchier utahensis Koehne. ssp. *utahensis*
Geum macrophyllum Willd.
Holodiscus dumosus (Nuttall) Heller var. *glabrescens* (Greenman) C.L. Hitchcock
Potentilla biennis Greene
Potentilla diversifolia Lehm.
Potentilla rivularis Nuttall var. *millegrana* (Engelmann) Watson
Prunus andersonii Gray
Purshia tridentata (Pursh) DC.
Rosa woodsii Lindley var. *ultramontana* (Watson) Jepson

Rubiaceae

Galium trifidum L. var. *pusillum* Gray

Salicaceae

Salix exigua Nuttall
Salix lasiandra Bentham var. *caudata* (Nuttall) Sudworth
Salix lutea Nuttall

Scrophulariaceae

Castilleja applegatei Fernald
Mimulus coccineus Congdon
Mimulus guttatus Fisch. ex DC. ssp. *guttatus*

Scrophulariaceae (concluded)
Penstemon rydbergii A. Nelson var. *varians* (A. Nelson) Cronquist
Penstemon speciosus Douglas ex Lindley
Verbascum thapsus L.
Veronica peregrina L. ssp. *xalapensis* (HBK) Pennell
Veronica americana (Raf.) Schwein. ex Bentham

Solanaceae
Nicotiana attenuata Torrey ex Watson

Urticaceae
Urtica dioica L. var. *angustifolia* Schelcht
Urtica dioica L. var. *holoserica* (Nuttall) C.L. Hitchcock

Zannichelliaceae
Zannichellia palustris L.

APPENDIX E

DEER STUDIES

CASA DIABLO GEOTHERMAL DEVELOPMENT PROJECT:

DEER STUDY FINAL REPORT, 1987

Thomas E. Kucera
2909 Regent #2
Berkeley CA 94704

INTRODUCTION

Proposals have been made to develop geothermal electric generating plants in the southwest portion of Long Valley in Mono County, California. These developments, including those known as PLES I and MP II and III and referred to collectively as the Casa Diablo Geothermal Project, have raised concerns with respect to potential deleterious impacts on migratory mule deer (Odocoileus hemionus) which use the project area and vicinity. The Biotic Assessment of the project prepared in January 1987 was considered by the management agencies involved to be deficient in data on deer in the area. The present investigator was subsequently contracted to gather data to allow an assessment of the importance of the area to deer through an annual cycle, i.e., spring, summer and fall. No wintering activity is to be expected. This report concerns the periods of spring migration, summer, and the fall migration, 1987.

The Eastern Sierra Nevada is known for its visual and biological resources, and the quality of the natural environment. Among the most important components of this natural environment, symbolically, esthetically and economically, are the impressive numbers of mule deer. Only in the last three years has intensive ecological research on these animals been conducted. It is now known that more than half of the 6000 deer which winter near Bishop migrate to the north and pass near the town of Mammoth Lakes to get to their summer ranges (Kucera, unpubl.). The annual life cycle of deer in the Eastern Sierra Nevada may be divided into four periods: winter, spring migration and staging, summer, and fall migration. These seasonal movements are a response to the seasonal availability of habitat, and as parts of a component system, all are important in maintaining deer populations.

Most deer in this part of the Eastern Sierra winter at lower elevations some 20 airline miles to the southeast and east of the proposed geothermal area (Figure 1). Several "herds" as defined by the California Department of Fish and Game (DFG) are of concern in the present situation. These are the Buttermilk and Sherwin Grade herds, which winter in Round Valley, at the base of the eastern escarpment of the Sierra Nevada just west of Bishop, and the Casa Diablo herd, which winters between the Benton Range and the White Mountains, from the Casa Diablo Peak area north past the town of Benton (DFG 1984, 1985a, 1985b).

The spring migration begins in April, when deer leave their winter ranges and move to intermediate altitudes. They congregate in "holding areas" for as long as six weeks, feeding on spring vegetation and regaining condition lost over the winter, until they move to summer ranges. Here, typically at higher elevations and frequently west of the Sierra crest, fawns are produced and reared. The fall migration back to the winter range typically is more rapid than that of the spring, and often is patterned by fall storms. Deer arrive on the winter range during September, October, and November, breed in December and January, and begin the annual cycle again.

The objective of the present work is to describe and quantify the amount, timing and specific locations of mule deer use of the Casa Diablo Geothermal Project Area ("Study Area") during the spring, summer, and fall of 1987. This information is

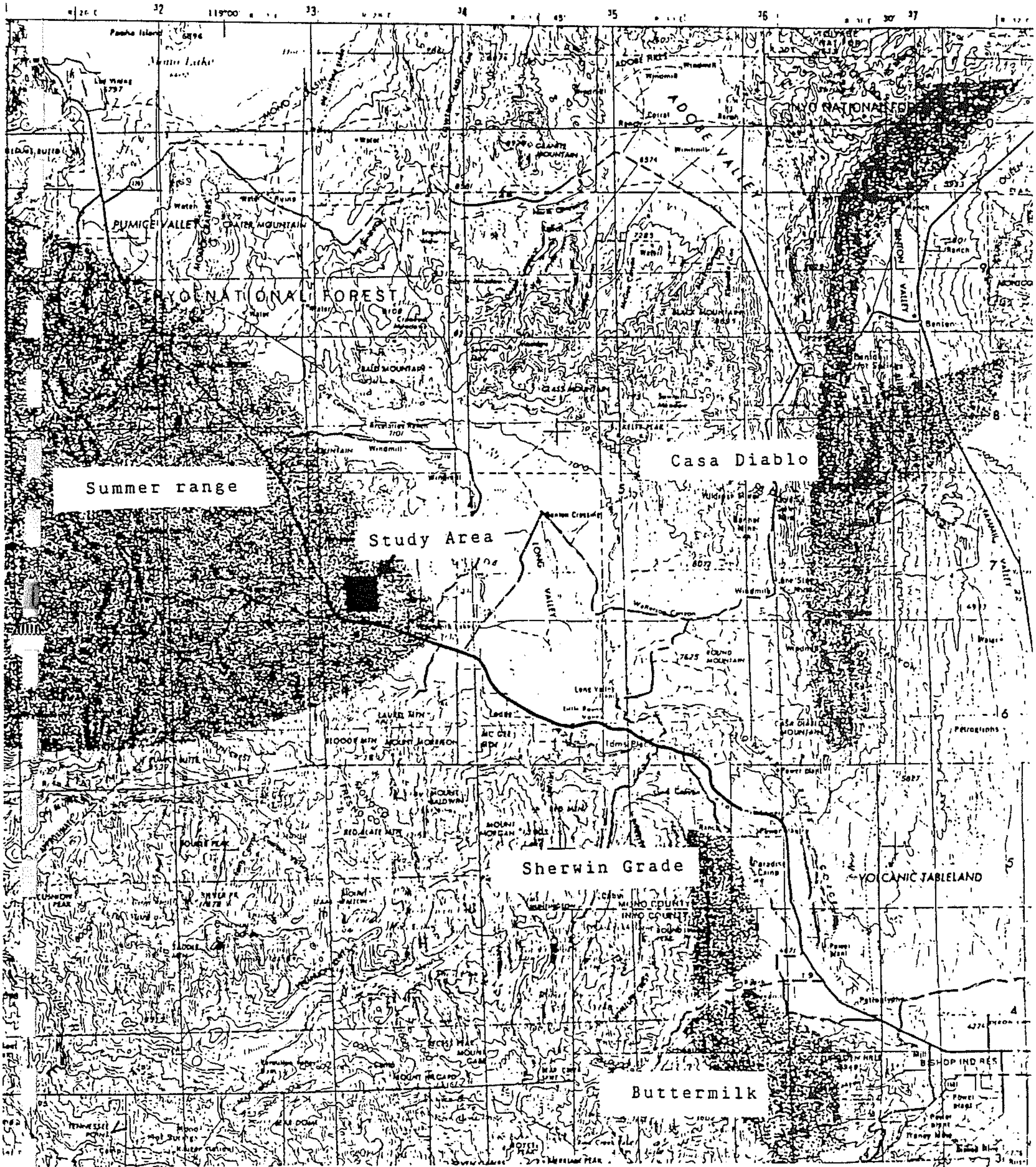


Figure 1. Regional map indicating locations of Buttermilk, Sherwin Grade and Casa Diablo Winter ranges, and approximate summer ranges of deer using the Long Valley area on migration.

designed to meet the information needs of public resource management and planning agencies with respect to baseline conditions in the Study Area, and to assist in assessing impacts to deer of a geothermal development and designing measures to reduce those impacts.

ACKNOWLEDGMENTS

This investigation was conducted under a contract from Environmental Management Associates, Brea CA. Some of the information presented here is from a larger investigation of Eastern Sierra deer supported by the Bishop Resource Area of the Bureau of Land Management, the California Department of Fish and Game, Inyo and Mono Counties, the University of California, Berkeley, and several private funding organizations. Most of the fieldwork was conducted by Timothy Taylor.

STUDY AREA

The Casa Diablo Geothermal Study Area is located in portions of Sections 29 and 32 of T. 3 S, R. 28 E, Mono County, CA (Figures 1 and 2). It is immediately north of Highway 395, approximately 3 miles east of the town of Mammoth Lakes. The land is a mixture of both public and private ownership.

METHODS

A track survey route was laid out on the dirt roads which pass through the Study Area (Figure 2). This route was divided

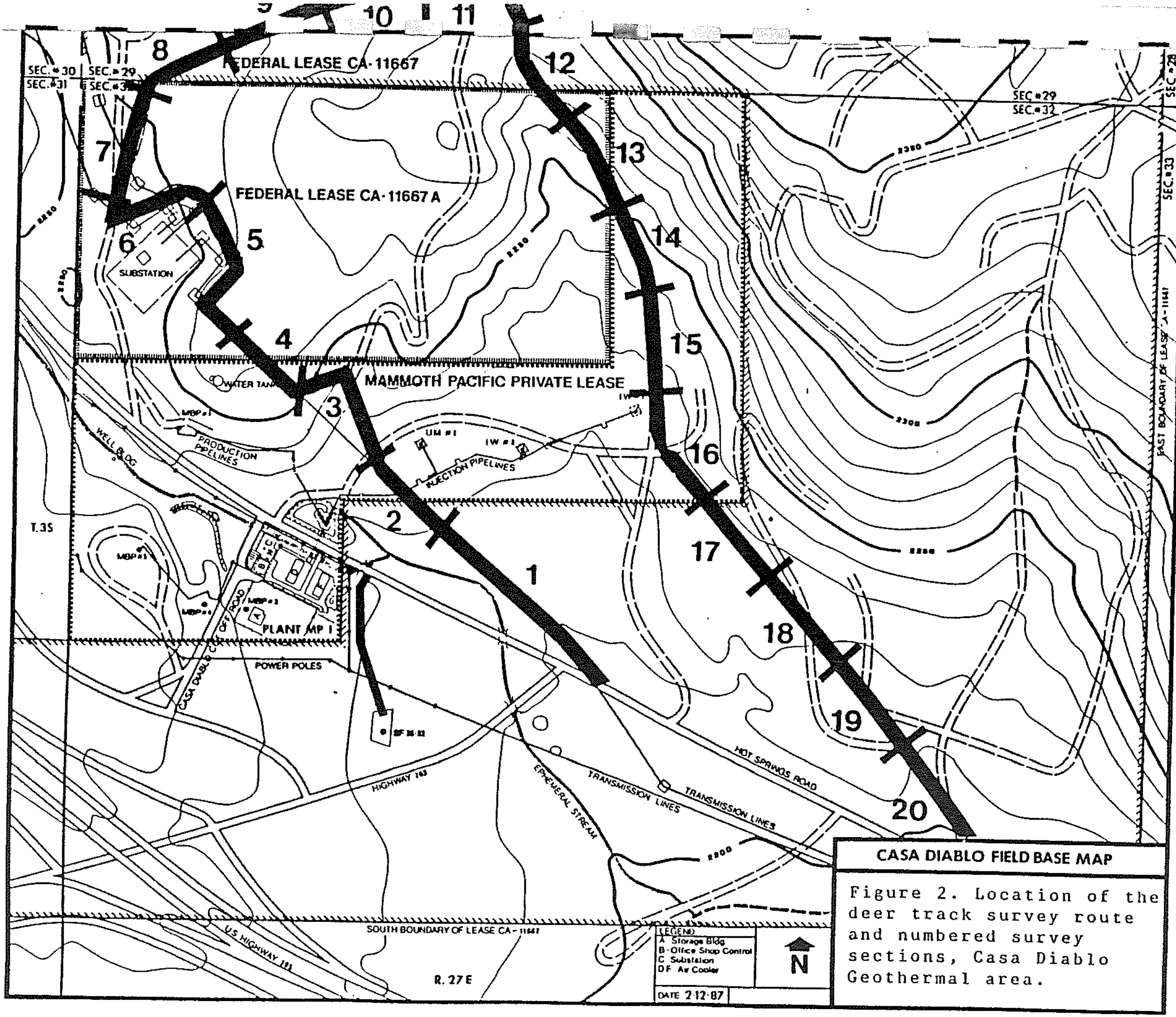


Figure 2. Location of the deer track survey route and numbered survey sections, Casa Diablo Geothermal area.

and marked into 20 sections each 0.1 miles long except Section 1, which was 0.2 miles long. In adition, the dirt road leading from Hot Springs Road to well SF 35-32 was included in the surveys.

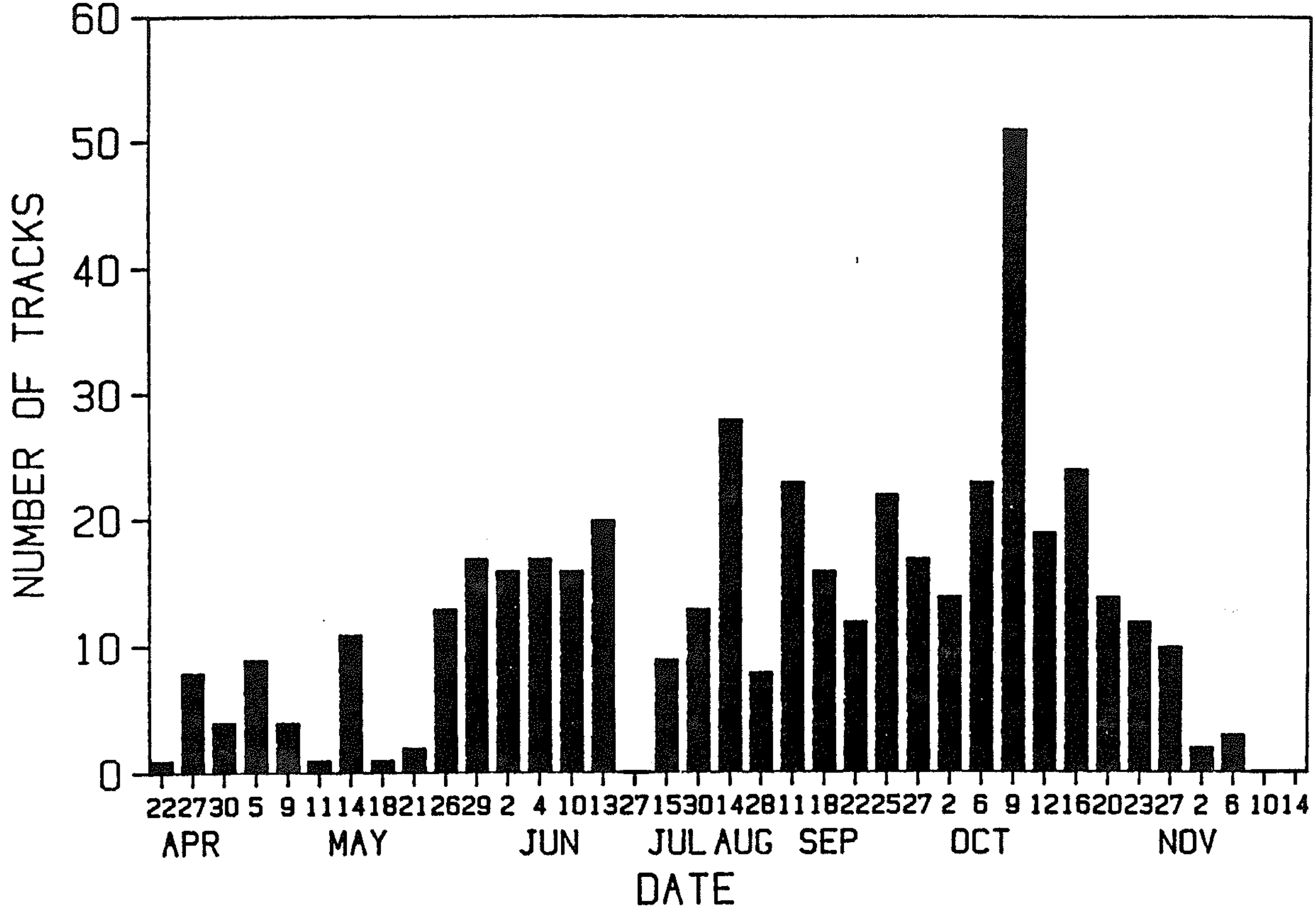
Beginning on 21 April 1987, the entire route was cleared of tracks and a tracking substrate prepared by dragging the route with a "sled" pulled by a vehicle. This was done in late afternoon, and the following morning, the route was walked or driven and all deer tracks observed on the road were counted, both by survey section and by direction of travel. Data recorded were the number of individual deer making the observed tracks and their direction of travel. Because the route was dragged each evening before a survey to obliterate all tracks, the tracks counted on the surveys were made by animals within approximately the previous 12-18 hours. Recording tracks by survey section was designed to give a quantitative picture of the local pattern of deer movement in the Study Area. Recording tracks by direction of movement was designed to allow separation of back-and-forth or very localized movements from migrational movements.

RESULTS

1. Timing of deer activity

Figure 3 shows the total number of tracks made by individual deer throughout the period of study, presented without regard to direction of movement or location. During the spring (22 April-13 June), a pattern of gradual increase in the number of tracks is apparent, with the greatest number of tracks, 20, on 13 June. Subsequently, use was relatively constant except for July and November surveys, and the survey on 9 October. The low counts in July may have reflected restricted activity during fawning. The

FIGURE 3. TOTAL NUMBER OF DEER TRACKS COUNTED ON SURVEYS, 1987



relatively high 9 October total was no doubt due to migrating animals, and the low counts late in the period reflected the fact that most animals had migrated by mid-November. No major fall storm occurred to trigger a large migration, and this is reflected in the pattern of tracks.

Figure 4 shows the breakdown of tracks counted on the spring surveys by direction of movement. Movements to the north and west are generally in the direction of spring migration; those to the south and east are opposite. Thus, subtracting the south and east-moving tracks from the north and west-moving ones, respectively, yields a crude estimate of the net number of deer moving through between the dragging of the route and the counting of the tracks. This is shown in Figure 5, in which the number of tracks heading south was subtracted from those heading north, and the number of tracks heading east was subtracted from those heading west, on each survey. Negative numbers may be interpreted as indicating predominantly localized, nondirectional movements. As indicated in Figure 5, most migrational movements in the Study Area occurred throughout late April and May. Beginning in late May, the negative net track numbers indicate fewer directional or migrational movements and more local movements, likely from deer on what will be their summer range.

Figure 6 shows the breakdown of tracks counted on the summer and fall surveys by direction of movement. Opposite that of the spring pattern, movements to the south and east are generally in the direction of the fall migration; those to the north and west are opposite. Figure 7 presents the number of tracks heading north subtracted from those heading south, and the number of

FIGURE 4. DEER TRACKS BY DIRECTION OF MOVEMENT IN THE PLES GEOTHERMAL SITE, SPRING 1987

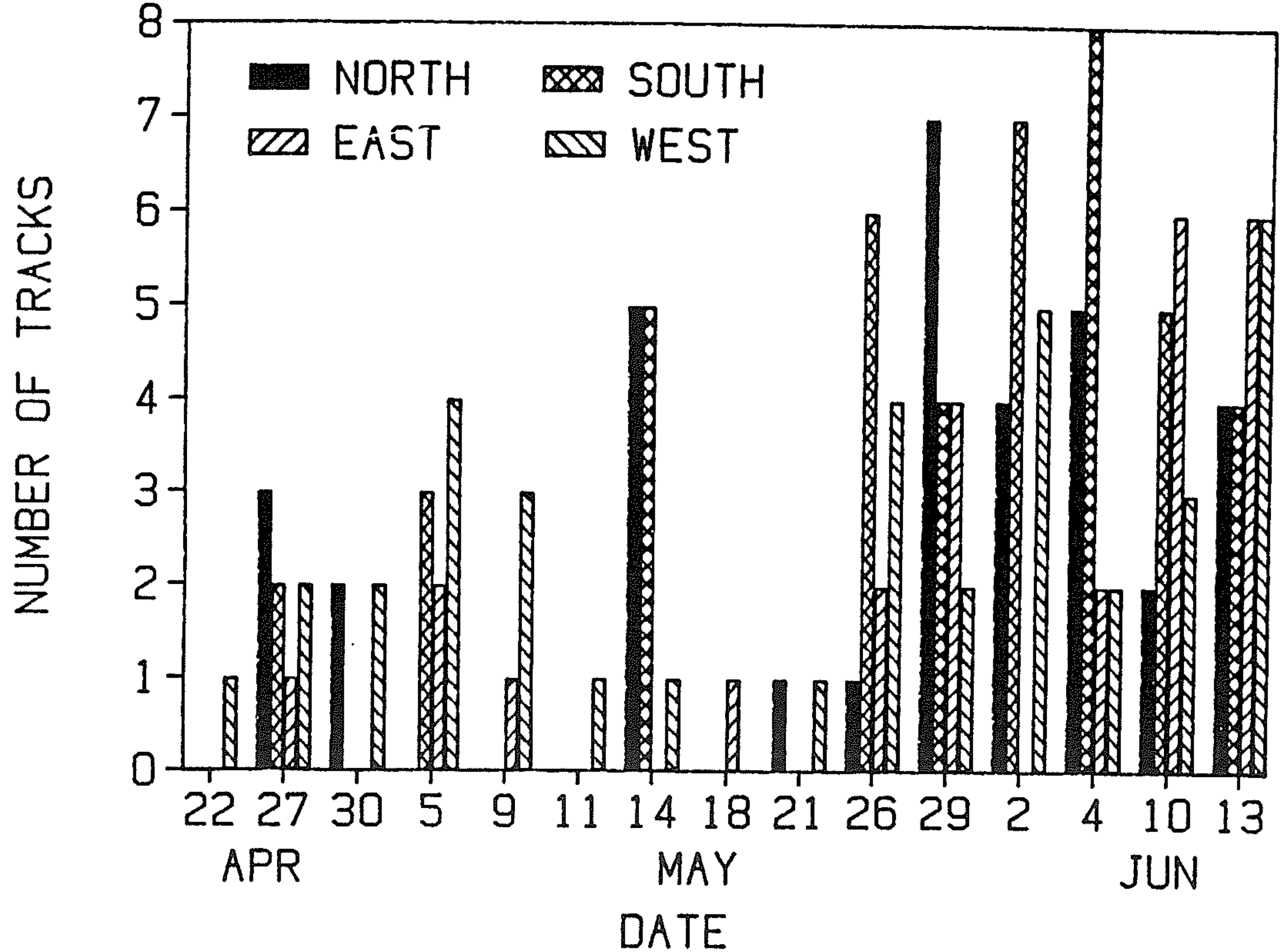


FIGURE 5. NET DEER TRACKS BY DIRECTION OF MOVEMENT IN THE PLES GEOTHERMAL SITE, SPRING 1987

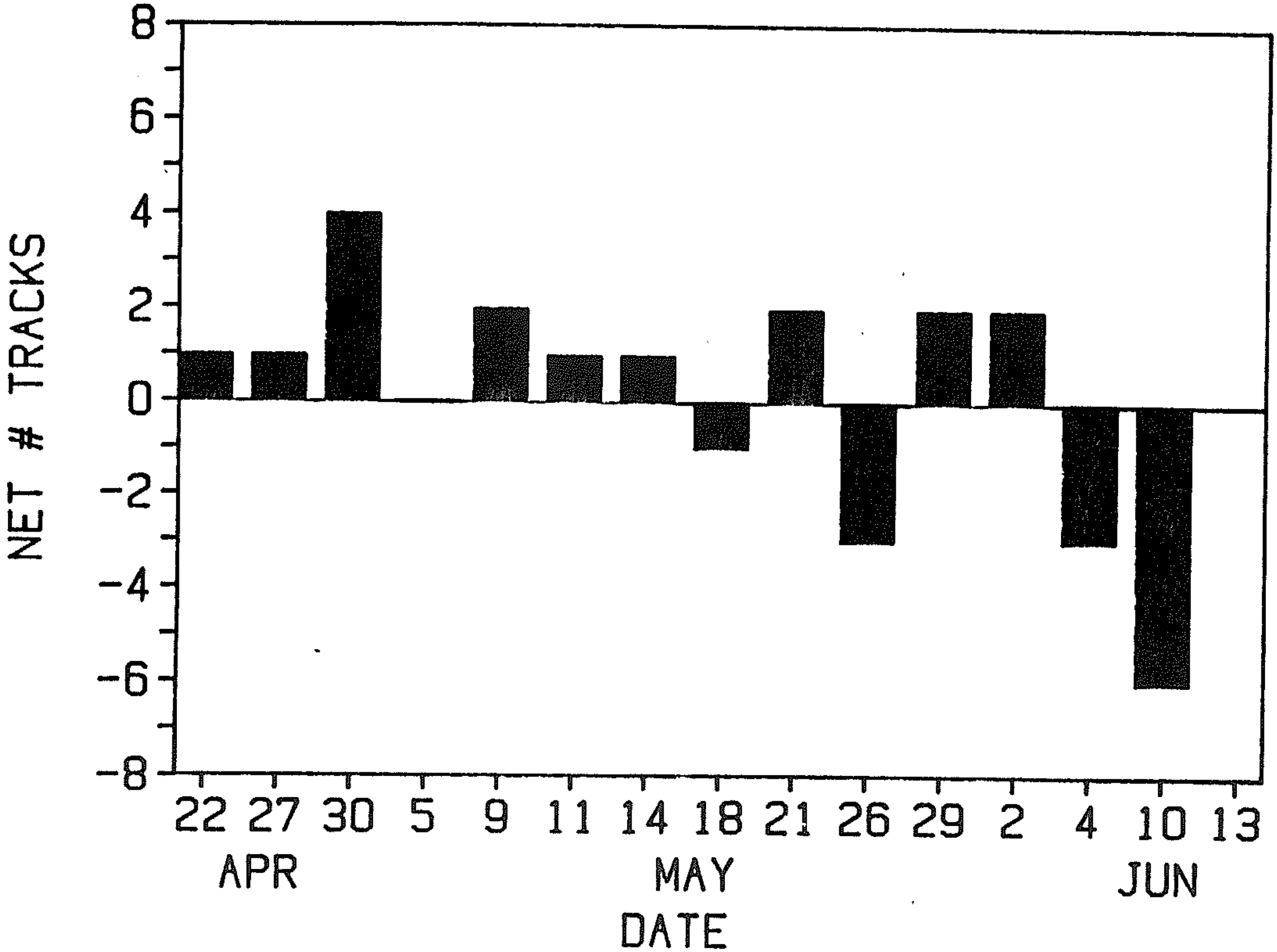


FIGURE 6. DEER TRACKS BY DIRECTION OF MOVEMENT IN THE PLES GEOTHERMAL SITE, SUMMER-FALL 1987

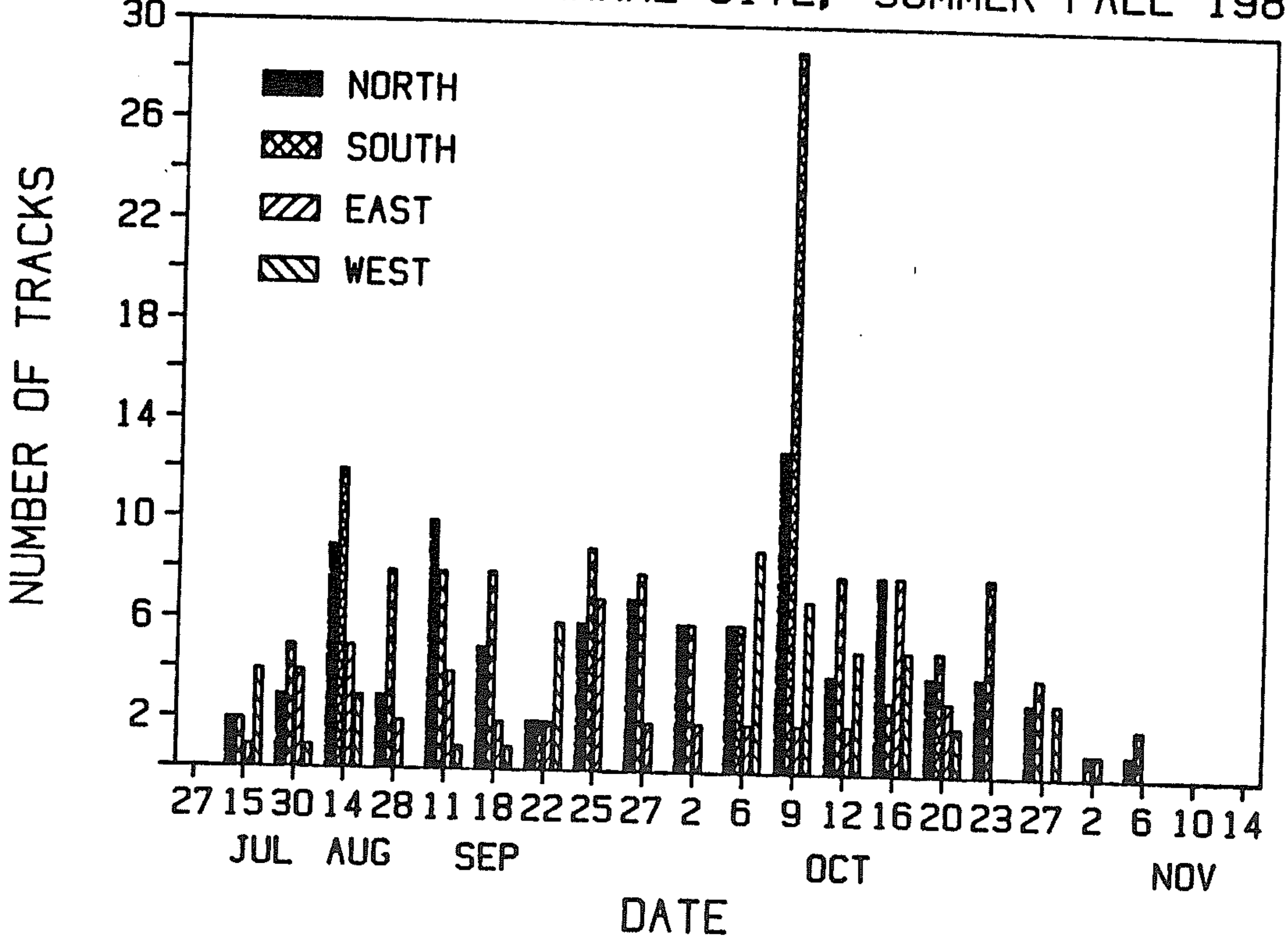
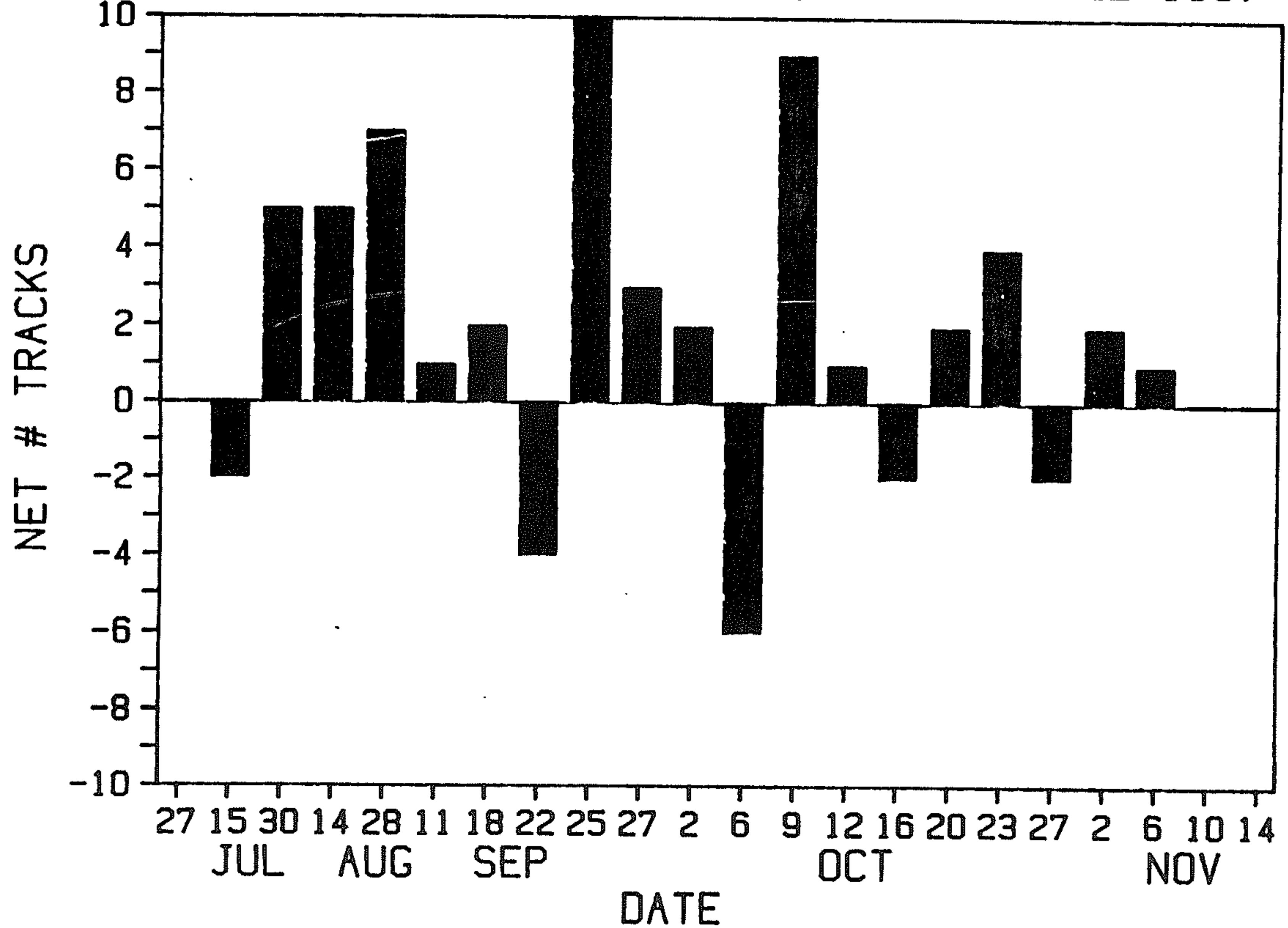


FIGURE 7. NET TRACKS BY DIRECTION OF MOVEMENT IN THE PLES GEOTHERMAL SITE, SUMMER-FALL 1987



tracks heading west subtracted from those heading east, on each survey. The pattern of net tracks in Figure 7, however, yields no straightforward interpretation. The period of summer residency, July through September, shows a predominantly positive net number of tracks, a period during which, if movements were predominantly local, one would expect a balance of approximately zero or below.

2. Locations of deer movements

Figure 8 presents the total number of deer tracks by survey section counted during the spring (22 April-13 June) of 1987. The large number of tracks indicated for Section 1 is somewhat misleading because that section is twice as long as the others. With this in mind, the distribution of tracks in the survey sections appears rather uniform during the spring. In contrast, the distribution of tracks in the survey sections during summer and fall (27 June-14 November) (Figure 9) is more heavily weighted toward the first 10 sections, although deer activity is present in all.

The net tracks by survey section in the spring (Figure 10) show no consistent pattern of movements. It is apparent that directional movements occurred in Sections 8, 10-12, and 18-20, which correspond to the most northerly and northwesterly, and southwesterly portions, respectively, of the Study Area.

The deer activity between June and November can be divided into the periods of summer residency and fall migration. Because there was no major fall storm to elicit one major wave of migration, the fall migration period will somewhat arbitrarily be defined as starting with the 9 October survey. This date is supported by other observations in the vicinity of the study

FIGURE 8. TOTAL NUMBERS OF TRACKS COUNTED BY SURVEY SECTION IN THE PLES GEOTHERMAL SITE, SPRING 1987

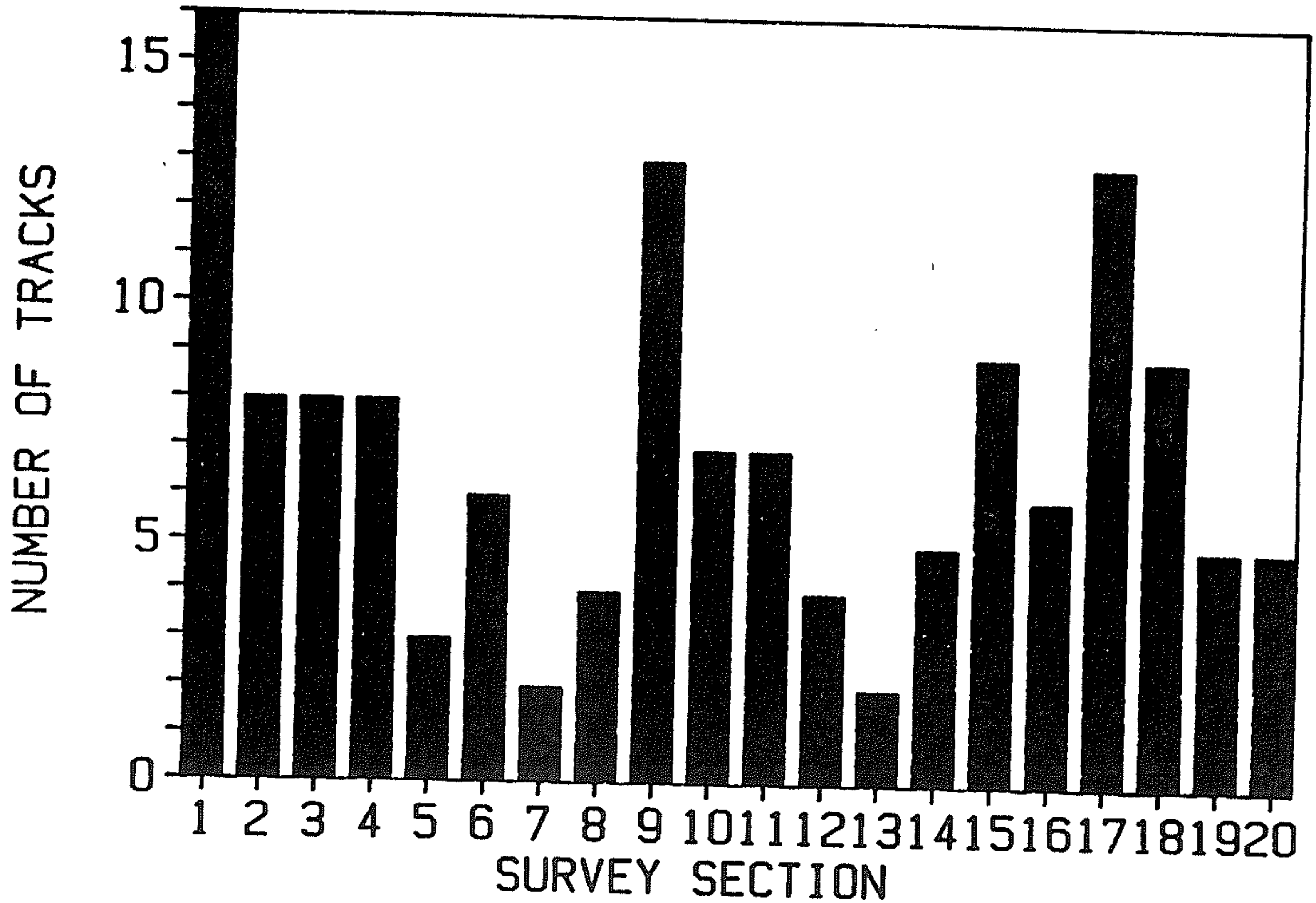


FIGURE 9. TOTAL NUMBERS OF TRACKS COUNTED BY SURVEY SECTION, PLES GEOTHERMAL SITE, SUMMER-FALL 1987

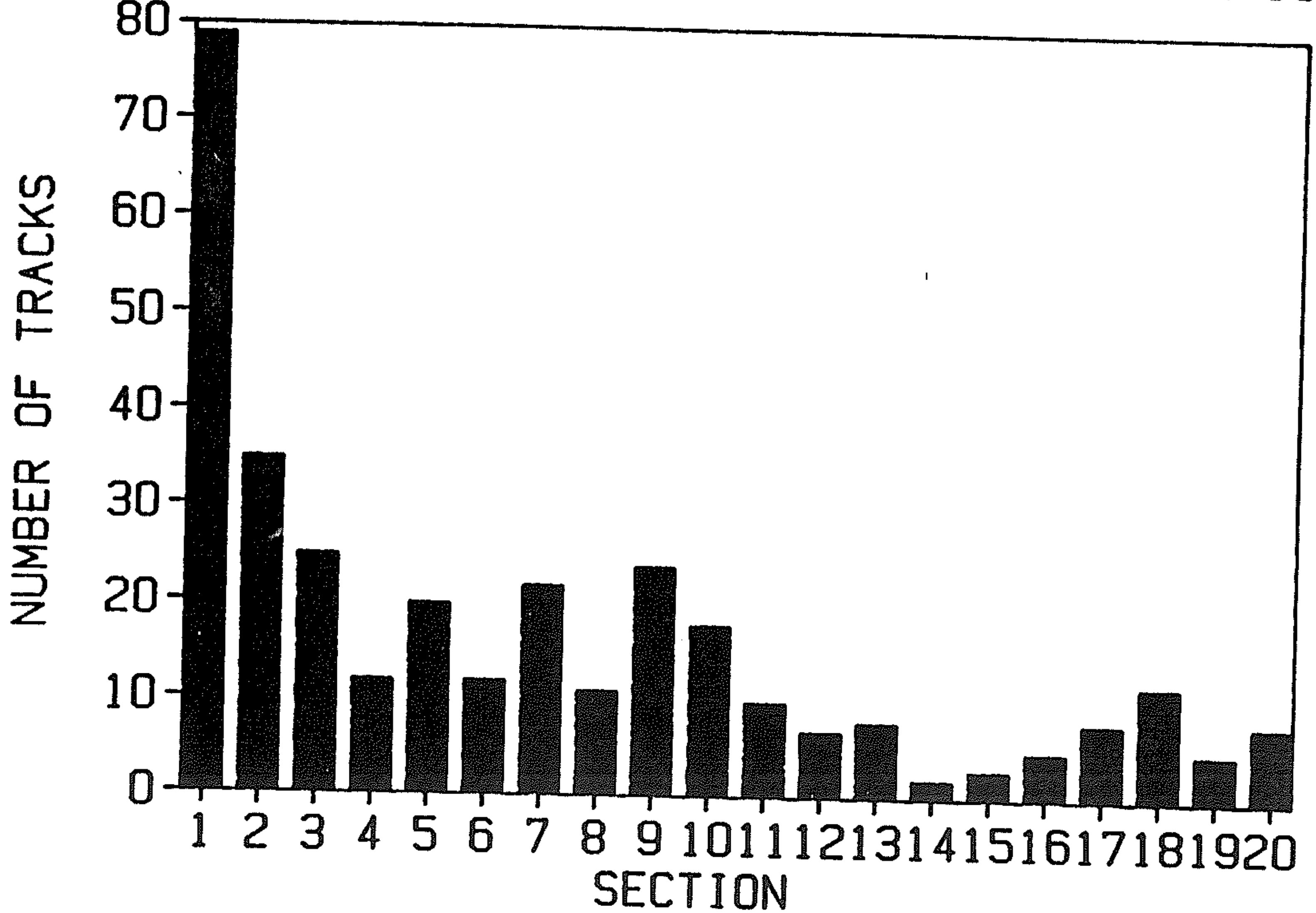
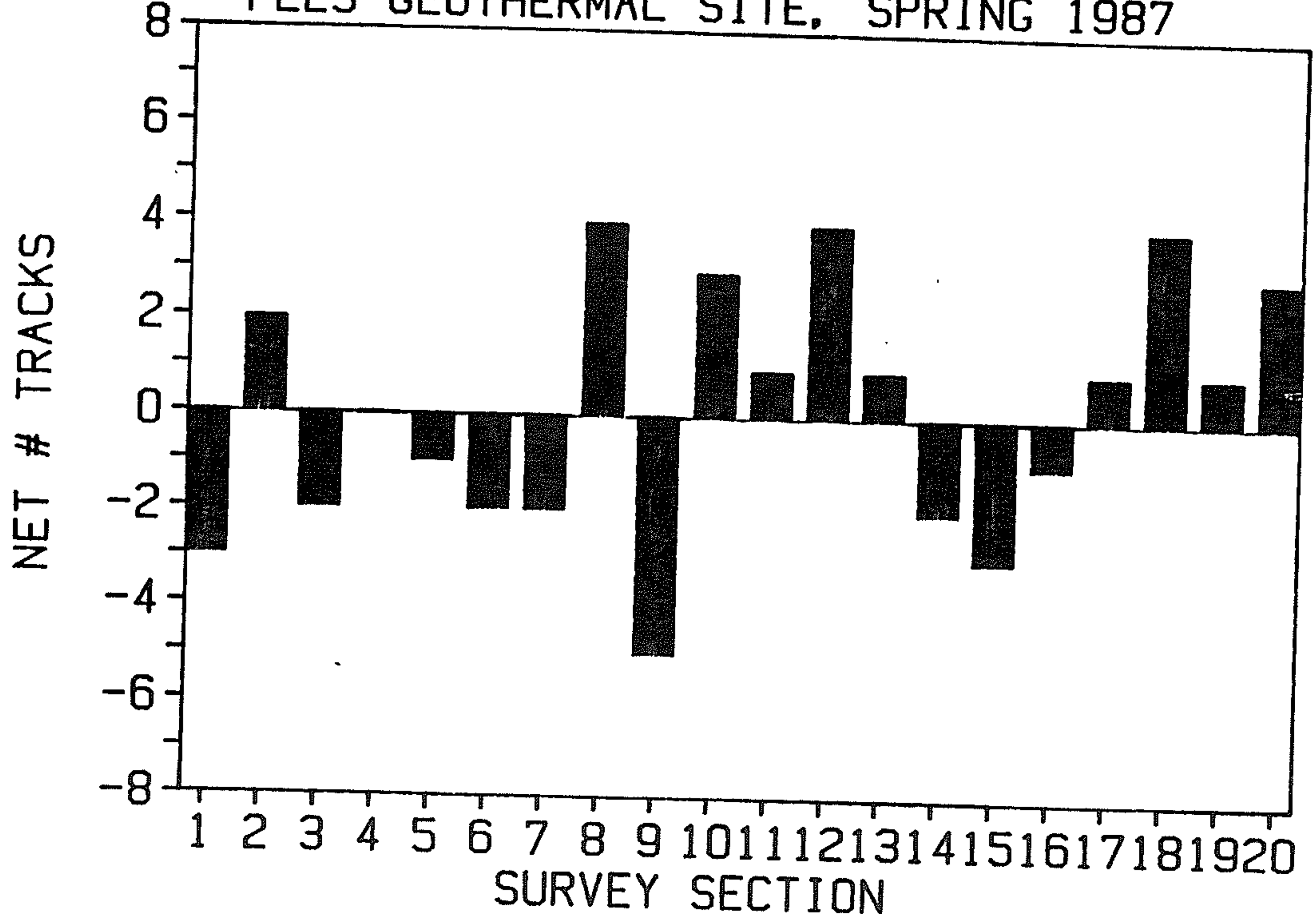


FIGURE 10. NET NUMBERS OF TRACKS BY SURVEY SECTION, PLES GEOTHERMAL SITE, SPRING 1987



area. Figure 11 shows the tracks by survey section divided into summer and fall migration periods. These comprise 12 and 10 surveys, respectively. No consistent patterns are obvious, except that more tracks were counted in Section 1 during migration than during summer. Total tracks were 168 in summer and 158 in fall.

On the road to well SF 35-32, single sets of west-moving tracks were observed on 10, 18, 21, and 26 May. No tracks were observed here on any survey during the summer or fall.

Throughout the survey period, deer were observed visually on only 3 occasions while conducting surveys. On 4 June, 2 adult females were seen near Sections 10 and 11. On 8 October, 5 adult females, 5 fawns and 1 yearling male were seen between Sections 9 and 12. On 26 October, 4 adult females and 1 fawn were seen in Section 10. The summer range of one doe radio-collared in 1984 on the Sherwin Grade included part of the Study Area in 1987, as in previous years.

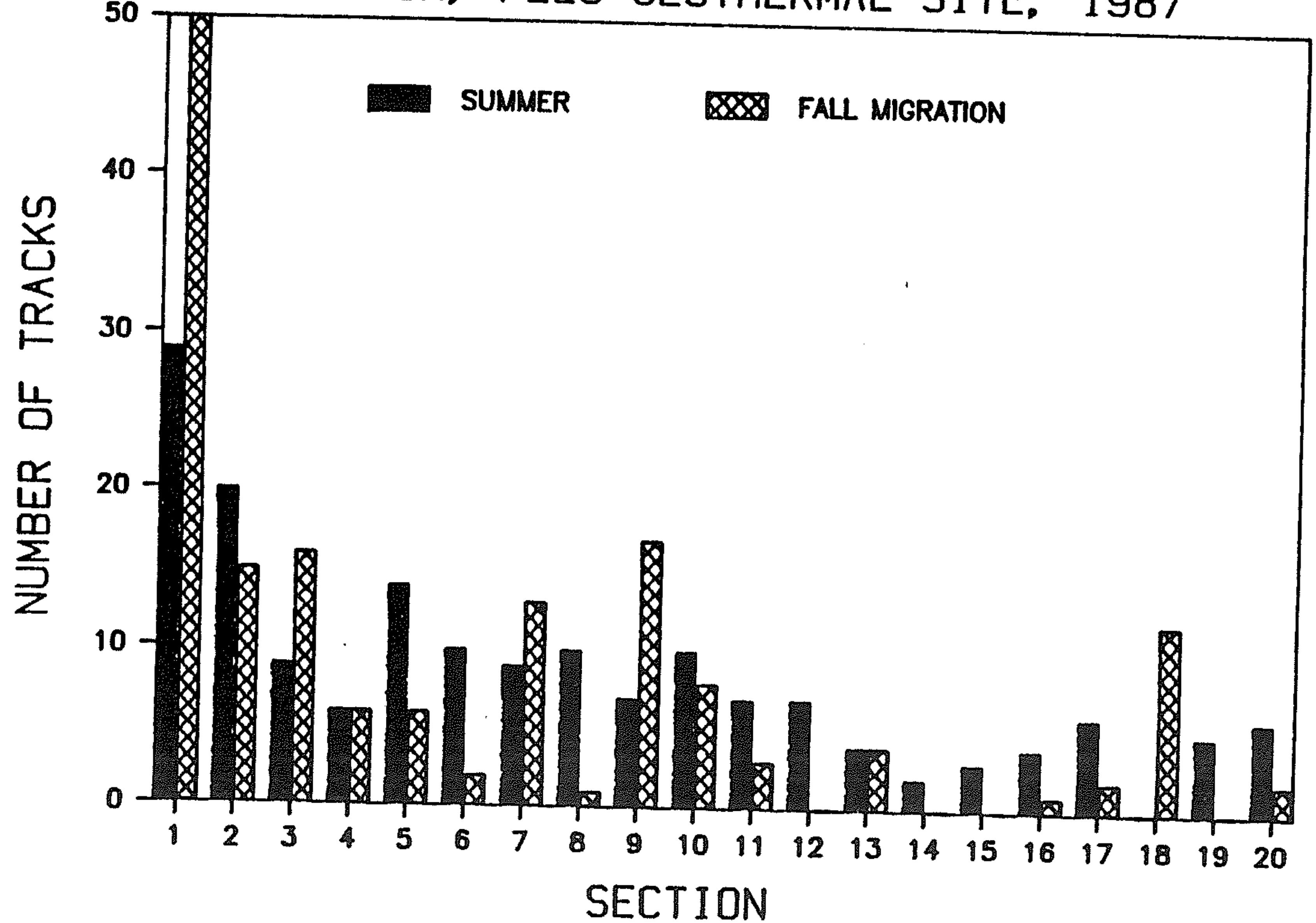
No specific areas of deer movement or well-defined concentration areas were apparent from covering the area on foot during any period.

DISCUSSION

Results of the 1987 track surveys indicate a generally somewhat dispersed pattern of deer activity in and movement through the Study Area. Activity was recorded throughout the spring, summer, and fall periods. No well-defined migration trails were observed, and the track counts indicated deer activity in all sections.

The number of animals involved in the spring migration can be at least roughly estimated. On the assumption that the period

FIGURE 11. TOTAL DEER TRACKS BY SUMMER AND FALL MIGRATION, PLES GEOTHERMAL SITE, 1987



of spring migration was 15 April to 2 June, the 12 surveys covered approximately 25% of the 48 days in this period. The net number of tracks in this period was 13 (Figure 5). Assuming this to be a reasonable approximation of the number of deer actually moving through between the time the area was dragged and when the tracks were counted the next morning, a total of 52 (13/0.25) deer moved through the Study Area during the survey period. This does not take into account those deer that may have moved through during the day. Making the assumption that 75% of deer would migrate at night (between dragging and counting) and 25% would migrate during the day, a grand total of 69 (45/0.75) deer moving through during the spring period can be estimated, given the stated assumptions.

This estimate of 69 deer is meant only as an approximation of the number of deer using the Study Area on spring migration. Potential sources of error, e.g., multiple counts of the same animal, or tracks missed because of poor tracking substrate, are impossible to quantify. However, the precise number is not important; what matters is the estimate of magnitude. There certainly are not hundreds or thousands of animals using this area, as is the case in other local areas, but likely there are dozens. This movement does not seem to be concentrated in any localized portion of the Study Area, but is dispersed throughout it, which may not be unexpected given its relatively small size and lack of extreme topography.

During the summer, the number of tracks counted on the various surveys varied from 0 to 29, indicating a moderate amount of summering activity. There is no way to determine absolute numbers of animals from these track counts, but 6-10 might be a reasonable guess. Fawns were produced in the area; the first fawn tracks were observed on 14 August. Given an average fetal rate of 1.5/doe, the deer summering in the area would produce something like 10-15 fawns.

Attempting to estimate even crudely the number of animals passing through on fall migration, given the unpredictably pulsed pattern of the fall 1987 migration in addition to the problems of estimation discussed above, is not meaningful. One can safely assume the magnitude of the fall migration to be that of the spring plus that year's fawns. Deer movement through the area in the fall was apparent, and, as in the spring, the precise number is not important; again, what matters is the estimate of magnitude. As in the spring, it is likely that there are dozens, dispersed throughout.

Deer from three designated "herds" are involved: the Buttermilk, Sherwin Grade, and the Casa Diablo herds. Radioed or otherwise marked deer from all three herds have been observed in the vicinity of the Study Area (Kucera, unpubl., Taylor 1988).

Recent radio-telemetry information indicates that most of the Buttermilk and Sherwin Grade deer which migrate north do so along the base of the mountains west of Highway 395 (Kucera, unpubl.). Likewise, most Casa Diablo deer move along the base of the Glass Mountains northeast of the Study Area (Taylor 1988). A portion of each herd, however, does move near or right through the Study Area. One deer from the Sherwin Grade range summered within a portion of the Study Area. Taylor (1988) reported that no radioed deer from the Casa Diablo herd migrated near the Study Area, but several ear-tagged deer were seen within several kilometers. Although Figure 3 in Taylor (1988) indicates a major migration route nearby, apparently on the basis of the sightings of the ear-tagged animals, the present study found no evidence of a major route through the Study Area. The present track data, as well as deer sightings, indicate light to moderate and relatively dispersed deer activity.

Impacts of geothermal development on these summering and migrating deer are difficult to predict precisely, but in a general sense are a function both of the location, amount and kinds of changes associated with the development, and of the availability of potential alternate travel routes. It was the case that deer activity was rather dispersed throughout the area. The locations of the proposed power plant sites are shown in Figure 12. These occur most closely to Survey Sections 1 and 15-17 (Figure 2). Additional facilities likely will include a number of wells, pipelines, and a transmission line, as well as the power plants. Section 1 had relatively high deer use, and Sections 15-17 relatively low (Figures 6 and 7). Assuming a "worst case" scenario, one in which deer completely avoid the proposed facilities and associated human disturbance, it is difficult to see how making several dozen deer move several hundred yards around the facilities would constitute a great hardship. Given the existing terrain, such an avoidance would likely have a trivial impact on migrating deer. Of course, certain facilities, e.g., fences, pipelines, etc., could be designed to minimize any impacts to deer and to facilitate their passage. Summer use by deer would be restricted by the developments and human activity, with a consequent lowering of carrying capacity and decreased fawn production.

From the standpoint of deer migration and summer use, the locations of the presently proposed facilities (Figure 12) are less preferable than the initially proposed site (Figure 9 in Kucera 1987). The present proposal has would have the new power plants across Hot Springs Road from the existing plant, thus effectively increasing the area impacted by the project. In general, the more concentrated an area of disturbance, the less will be its deleterious impact. The present configuration, however, apparently is preferable from the standpoint of minimizing visual impacts of the project.

At present, alternate routes for migration exist, giving deer an opportunity to avoid the project area if developed. However, there are proposals for additional developments in the region, e.g., the Mammoth/Chance geothermal project, the Doe Ridge project, the Sherwin Bowl Ski Area, the Snowcreek development, Juniper Ridge, etc. Although it is impossible to discuss thoroughly the impacts of a project without reference to the context in which that project occurs, a regional summary and analysis taking such additional projects into account are not within the scope of the present work. No doubt the consequences of some of these proposed projects, because of their nature, size, and/or geographical location, are potentially much greater than those to be anticipated from Casa Diablo. Others may be more benign. The present study was not designed to evaluate cumulative impacts outside of the Study Area.

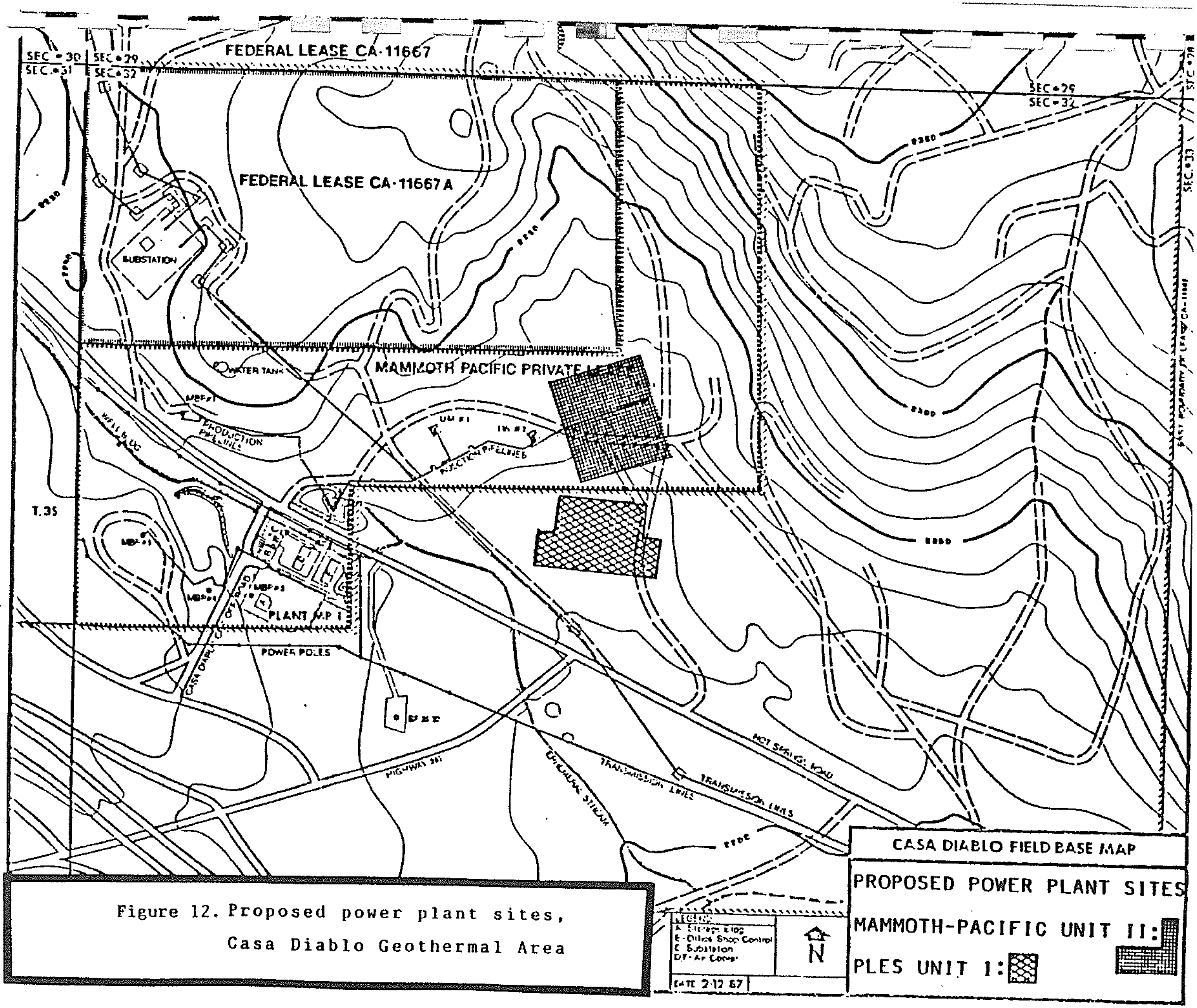


Figure 12. Proposed power plant sites,
Casa Diablo Geothermal Area

The present investigation and discussion indicate that the Casa Diablo Geothermal Project Area exhibits a light to moderate amount of deer activity in summer and during the fall migration. Considered by itself, it will likely not have a major impact upon the summer residents or on fall migration. It is likely that the earlier proposed site location, adjacent to the existing power plant, would have less of an impact both to summer resident and migratory deer than the alternatives, across Hot Springs Road. There will be loss of summer habitat causing some reduction in local carrying capacity and fawn production. Regarding migration, in the worst and unlikely case that deer avoid the project entirely, there are at present alternate routes available to allow migrating deer to reach their summer ranges. Thus, the Casa Diablo Geothermal Project by itself will likely have minimal negative impact.

LITERATURE CITED

California Department of Fish and Game. 1984. Buttermilk Deer Herd Management Plan. Prep. by Tom Blankinship, Bishop CA. 56pp.

-----. 1985a. Management Plan for the Casa Diablo Deer Herd. Prep. by Ronald D. Thomas, DFG, Bishop CA. 53pp.

-----. 1985b. Management Plan for the Sherwin Grade Deer herd. Prep. by Ronald D. Thomas, DFG, Bishop CA. 53pp.

Kucera, T. E. 1987. Casa Diablo Development Project: Deer Migration Study, Spring 1987. Report sumitted to Environmental Management Associates, Inc. Brea CA. 19pp. typescript.

Taylor, T. J. 1988. Migration and seasonal habitats of the Casa Diablo deer herd. California Department of Fish and Game, Bishop CA.

July 6, 1988
BioSystems Analysis, Inc.

SCOPE-OF-WORK

Casa Diablo Geothermal Biological Studies

BioSystems Analysis, Inc. will conduct a field biological inventory of the 280-acre Casa Diablo geothermal site, Mono County, California. The purpose of the inventory is to provide base-line data on vegetation, rare plants, birds and small mammals. Inventory methods will be systematic and quantitative, facilitating re-sampling to assess the nature of any post-project impacts.

1. Rare Plant Surveys

The entire study area will be surveyed for rare, endangered or sensitive plants. Emphasis will be placed on floristic characterization of those habitats most likely to support rare plant populations. Species considered for survey will include: 1) species listed under the Endangered Species Act of 1973 (as amended); 2) Federal candidate species and BLM sensitive species; 3) U.S.Forest Service sensitive species; 4) species on List 1B, List 2 or List 3 or List 4 of the California Native Plant Society Inventory. Table 1 enumerates species with the potential to occur in the vicinity of the Study Area (based on known geographic range and habitat requirements).

Methodology of the survey will follow Nelson (1987) and California Department of Fish and Game, Nongame Heritage Program (1984) guidelines. Using these methods, the entire flora of the site is inventoried. All plant species encountered along roving "meander-transects" by botanists on foot are noted. Survey of the site will be conducted between June and August, 1988.

2. Fumarole Vegetation Characterization

BioSystems botanists will conduct focused, quantitative vegetation inventory of selected fumarole areas (Figure 1). Three types of information will be provided for each fumarole site: 1) quantitative vegetation characterization; 2) detailed vegetation map; 3) photographic characterization. At each site characterized, grid-lines will be established. Grid size will be adjusted to accommodate the size of the site, and will range from approximately 1 by 1 meter to 10 by 10 meters. Location to nearby landmarks will be recorded for relocation. Where necessary, permanent stakes will be installed to facilitate relocation of the grid.

Table 1. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
Astragalus monoensis Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
Astragalus johannis-howellii Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
Astragalus lentiginosus var. piscensis / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
Centaurium namophilum Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
Eriogonum ampullaceum Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
Fimbristylis spadicea Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
Lupinus duranii Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
Lupinus montigenus Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
Lupinus sublanatus Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

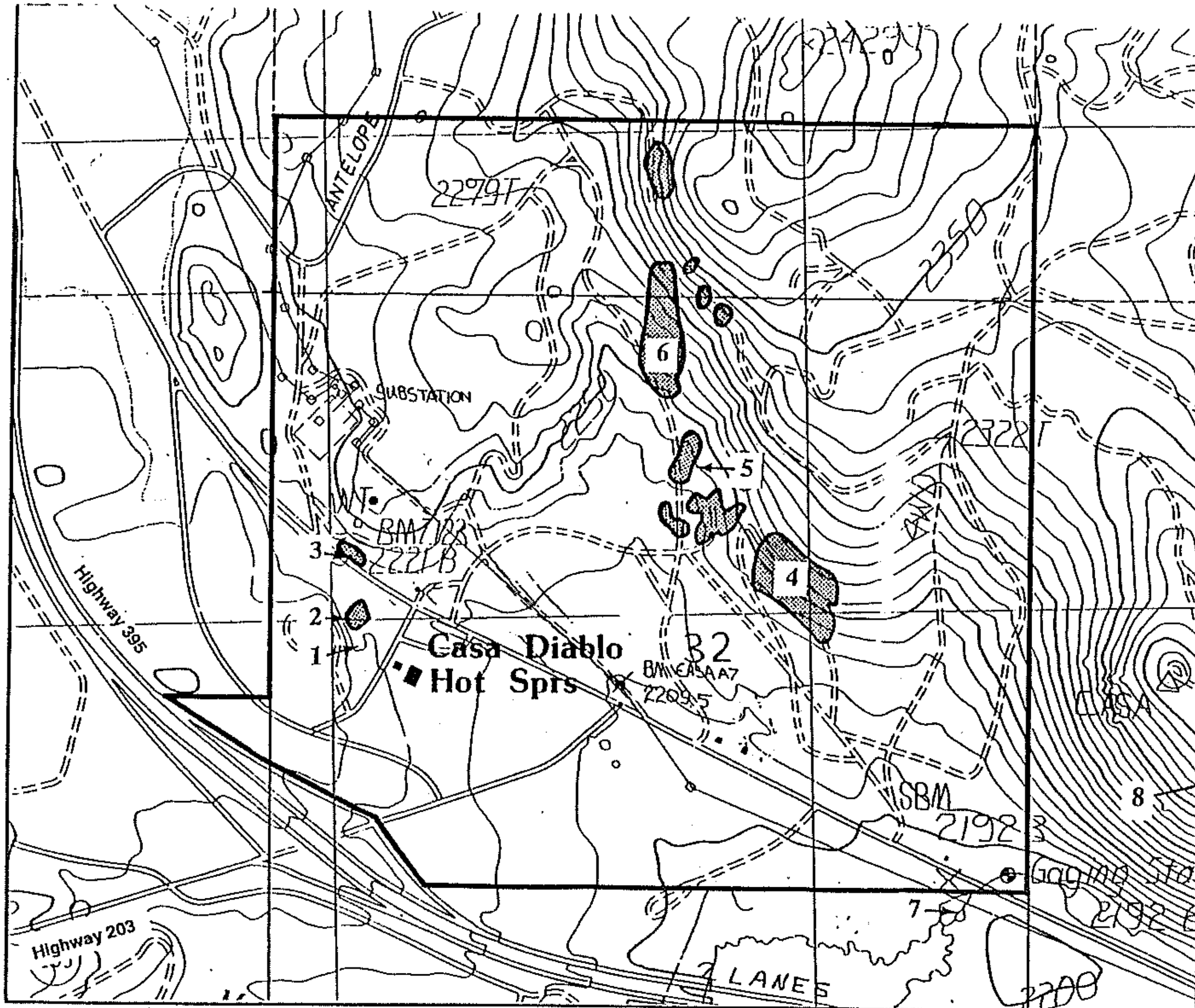
Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
Pedicularis crenulata var. candida / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
Sedum pinetorum Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
Sidalcea covillei Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   Category 2 = currently under review with extisting information insufficient to support listing.
   Category 3c = currently not under review, as taxon is more common than formerly thought.

4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.



FUMEROLE VEGETATION INVENTORY

1. Casa Diablo Geyser
2. Casa Diablo Marsh
3. Casa Diablo North
4. East Graben-South
5. East Graben Flat
6. East Graven North
7. Meadow Hot Spring
8. Colton Hot Spring

SCALE 1:8,615

0 850 1700 FEET

N

(Source: 1983 U.S.G.S. Old Mammoth Quadrangle)

Table 1. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
Astragalus monoensis Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
Astragalus johannis-howellii Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
Astragalus lentiginosus var. piscensis / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
Centaurium namophilum Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
Eriogonum ampullaceum Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
Fimbristylis spadicea Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
Lupinus duranii Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
Lupinus montigenus Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
Lupinus sublanatus Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
<u>Pedicularis</u> <u>crenulata</u> var. <u>candida</u> / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
<u>Sedum</u> <u>pinetorum</u> Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
<u>Sidalcea</u> <u>covillei</u> Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   Category 2 = currently under review with extisting information insufficient to support listing.
   Category 3c = currently not under review, as taxon is more common than formerly thought.
4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.

Quantitative vegetation characterization of each site will be accomplished by quadrat sampling. Quadrat sampling protocol will follow standard synecological vegetation inventory methods (Mueller-Dombois and Ellenberg 1974). Quadrat size will be adjusted to suit the size of a particular area under study, but in all cases will range from 0.2 dm by 0.5 dm to 1 by 1 m.

Data will be summarized in summary tables and graphics. Raw data from each sampling site will be provided in both hard-copy and electronic form (any MS-DOS format).

3. Breeding Bird Census. A combination of circular plots and linear transects will be used to determine the composition and relative abundance of the avifauna present on site. Five circular plot centers will be established in representative areas of the habitats present on site: pinyon-juniper woodland, Jeffrey pine forest, Jeffrey pine-pinyon pine forest, sagebrush scrub, and a Nebraska sedge meadow-Jeffrey pine forest-sagebrush scrub ecotone. In addition, data will be collected along linear transects established between the circular plot centers. Species, number of birds, sex, activity, method of detection, distance and azimuth, and time were recorded for each sighting.

Sampling will take place for five consecutive days during the breeding season. Each plot will be sampled twice daily; within one hour of sunrise and within one hour of sunset. Data analysis will provide information on species occurrence, relative density, and relative abundance. Plot centers will be marked with permanent posts so that the identical sites may be sampled during and after construction. The data will be useful in comparing any changes in composition, density, or abundance before and after construction.

4. Small mammal trapping. Baseline data on the small mammal community composition will be collected during 4 consecutive nights of live-trapping. Traps will be placed in representative areas of the major habitat types in approximate proportion to the amount of that habitat on site. In addition to the major habitat types mentioned above, traps will be also be placed in unique or potentially critical habitat areas: rhyolite buckwheat scrub (East Graben); hydrothermally altered areas (Casa Diablo marsh, Meadow Hot spring, and Colton hot spring). Traps will also be placed at the sites of the MP-1 and PLES-1 powerplants.

Traps will be set and baited at dusk and checked at dawn. They will remain closed during the day to avoid heat stress to any animal. Species, sex, physical condition, breeding condition, and trap location will be recorded. Locations and diagrams of the trapping grids or transects will be mapped so that they may be duplicated during or after construction. Trapping results will be analyzed for species composition and relative abundance.

x.x Rare Plant Survey

x.1 INFORMATION REVIEW

Selection of methodology appropriate for conducting a rare plant survey of the study area was made after consultation with U.S.F.S personnel (Christina Hargis, Inyo National Forest, pers. communication). Field work was conducted under the guidelines of the California Department of Fish and Game (1984), and those of Nelson (1984, 1987).

Species targeted for survey were those identified by Taylor and Buckberg (1986) via: 1] review of published and unpublished literature, including relevant environmental documents from the vicinity of the study region; 2] information from the Natural Diversity Data Base of the Natural Heritage Section, California Department of Fish and Game (Shevock and Hennessy 1987); and 3] communication with botanists with expertise with the local flora or particular taxonomic groups. Since the information assembled by Taylor and Buckberg (1986) considered current, no new data source review was conducted for the 1988 surveys.

Table 1 provides an enumeration of those rare plants with the potential to occur in the study area - basically any plants listed or considered for listing as rare, threatened, sensitive, or endangered by: *1)* the U.S. Fish and Wildlife Service (50 CFR Part 17, USFWS 1985) under the Endangered Species Act of 1973, as amended; *2)* the U.S. Forest Service (USFS 1984, cf. Smith 1987); *3)* the Bureau of Land Management (those taxa listed in USFWS 1985, cf. Hastey 1987); *4)* the California Fish and Game Commission under both the Native Plant Protection Act (Chapter 10, Section 1900, Fish and Game Code, Cochrane 1987) and the California Endangered Species Act (Sections 2050-2098, Fish and Game Code) or species that qualify for listing under the California Environmental Quality Act (Section 15380); *5)*; the California Native Plant Society (Smith and York 1984).

x.2 FIELD METHODS

Table 1 presents status, habitat, and distributional information for 12 CNPS rare or endangered plants with potential to occur in the vicinity of Casa Diablo Hot Springs. This table presents a refined working list for field surveys, based upon the data review described above. Known populations of many of these species in the eastern Sierra region were visited during the course of our surveys to ascertain phenology and microsite requirements for particular taxa.

Rare plant surveys were conducted on 7 June 1986 and again on 29-30 June 1988. All potential habitat for the 12 potential rare plants listed in Table 1 was visited. Field survey of the study area used the meander method of Nelson (1987). Two botanists walked in a meandering fashion through the survey area, recording each plant species encountered. The surveys were conducted at the peak of the growing and flowering season for the area, at the appropriate stage of phenology to identify any plant species encountered.

Table 1. Rare plants potentially occurring in the Casa Diablo Hot Springs region.

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering Period (10)
Astragalus monoensis Mono milkvetch	Sensitive	Category 1	Rare	2-2-3 List 1B	Sagebrush flats	pumice soils	6700-11,000	Mono	May-July
Astragalus johannis-howellii Howell's locoweed	None	Category 3C	Rare	2-2-2 List 1B	Sagebrush scrub	travertine or rhyolite	7000,8000	Mono [NV]	May-July
Astragalus lentiginosus var. piscensis / Fish Slough milkvetch	None	Category 1	None	3-2-3 List 1	Alkali sink	pH > 8.5	ca. 5000	Mono	July
Centaurium namophilum Nevada Centuray	None	None	None	1-1-3 List 4	Alkali sink	springs and seeps	above 4000	Mono, Inyo [NV, OR]	April-July
Eriogonum ampullaceum Mono Buckwheat	Sensitive	Category 2	None	2-2-3 List 1B	Sagebrush scrub and meadow borders	alkaline soils	5500-7500	Mono [NV]	May-July
Fimbristylis spadicea Hot Spring Sedge	None	Category 3c	None	2-2-1 List 2	Alkali sink	hot springs	2500-5500	Inyo, Mono, San Bernardino	April-June
Lupinus duranii Mono Lake lupine	None	Category 2	None	1-1-3 List 4	Sagebrush scrub & Jeffrey Pine	pumice soils	6500-9500	Mono	May-July
Lupinus montigenus Pumice Bush Lupine	None	None	None	None App. 1	Jeffrey Pine & Sagebrush	snowbanks	6000-10,000	Mono, Inyo [NV]	May-August
Lupinus sublanatus Mammoth Lupine	None	None	None	1-1-3 List 3	Jeffrey Pine	unknown	ca. 8000	Mono	July?

Table 1 (continued).

Species (1)	U.S.F.S. Status (2)	U.S.F.W.S. Listing (3)	State Status (4)	CNPS Status (5)	Habitat Type (6)	Substrate (7)	Elevation Range (8)	Known Distribution (9)	Flowering (10)
Pedicularis crenulata var. candida / Scolloped Lousewort	Sensitive	None	None	3-1-1 List 2	meadows	organic soils	ca. 7500	Mono [to Rocky Mountains]	June-August
Sedum pinetorum Pine City Stonecrop	None	Category 2	None	None App.1	pine forest	"in the duff"	ca. 8500-9500?	Mono	July?
Sidalcea covillei Owens Valley checkermallow	None	Category 2	Endg.	2-2-3 List 1B	Alkali sink	meaodw borders	4000-5500	Inyo	May-July

NOTES:

1. Nomenclature for scientific names and common names follows Smith and York (1984).
2. U.S. Forest Service management status (Region 5, Forest Service Manual, Title 2600).
3. Notice of Intent (50 CFR Part 17, Federal Register Vol. 50, No. 188, 27 September 1985).
   Federal Status designations are as follows:
   Category 1 = currently under review with extisting information sufficient to support listing as endangered or threatened.
   Category 2 = currently under review with extisting information insufficient to support listing.
   Category 3c = currently not under review, as taxon is more common than formerly thought.

4. California Department of Fish and Game, Designated Endangered or Rare Plants (26 March 1985)
5. Smith and York (1984). CNPS Listr 1B = Plants rare or endangered in California and elsewhere.
   List 2 = plants rare in California but more common elsewhere. List 3 = plants needing more information;
   List 4 = plants rare but not endangered in California. The R-E-D Code (Rarity-Endangerment-Distribution)
6. Based on Dedecker (1984) and field observations.
7. Based on field observations.
9. CNDDB records and Munz (1959, 1968).
10. Field observations.

x.x Results

x.1 RARE PLANTS

No rare or endangered vascular plant species were observed on the study area during our survey. Inspection of habitat features of the site confirmed our previous assumption (Taylor and Buckberg 1986) that sensitive plant populations were not likely for the Casa Diablo Hot Springs site, based on 1) habitat features, and 2) a long history of local plant collection along Highway 395 in the general region.

Appendix A provides a list of vascular plant species observed on the study site. A comparison with the species list compiled during our previous survey, conducted in the winter of 1986, indicates a considerably more diverse flora for the Casa Diablo Hot Springs site. In 1986, 90 taxa of vascular plants were seen. Our surveys during the summer of 1988 added 66 plant taxa to the species list, for a total of 166 taxa comprising 40 families of vascular plants. The majority of additions to the species list were plants growing in meadow vegetation along Mammoth Creek, and in the outflow marshes from Casa Diablo Hot Spring, Meadow Hot Spring and Colton Hot Spring. Relatively few species occurring in upland habitats (i.e., Jeffrey Pine Forest or hydrothermally altered areas) went undetected in our previous survey.

x.0 LITERATURE CITED

California Department of Fish And Game. 1984. Guidelines for assessing effects of proposed developments on rare and endangered plants and plant communities. Resource Agency, State of California 4 May 1984.

Cochrane, S.A. 1987. Endangered Plants and California State Laws. pp. 33-38 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Cronquist, A., A. Holmgren, N. Holmgren and J. L. Reveal. 1972. Intermountain Flora. Volume 1. Hafner Publishing Co., New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1977. Intermountain Flora. Volume 6. Columbia University Press, New York.

Cronquist, A., A. Holmgren, N. Holmgren, J. L. Reveal and P. Holmgren. 1984. Intermountain Flora. Volume 4. New York Botanical Garden, Bronx, NY.

Dedecker, M. 1984. Flora of the Northern Mojave Desert, California. California Native Plant Society, Special Publication No. 7.

Dedecker, M. 1979. Report on the flora of Glass Mountain Ridge. unpublished administrative report, Inyo National Forest, Bishop, CA.

Dedecker, M. 1974. Plant checklist for the Owens Valley. Final Environmental impact report, increased groundwater pumping in the Owens Valley. City of Los Angeles, Department of Water and Power.

Hastey, E.L. 1987. Conservation of rare plants on Public Lands in California. pp. 51-60 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Howald, A. 1981. A Flora of Valentine Eastern Sierra Reserve. Part I. Valentine Camp. Herbarium, University of California, Santa Barbara.

Munz, P. A. Supplement to A California Flora. University of California Press, Berkeley.

Munz, P. A. and D. D. Keck. A California Flora. University of California Press, Berkeley.

Nelson. J. R. 1984. Rare plant field survey guidelines. pp. vi-vii in: J.P. Smith and R. York [Eds.], Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society, Special Publication No. 1 [3rd edition].

Nelson, J.R. 1987. Rare Plant Surveys: Techniques for Impact Assessment. pp. 159-166 in: T. Elias [Ed.], Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Sacramento, CA.

Shevock, J.R., and L.L. Hennessy. 1987. The California Natural Diversity Data Base - a common denominator. pp. 181-184 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

Smith, Z.G., Jr. 1987. Sensitive plant management on the National Forests in California. pp. 61-66 in: T. Elias [Ed.], Conservation and Management of Endangered Plants. California Native Plant Society, Sacramento, CA.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants. Federal Register 50(188):39526-39527.

U.S. Forest Service 1984. Master List - Region Five Sensitive Plant Species. U.S. Forest Service, San Francisco, CA.

Orr, B. 1981. A Flora of Valentine Eastern Sierra Reserve. Part II. Sierra Nevada Aquatic Research Laboratory. Herbarium, University of California, Santa Barbara.

Smith, J. P. Jr. and R. York. 1984. Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1 [3rd edition].

Taylor, D. W. 1981. Plant Checklist for the Mono Basin, California. Mono Basin Research Group, Mono Lake Committee, Lee Vining, CA.

Taylor, D.W. and R. Buckberg. 1986. Biotic assessment for proposed geothermal energy facilities, Casa Diablo Hot Springs, Mono County, California. Unpublished report to Environmental Management Associates, Inc., Brea, CA.

July 12, 1988

Checklist of Vascular Plants Observed at Casa Diablo Hot Springs, Mono County, California

Dean Wm. Taylor & Glenn L. Clifton
BioSystems Analysis, Inc.

This checklist covers the general vicinity of Casa Diablo Hot Springs, including a 620 acre area surveyed in 1986 (Taylor and Buckberg 1986), and a smaller (±280 acres) surveyed in the summer, 1988. The list is is based on four visits: 25-26 November, 1986; 30 April 1987; 7 June 1988 and 29 June 1988. Nomenclature generally corresonds to Munz and Keck (1959), except where superceeded by more recent monographic treatment for a given taxon, or by the appropriate edition of the Intermountain Flora (Cronquist et al. 1972, 1977, 1985). This list corrects several epithets applied to dried remains of plants observed during a winter visit in 1986 (November 25-26).

Alliaceae
- *Muilla transmontana* Greene

Apiaceae
- *Pteryxia terebinthina* (Hooker) Coulter & Rose var. *californica* (Coulter & Rose) Mathias

Asteraceae
- *Achillea millefolium* L. var. *borealis* (Bong) Farw.
- *Anisocoma acaulis* Torrey & Gray
- *Artemisia cana* Pursh ssp. *bolanderi* (Gray) G.H. Ward
- *Artemisia ludoviciana* Nuttall ssp. *ludoviciana*
- *Artemisia nova* A. Nelson
- *Artemisia tridentata* Nuttall ssp. *vaseyana* (Rydberg) Beetle
- *Chaenactis douglasii* (Hooker) Hooker & Arnott var. *rubricaulis* (Rydb.) Ferris
- *Chrysothamnus nauseosus* (Pallas) Britton ssp. *albicaulis* (Nuttall) Hall & Clements
- *Cirsium drummondii* Torrey & Gray
- *Conyza canadensis* L.
- *Ericameria bloomeri* (Hooker) J.F. MacBride var. *bloomeri*
- *Erigeron divergens* Torrey & Gray
- *Erigeron loncophyllus* Hooker var. *loncophyllus*
- *Layia glandulosa* (Hooker) Hooker & Arnott
- *Machaeranthera canescens* (Pursh) Gray ssp. *cansecens*
- *Malacothrix clevlandii* Gray
- *Pyrrocoma lanceolatus* (Hooker) Greene
- *Senecio vulgaris* L.
- *Stephanomeria spinosa* (Nuttall) S. Tomb
- *Taraxacum officionale* L.
- *Tetradymia cansecens* DC.
- *Wyethia mollis* Gray

Betulaceae
Alnus incana (L.) Moenc. ssp. *tenuifolia* (Nuttall) Breitung

Boraginaceae
Amsinckia tesellata Gray
Greeneocharis circumscissa (Hooker & Arnott) Rydberg var. *hispdiula* (MacBride)
Lappula redwoskii (Hornem.) Greene
Oreocarya confertiflora Greene
Plagiobothrys kingii (Watson) Gray var. *harkensii* (Greene) Jepson
Tiquilia plicata (Torrey) A. Richards

Brassicaceae
Caulanthus pilosus Watson
Descurania californica (Gray) O.E. Schultz
Descurania sophia (L.) Webb. ex. Prantl.
Lepidium perfoliatum L.
Lepidium virginicum L. var. *pubescens* (Greene) C.L. Hitchcock
Nasturtium officionale R. Br.
Rorippa teres (Michaux) R. Stuckey
Sisymbrium altissimum L.
Streptanthus tortuosus Kellogg var. *orbiculatus* (Greene) Hall

Caryophyllaceae
Cerastium vulgatum L.
Stellaria longipes Goldie

Chenopodiaceae
Salsola iberica Sennen & Pau

Cupressaceae
Juniperus occidentalis Hooker ssp. *australis* Vasek

Cyperaceae
Carex athrostachya Olney
Carex aquatilis Wahlenb.
Carex douglasii Boott
Carex nebrascensis Dewey
Carex rossii Boott ex Hooker
Carex simulata Mackenzie
Eleocharis acicularis (L.) Roemer & Schultes
Eleocharis bolanderi Gray
Eleocharis palustris (L.) Roemer & Schultes
Scirpus americanus Pers.
Scirpus nevadensis Watson

Equisetaceae
Equisetum arvense L.
Equisetum laevigatum A. Braun

Fabaceae
Astragalus purshii Douglas ex Hooker var. *lectulus* (Watson) Jones
Lupinus caudatus Kellogg
Lupinus polyphyllus Lindley ssp. *superbus* (Heller) Munz
Lupinus sellulus Kellogg ssp. *sellulus*
Trifolium longipes Nuttall
Trifolium wormskjoldii Lehm.
Trifolium repens L.

Gentianaceae
Frasera puberulenta A. Davidson

Geraniaceae
Erodium cicutarium (L.) L'Her

Hydrophyllaceae
Phacelia ramosissima Douglas ex. Lehm.

Iridaceae
Iris missouriensis Nuttall
Sisyrinchium idahoense Bicknell var. *occidentale* (Bicknell) Henderson

Juncaceae
Juncus balticus L.

Lamiaceae
Marrubium vulgare L.

Lemnaceae
Lemna minuta HBK.

Liliaceae
Calochortus bruneaunis Nelson & MacBride
Fritillaria atropurpurea Nuttall

Loasaceae
Mentzelia dispersa Watson

Loranthaceae
Arceuthobium camplypodium Engelmann
Phorodendron juniperinum Engelmann ex Gray var. *juniperunium*

Malvaceae
Sidelcea oregana (Nuttall ex. Torrey & Gray) Gray ssp. *spicata* (Regel) C.L. Hitchcock

Nyctaginaceae
Abronia pogonantha Hiemerl

Onagraceae

Epilobium ciliatum Raf. ssp. *ciliatum*
Gayophytum diffusum Torrey & Gray ssp. *parviflorumm* Lewis & Szweykowski
Oenothera caespitosa Nuttall. ssp. *marginatus*
Oenothera xylocarpa Coville

Papaveraceae

Argemone munita Durand & Hilgard ssp. *rotundata* (Rydb) G. Ownbey

Poaceae

Alopecurus aequalis Sobol
Agrostis exarata Trin. var. *pacifica* Vasey
Agrostis filiculmis M.E. Jones
Agrostis stolonifera L. var. *major* (Gaudin) Farw.
Agrostis variabilis Rydberg
Agropyron pectiniforme Roemer & Schultes
Agropyron trachycaulum (Link) Malte.
Bromus tectorum L.
Distichilis spicata (L.) Greene var. *stolonifera* Beetle
Distichilis spicata (L.) Greene var. *stricta* (Torrey)Beetle
Elymus cinereus Scribner & Merrill var. *cinereus*
Hordeum brachyantherum Nevski
Hordeum jubatum L. ssp. *jubatum*
Muhlenbergia asperifolia (Nees & Meyer) Parodi
Muhlenbergia richardsonis (Trin.) Rydberg
Oryzopsis hymenoides (Roemer & Schultes) Ricker var. *hymenoides*
Phleum pratense L. var. *pratense*
Poa compressa L.
Poa incurva Scribner & Williams
Poa nevadensis Vasey ex Scribner var. *juncifolia* (Scribner) Beetle
Poa pratensis L.
Polypogon monspeliensis (L.) Desf.
Puccinellia nuttalliana (Schultes) A.S. Hitchcock
Sitanion hystrix (Nuttall) J.G. Smith
Stipa comata Trin. & Rupr.
Stipa coronata Thurber var. *depauperata*
Stipa speciosa Trin & Rupr.
Vulpia bromoides (L.) S.F. Gray

Polemoniaceae

Eriastrum wilcoxii (A. Nelson) Mason
Gilia sp. (annual)
Leptodactylon pungens Torrey ssp. *pulchriflorum* (Brand) Mason
Linanthas pachyphyllus R. Patterson
Phlox stansburyi (Torrey) Heller

Polygonaceae

Bistorta bistortoides (Pursh) Small
Eriogonum kennedyi (Porter ex Watson) var. *purpursii* (K. Brandegee) Reveal
Eriogonum umbellatum Torrey var. *dichrocephalum* Gandog.
Eriogonum watsonii Torrey & Gray
Eriogonum wrightii Torrey ex Bentham var. *subscaposum* Watson
Polygonum aviculare L.
Rumex crispus L.
Rumex salicifolius Weinm.

Portulacaceae

Calyptridium monospermum Greene
Lewisia rediviva Pursh ssp. *minor* (Rydberg) N. Holmgren

Pinaceae

Pinus jeffreyi Grev. & Balf.
Pinus monophylla Torrey & Fremont

Ranunculaceae

Ranunculus aquatilis L.
Ranunculus cymbalaria Pursh var. *saximontanus* Fernald

Rhamnaceae

Ceanothus velutinus Douglas ex Hooker var. *velutinus*

Rosaceae

Amelanchier utahensis Koehne. ssp. *utahensis*
Geum macrophyllum Willd.
Holodiscus dumosus (Nuttall) Heller var. *glabrescens* (Greenman) C.L. Hitchcock
Potentilla biennis Greene
Potentilla diversifolia Lehm.
Potentilla rivularis Nuttall var. *millegrana* (Engelmann) Watson
Prunus andersonii Gray
Purshia tridentata (Pursh) DC.
Rosa woodsii Lindley var. *ultramontana* (Watson) Jepson

Rubiaceae

Galium trifidum L. var. *pusillum* Gray

Salicaceae

Salix exigua Nuttall
Salix lasiandra Bentham var. *caudata* (Nuttall) Sudworth
Salix lutea Nuttall

Scrophulariaceae

Castilleja applegatei Fernald
Mimulus coccineus Congdon
Mimulus guttatus Fisch. ex DC. ssp. *guttatus*

Scrophulariaceae (concluded)

Penstemon rydbergii A. Nelson var. *varians* (A. Nelson) Cronquist
Penstemon speciosus Douglas ex Lindley
Verbascum thapsus L.
Veronica peregrina L. ssp. *xalapensis* (HBK) Pennell
Veronica americana (Raf.) Schwein. ex Bentham

Solanaceae

Nicotiana attenuata Torrey ex Watson

Urticaceae

Urtica dioica L. var. *angustifolia* Schelcht
Urtica dioica L. var. *holoserica* (Nuttall) C.L. Hitchcock

Zannichelliaceae

Zannichellia palustris L.

MIGRATION AND SEASONAL HABITATS OF THE CASA DIABLO DEER HERD

CASA DIABLO DEER STUDY

March 1988

Prepared by:

Timothy J. Taylor
P.O. Box 191
June Lake, CA 93529

TABLE OF CONTENTS

FIGURES

APPENDIX

Figures

MIGRATION AND SEASONAL HABITATS OF THE CASA DIABLO DEER HERD

TIMOTHY J. TAYLOR
California Department of Fish and Game
Bishop, CA. 93514

ABSTRACT: One hundred and seventeen mule deer, Odocoileus hemionus hemionus, were captured on wintering areas from January-March 1986 and January-March 1987. Twenty-seven females and 1 adult male were radio-collared and monitored for two spring and two fall migrations in order to delineate migration routes and seasonal ranges. Timing of spring migration was similar during both years despite extremes in severity of winters. Two radio-collared does utilized different spring migration routes and wintering areas in consecutive years. Timing of fall migration was correlated with snowfall in 1987, but not in 1986. Deer remained on holding areas and delayed migration for up to 6 weeks during both spring and fall. Fifteen radio-collared deer occupied summer range on the east slope of the Sierra Nevada; 14 of these utilized aspen riparian habitats. Three radio-collared does crossed the Sierra crest to west side summer ranges. Those radio-collared does occupying summer range in Jeffrey pine (Pinus jeffreyi) habitat had larger home ranges than those in more diverse areas. All radio-collared deer exhibited strong fidelity to summer home ranges. Water was found to be the factor most limiting deer distribution and densities throughout portions of winter and summer ranges.

INTRODUCTION

The Rocky Mountain mule deer is the most adaptive and widespread western ungulate (Poole 1976). However, a decline of mule deer in the west has been a major concern of many state conservation agencies (Julander and Low 1976). A general statewide decline in California's deer herds has been occurring since the mid 1950's (Bertram and Rempel 1977, Dasmann 1981). Longhurst et al. (1976) concluded that the decline in California has resulted from a number of different causes including diminishing food supplies and loss of habitat resulting from changes in burning, logging, grazing practices, and other land use factors. On lower western slopes of the Sierra Nevada, increasing urbanization, recreational developments, construction of reservoirs and other land uses have resulted in a serious decline in deer numbers (Dasmann 1981). Recent plans for recreational, urban, geothermal, and hydropower developments in areas of critical mule deer range on the east slope of th Sierra Nevada in Mono County have prompted the California Department of Fish and Game to conduct this study of the Casa Diablo deer herd.

The Casa Diablo herd, which consists of an estimated 1,500 animals, is the smallest of five migratory mule deer herds occurring in Mono Count (Thomas 1984). Since this herd generally was known to occupy seasonal ranges throughout the southern and central portion of Mono County (where the majority of development is occurring) it was imperative that studies be conducted in order to delineate all critical habitats used by this herd. To effectively manage migratory deer in the Sierra it is crucial that migration routes and all seasonal habitats be delineated (Bertram and Rempel 1977). Prior to this study, little was known about specific locations of migration routes, holding and summering areas, and transitional ranges of the Casa Diablo herd.

The major objectives of this study, which was conducted from January 1986-January 1988, were to (i) delineate all critical habitats used by the Casa Diablo deer herd; (ii) analyze the quality and quantity of all critical habitats defined; (iii) assess the impacts of land uses, existing and proposed, on critical habitats; (iv) identify habitat factor limiting the herd; and (v) formulate recommendations to reduce the impacts of these factors.

STUDY AREA

The Casa Diablo deer herd occupies approximately 2,200 km in Mono County, California. The herd winter range, located on the Inyo National Forest in southeastern Mono County (Figure 1), encompasses approximately 260 km , varying in elevation from 1,640-2,450 m. Winter range vegetatio is a Great Basin sagebrush type, consisting mainly of big sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata*), and rubber rabbitbrush (*Chrysothamnus nauseosus*). Singleleaf pinyon pine (*Pinus monophylla*) - western juniper (*Juniperus occidentalis*) woodland dominate vegetation between 1,950-2,450 m. Terrain is moderately sloping with soils consisting of an admixture of sandy loams which are generally shallow and rocky (Thomas 1984). Average annual precipitation, measured

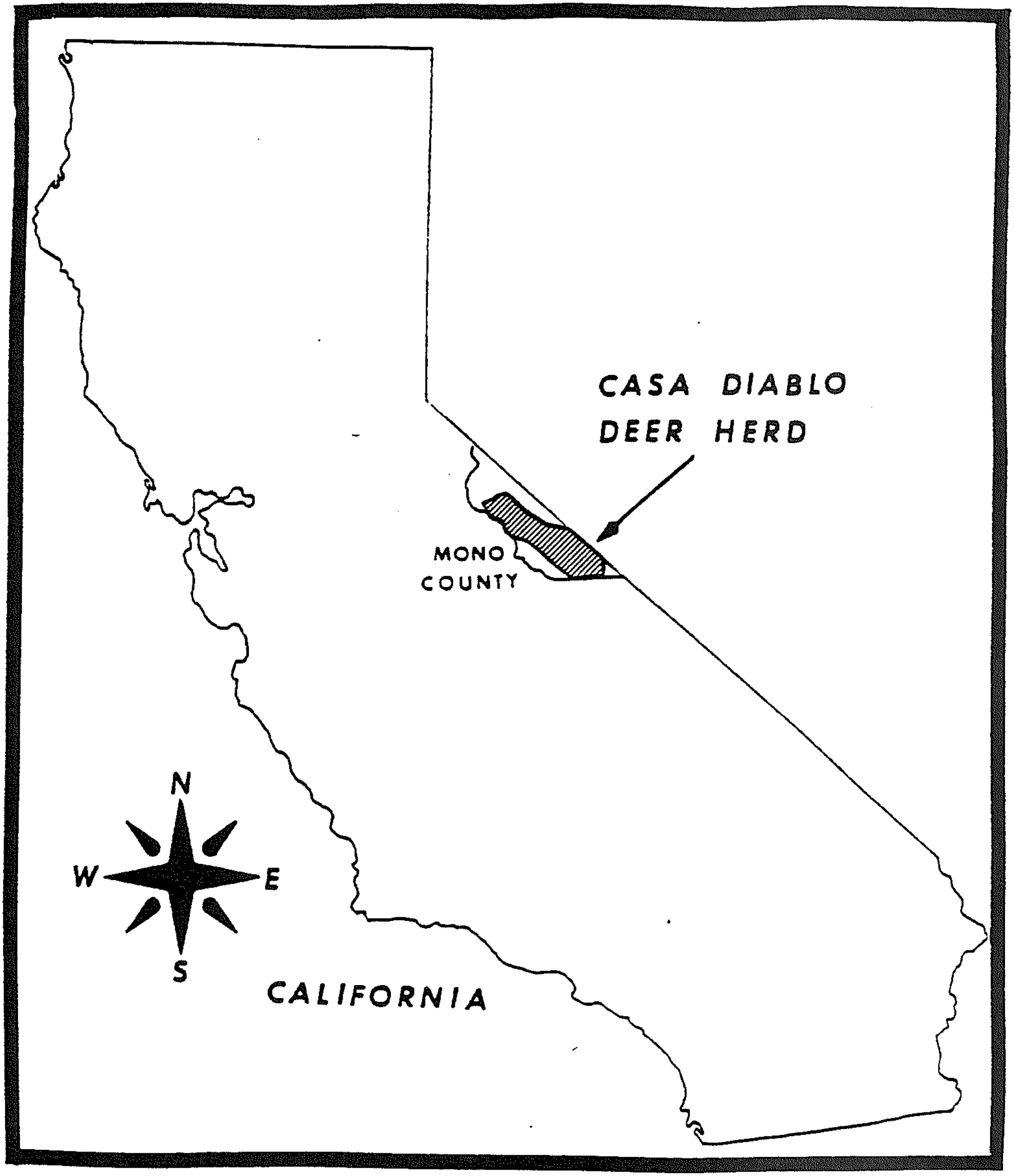


Figure 1. Location map, Casa Diablo deer herd.

at the Calif. Agric. Inspect. Sta. in Benton, California, is 150 mm, occurring mostly as snow in January and February.

The Casa Diablo winter range was divided into six subwintering area based on major areas of deer concentration (Figure 2). From north to south these wintering areas include: Truman Meadows, located approximatel 13 km north of Benton, California near the California-Nevada state line; Marble Creek, located approximately 7 km south of Benton at the base of the western escarpment of the White Mountain range and east of U.S. Hwy 6; The Blind Spring Hills area, located due west of Marble Creek and immediately west of Hwy 6 in the Benton Mountain Range; Chidago Flat, located approximately 21 km south of Benton and 14 km west of Hwy 6; Casa Diablo Mountain, located 29 km south of Benton and 14 km west of Hwy 6; and The Volcanic Tablelands, located 43 km south of Benton and 7 km north of Bishop, California.

Deer from the Casa Diablo herd occupy approximately 1,940 km of summer range on the Inyo National Forest in west-central Mono County, mainly along the east slope of the Sierra Nevada (Figure 2). Portions of Madera County and Tuolumne counties on the west side of the Sierra are also used to a limited extent by summering deer. Nine major summer range habitat types, varying in elevation between 2,130-2,950 m were described in areas used by radio-collared and ear tagged deer (USDA 1981).

Singleleaf Pinyon Pine-Western Juniper----This type occurs mainly on dry south and east facing slopes of the Sierra Nevada and Glass Mountain ranges. Single-leaf pinyon pine is the dominant conifer species between approximately 2,070-2,600 m near Lee Vining and also dominates deer summer range on the west slope of the White Mountains. Associated understory species include curlleaf mountain mahogany (*Cercocarpus ledifolius*), big sagebrush, bitterbrush, and rabbitbrush.

Jeffrey Pine.----This type is open Jeffrey pine (*Pinus jeffreyi*) forest which occurs in large stands between elevations of approximately 2,200-2,450 m. Associated understory species include big sagebrush, bitterbrush, gooseberry (*Ribes* spp.), and mountain snowberry, (*Symphoricarpos vaccinioides*). This is also the dominant vegetation type found on all holding areas used by the Casa Diablo deer herd.

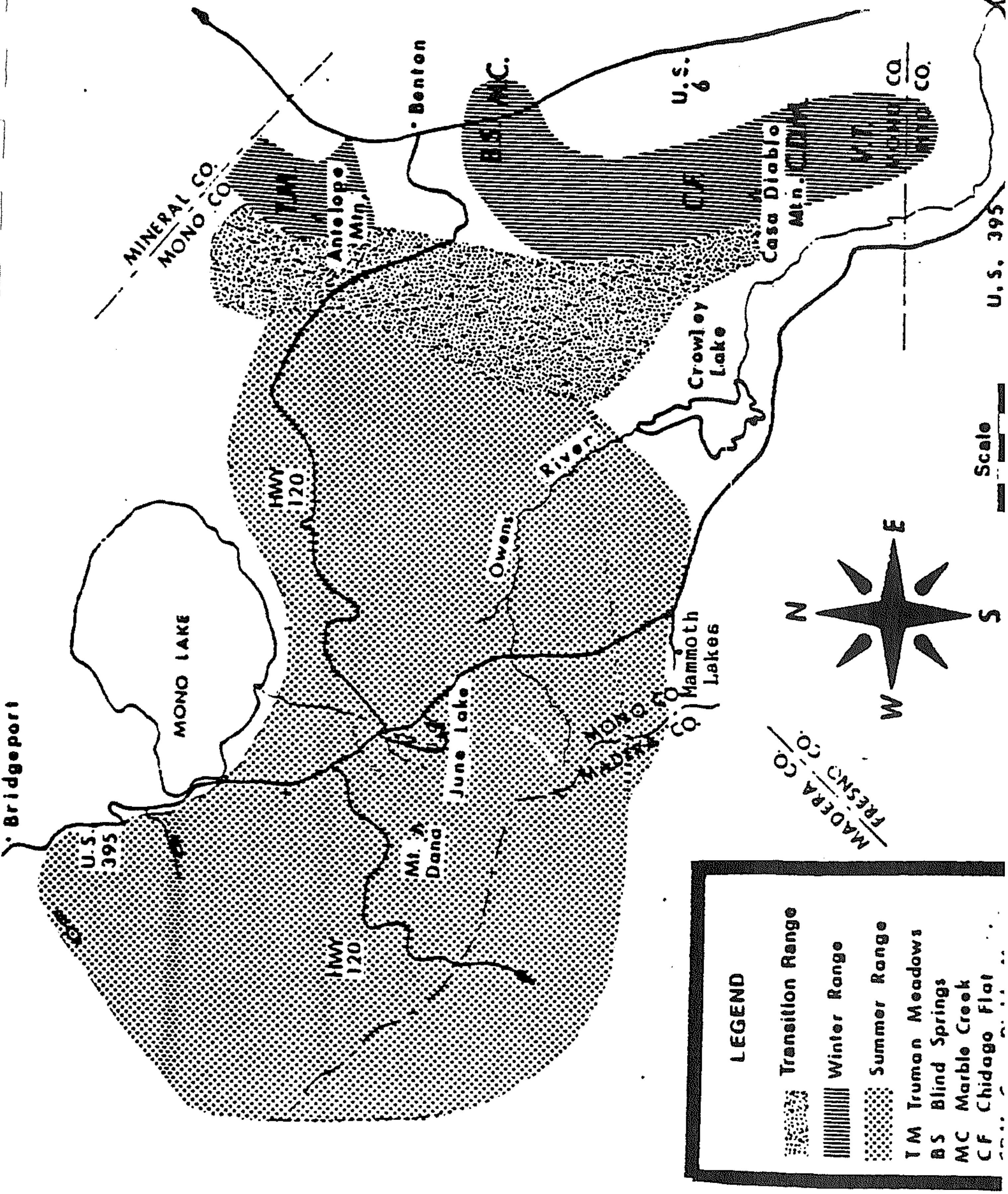


Figure 2. Location of Casa Diablo deer herd winter and summer ranges, Mono County, California.

Mixed Conifer Forest.----The codominants of this vegetation type occurrin on the east slope of the Sierra Nevada between approximately 2,400 -2,600 m include Jeffrey Pine, white fir (Abies concolor), lodgepol pine (Pinus contorta), and western white pine (Pinus monticola). A higher elevations of the Mixed Conifer type, red fir (Abies magnifica) is an occasional associated species and white fir often occurs in pure stands at lower elevations.

Quaking Aspen Riparian.----This dense cover type occurs within a few meters of most stream channels on the east slope of the Sierra Nevada and throughout the Glass Mountains and is dominated by quaking aspen (Populus tremuloides), willow (Salix spp.), wild rose (Rosa woodsii), gooseberry, and snowberry. Groves of quaking aspen, which provide critical fawning and fawn rearing habitat, also are indicators of moist conditions and are located mainly near high elevation meadows.

Lodgepole Pine Forest.----This forest type is found above the Mixed Conifer type on the east slope of the Sierra and north slope of the Glass Mountains at elevations between approximately 2,600-3,000 m. It is composed of lodgepole pine which often occurs in large, dense, homogeneous stands. Within the lodgepole pine forest perennial grasses and forbs (needle-and-thread grass (Stipa comata), bluegrass (Poa pratensis), bromegrass (Bromus tectorum), lupine (Lupinus duranni), and pussy paws (Calyptridium caudiciferum)), dominate openings of poorly developed, dryer soils.

Montane Meadow.----This meadow type is found mainly at mid and upper elevations on the east slope of the Sierra and throughout the Glass Mountains and is composed primarily of sedges (Carex spp.), and rushes (Juncus spp.), and designates year long water availability. Perennial grasses, forbs, willows, quaking aspen, and lodgepole pine are associated with these meadows.

Whitebark Pine.----This forest type, dominated by whitebark pine (Pinus albicaulis), occurs on high windswept ridges at treeline on the east slope of the Sierra.

Great Basin Sagebrush.----This type generally occurs on dry slopes and plains from 1,220-3,320 m, east of the Sierra Crest. Big sagebrush is dominant with bitterbrush often occurring as a codominant. This type often is found in association with Jeffrey pine.

Montane Chaparral.---This type occurs on open flats and rocky ridges from 2,135-3,050 m. Greenleaf manzanita (Arctostaphylos patula), mountain whitethorn (Ceanothus cordulatus), Chinquapin (Castanopsis sempervirens), and tobacco brush (Ceanothus velutinus), occur as codominants. This type often is found in association with Great Basin sagebrush.

METHODS

Deer were captured on the Casa Diablo winter range from January-February 1986 and January-February 1987 using Clover traps (Clover 1956), baited with alfalfa hay. Three to five trap sites were located throughout each area and prebaited for two weeks with alfalfa hay. Traps were operated on 2-3 days each week until late February, at which time bait acceptance became poor due to the presence of herbaceous growth.

On 26 and 27 February and 7 March 1986, deer were captured and marked on all six subwintering areas (Figure 2) using linear, nylon tangle nets (2 x 90 m) and a Bell Jet Ranger III helicopter (Beasom et al. 1980). Deer were hazed slowly by the helicopter into nets placed at strategic locations, usually preselected by the pilot through aerial reconnaissance. Net sites usually employed natural escape routes, such as ravines. Anywhere from 1-10 deer were captured on several successive drives until desired numbers were obtained for each wintering area.

All deer were physically restrained and marked with two large, plastic, consecutively numbered cattle ear tags (7.5 x 11.5 cm; Apollo Tag Systems), color coded to wintering area. Twenty-six adult females were fitted with radio collars. In addition, one adult male was instrumented with a radio transmitter mounted on an expandable collar to allow for neck swell during the rut. A single adult female was captured on its spring range by use of a tranquilizer dart carrying 3 cc of a Rompon-ketamine hydrochloride mixture, fitted with a radio-collar (.220) and released.

Adult radio collars (159.021-159.450 MHz; Telonics, Inc., Mesa, Arizona), weighed 260-270 g and had an operational life of 24-36 months a 35-75 pulses/minute. Thirteen radios were equipped with mortality sensors that doubled the pulse rate of the signal when an animal was stationary for 3-5 hours.

The locations of all radioed animals were obtained by triangulation from the ground or from a fixed-wing aircraft during the course of the study. Deer were located from the ground at least 2-3 times weekly during the winter and summer months and 5-6 times weekly during spring and fall migrations. Initial ground locations were made from a vehicle equipped with a Telonics TR-2 receiver with an attached programmer/scanner (TS-1) and a base loaded whip antenna. Triangulation bearings were obtained using a hand-held, 2-element antenna (RA-2A; Telonics, Inc., Mesa, Arizona). Visual sightings of radio collared deer were made whenever possible. Radio locations and visual sightings were marked on U.S. Geological Survey 7.5 minute series topographic maps.

Fixed-wing flights were conducted once weekly, weather permitting, during spring and fall migration and once every 2-3 weeks during the winter and summer, usually between 0900 and 1100 hours. Flights were conducted in a Cessna 185 at air speeds of 120-180 km/hour.

Migration routes, holding areas, and winter and summer home ranges were identified and then delineated using radio telemetry. Winter and summer home ranges (Burt 1943), were determined using the Modified Minimum Area Method (Harvey and Barbour 1965). Each home range included a minimum of five relocation points determined from visual observations. Radio-collared deer were considered to show fidelity to a specific seasonal home range if ranges in consecutive years overlapped.

Holding areas were recognized as sites along migration corridors where deer remained for several days or more during migration (Bertram and Rempel 1977). All holding areas identified were designated a number as to the position in which they occur along the migration corridor, e.g., HA-I.

Post season deer composition counts were conducted over the entire winter range by use of a Bell Jet Ranger III helicopter during early January 1986, 1987, and 1988. Spring composition counts were conducted on foot in March and early April of 1986 and 1987 in more accessible portions of the winter range.

RESULTS

CAPTURE AND MARKING

A total of 117 deer (86 females and 31 males) were captured, marked, and released on all of the 6 subwintering areas of the Casa Diablo deer herd (Table 1). Thirty-eight of these were fawns (24 males and 14 females), 72 adult females, and 7 adult males.

TABLE 1. Total Number and Composition of Deer Captured, Marked, and Released on each of the Casa Diablo Wintering Areas. January-March 1986, January-February 1987.

LOCATION	ADULTS		FAWNS		TOTAL
	M	F	M	F	
MC	4	30	11	8	53
BS	2	16	5	1	24
TM	0	6	3	2	11
TL	0	9	3	0	12
CD	0	3	0	0	3
CF	1	8	2	3	14
TOTAL	7	72	24	14	117

MIGRATION CORRIDORS AND HOLDING AREAS

During the two spring and fall periods studied, 22 of 27 radio-collared deer marked on the Casa Diablo winter range in 1986 and 1987 migrated to the west of their respective wintering areas. Five de r all from the Marble Creek wintering area, migrated to the east, up the west slope of the White Mountains.

Beginning in early April, deer leave their respective wintering areas and move in a westerly direction along separate migration routes toward the Glass Mountains (Figure 3, Appendix Figure 1a). These route merge at the east end of the Glass Mountains and continue westward along the south slope. The Glass Mountains extend in a westerly direction fr Benton, California, and are bordered by Crowley Lake and the Owens River to the south and Hwy 120 to the north. They encompass approximately 25 km with an elevational range of 2,134-3,216 m.

During the spring of 1986, 19 of the 22 radio-collared deer which summered west of the Casa Diablo winter range migrated along the base c the south slope of the Glass Mountains. Deer movements were concentrat between 2,135-2,285 m, along the interface of pinyon-juniper woodland a Great Basin sagebrush habitat types. Deer typically preferred to remai in the more open sagebrush-scrub vegetation while migrating, perhaps i order to avoid predators and to take advantage of herbaceous vegetation occurring there.

Eighteen of the 19 radio-collared deer which migrated along the south slope of the Glass Mountains in spring of 1986, utilized a large spring holding area at the west end of this range near the headwaters of the Owens River. In addition, 16 non-radioed, ear tagged deer were observed on this holding area during the spring and fall migrations of 1986 and 1987 (Appendix Figure 2). This holding area, designated (HA-I), is located 29 km north of the Casa Diablo winter range. The average vertical rise in elevation between HA-I and Casa Diablo deer herd wintering areas is approximately 300 m. HA-I encompasses 26 km , varying in elevation between 2,134-2,256 m. The major habitat type occurring there is a mixture of Jeffrey pine and Great Basin sagebrush vegetation. This area also contained one large wet meadow, known as Alpers meadow, where deer often concentrated in significant numbers during the evening and early morning hours.

Radio-collared deer spent an of average 11 days on HA-I in 1986 (range 1-45), and 4 days (range 1-34) in 1987. Radio-collared deer which migrated to the west of HA-I spent an average of 22 days longer there in 1986, and 15 days longer in 1987, than deer which migrated to the north.

During the spring migration of 1986, 13 of the 18 radio-collared deer which utilized HA-I summered to the north, and 4 to the west. One radio-collared doe was killed by a mountain lion (_Felis concolor_), on 26 April near Alpers meadow. Its radio-collar was put on another adult doe in the same area on 10 May. This deer never migrated further, eventually summering near Big Springs at the headwaters of the Owens River.

The main migration corridor used by deer summering to the north of HA-I, extends in a northwesterly direction, contouring around the southern end of the Mono Craters toward the Aeolian Buttes (Figure 3, Appendix Figure 1a). Deer were found to cross a two lane section of Hwy 395 near the Aeolian Buttes, before continuing west around the northern end of Grant Lake to another spring holding area (HA-II), located at the foot of the Parker Creek and Walker Creek drainages. HA-II encompasses approximately 5.2 km at elevations ranging from 2,195-2,439 m. The major habitat type occurring on HA-II is a mixture Jeffrey pine and Great Basin sagebrush which include dense pockets of 1-2 m high curlleaf mountain mahogany. HA-II also includes several wet meadows the largest of which is approximately 1 km . During the spring migration of 1986, 12 radio-collared deer, all of which spent some time on HA-I, utilized HA-II

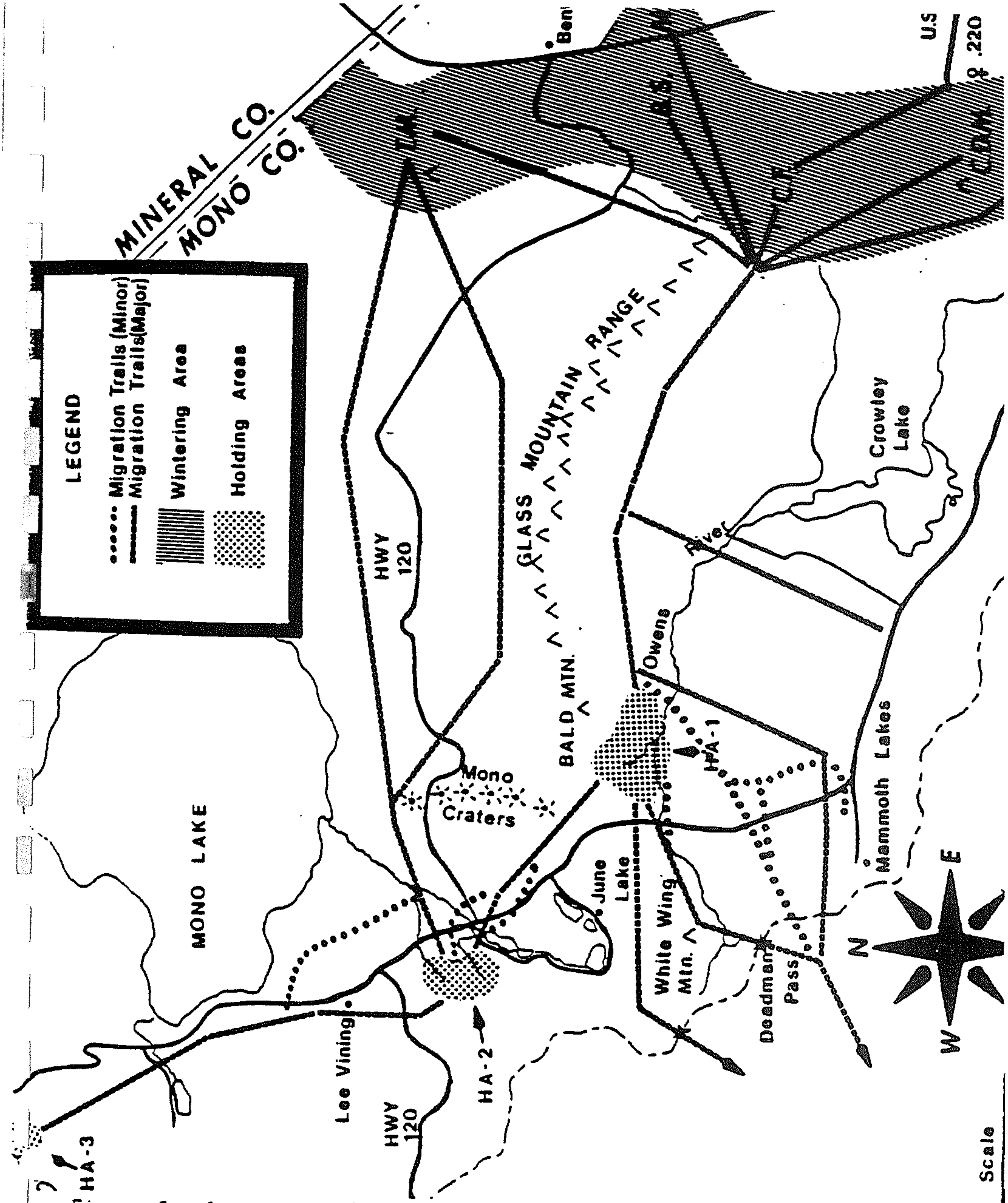


Figure 3. Locations of migration routes and holding areas of the Casa Diablo deer herd in Mono County, California.

from 1-47 days during April, May, and June. In addition, a total of 5 non-radioed, ear tagged deer were observed on HA-II during the spring migration of 1986 (Appendix Figure 2). Deer traveling to lower elevations did not use HA-II to the extent of those traveling to higher elevations.

One radio-collared doe was found to utilize HA-II during two different periods in the spring of 1986 before moving onto her summer range. This particular doe first arrived on HA-II on 12 April and remained there until 24 April after which time she traveled extensively to the north and west over an area encompassing 20 km at elevations between 2,320-2,750 m. She returned to HA-II for a second time on 2 May and remained there until 5 May, after which time she traveled to the south and east over much of the Reverse Peak area before finally settling down on her summer range on 10 May. Her movements appear to have been directly influenced by weather and its effects on plant phenology on her summer range, which was located within a steep canyon where limited sunlight and cool daytime ambient temperatures resulted in late development of forage.

In 1986, 6 radio-collared deer migrated north of HA-II, 4 of which summered in Lee Vining Canyon, 1 in Lundy Canyon, and 1 near lower Twin Lake. The radio-collared doe which summered near Lower Twin Lake was found to occupy another spring holding area (HA-III), located at the north end of Lower Twin Lake on Honeymoon Flat. She remained on HA-III for 5 days (12-17 June) in 1986, before moving 3 km east to her summer home range. HA-III encompasses 5 km at elevations ranging from 2,120-2,200 m and, like other holding areas, is composed of a mixture of Jeffrey pine and Great Basin sagebrush vegetation (Appendix Figure 1b).

As mentioned previously, 4 radio-collared deer migrated to the west of HA-I (Figure 3, Appendix Figure 1). These deer departed HA-I between 24 and 28 May in 1986 and traveled in a southwesterly direction, crossing what was then a two lane section of Hwy 395 just north of the Crestview maintenance station. One radio-collared doe migrated up the Glass Creek drainage on the north side of White-Wing Mountain before crossing San Joaquin Ridge to the west side of the Sierra. The other 3 radio-collared does migrated around the south side of White-Wing Mountain, two of which crossed San Joaquin Ridge over Deadman Pass (elevation 3,163 m). The other stopped approximately 1 mile east of the ridge where it summered on the south slope of White-Wing Mountain.

Although the winter range of radio-collared female .220, marked on HA-I, was never located, a portion of her migration route was delineated. Her migration route heads in an easterly direction from her summer range, located near HA-I, first contouring along the south slope of the Glass Mountains. It then proceeds through the Chidago Flat area and across the Volcanic Tablelands, after which it crosses Hwy 6, just south of the town of Chalfant and continues into the Piute Creek area of the White Mountains. The remainder of the migration route, like her winter range, was never delineated.

Sixteen of 22 radio-collared deer which summered to the west of the Casa Diablo winter range were monitored for both the 1986 and 1987 spring periods, and all but 2 used the same migration routes. These 2 deer, both from the Truman Meadows wintering area, migrated along the south slope of the Glass Mountains in 1986 in order to reach their summer range destinations. However, in 1987, both of these deer migrated along the north side of the Glass Mountains (Figure 3, Appendix Figure 1a). Doe .450 totally bypassed HA-I which she used in 1986, and migrated directly to her summer range. Doe .315 migrated along the north side of the Glass Mountains to as far as Sagehen Meadow, before turning south to HA-I.

SPRING MIGRATION

A total of 11 radio telemetry flights were made during the spring periods of 1986 and 1987 to locate deer during migration. All monitored deer from the Casa Diablo deer herd were migratory with distinct winter and summer ranges. Despite extreme differences in the amount of snowfall recorded during the winters of 1985-86 and 1986-87, little variation occurred in the overall timing of migration (Figure 4). The winter of 1985-86 was one of the wettest on record in the eastern Sierra, with 745.? cm of snowfall recorded at 2,378 m at Mammoth Lakes, Mono County (USFS, Unpubl.). In contrast, during the winter of 1986-87, 255.8 cm of snowfall was recorded at the same location.

Deer migrated approximately two weeks later in 1986 than in 1987. However, the overall timing of migration to the summer range between the two years was quite similar. In 1986, deer began leaving the winter range on 3 April, with 50% of all radio-collared deer having migrated by 20 April (Figure 4). By 15 May, all radio-collared deer had left the winter

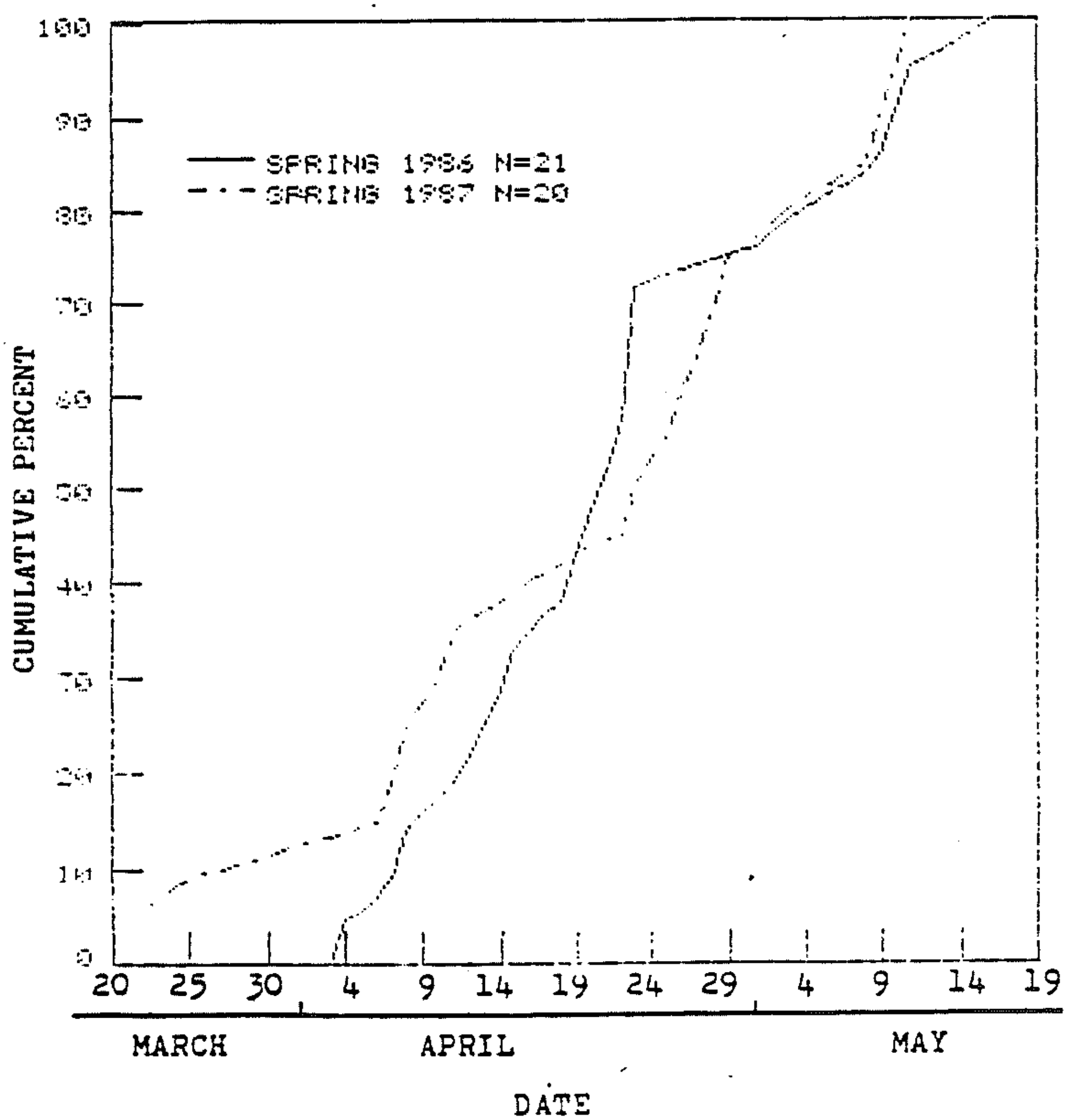


Figure 4. Cumulative percent of radio-collared deer migrating from the Casa Diablo winter range by date.

range.

In spring of 1987, 2 radio-colllared does migrated on 20 and 26 March. However, due to late development of spring green-up on the winter range, no other radio-collared deer were found to migrate until 6 April. By 22 April, 50% of all radio-collared deer had migrated and by 10 May, all had left the winter range. Migration from the winter range in spring of 1987 was more gradual than in 1986, with no peak periods of departure (Figure 4).

Deer that summered at higher elevations did not leave the winter range at a later date than those summering at lower elevations. However, deer which summered at higher elevations, or those having to cross the Sierra crest to gain access to west side summer ranges, did remain longer on spring holding areas. Changes in elevation between winter and summer ranges varied from 2,134-3,354 m. Distances traveled between winter and summer ranges varied from approximately 3.5 to 116 km.

Arrival dates of radio-collared deer on the summer range varied dramatically among some individuals during the two years studied and had no discernible pattern. Five deer arrived from 10-13 days later on their summer ranges in 1987 than in 1986. In contrast, five others arrived from 10-20 days earlier on their summer ranges in 1987 than in 1986.

FALL MIGRATION

Radio-collared deer were monitored for two consecutive fall seasons. Little variation exists in the timing of migration to the winter range between 1986 and 1987. However, migration to the winter range appeared to be less strongly correlated with weather in 1986 than in 1987. This mostly is due to the occurrence of only one minor storm in the fall of 1986, on 24 September. During the 1986 fall migration, 83% of radio-collared deer migrated between 3 October and 8 November (Figure 5). Two radio-collared does remained on their summer ranges until 3 January 1987, when the first significant winter storm occurred.

In 1987, the first radio-collared deer migrated from the summer range on 6 October. Eighty-two percent of radio-collared deer migrated in response to storms which occurred on 11-12, 22-23, and 27-28 October and 2-3 November.

Radio-collared does summering at higher elevations or west of the

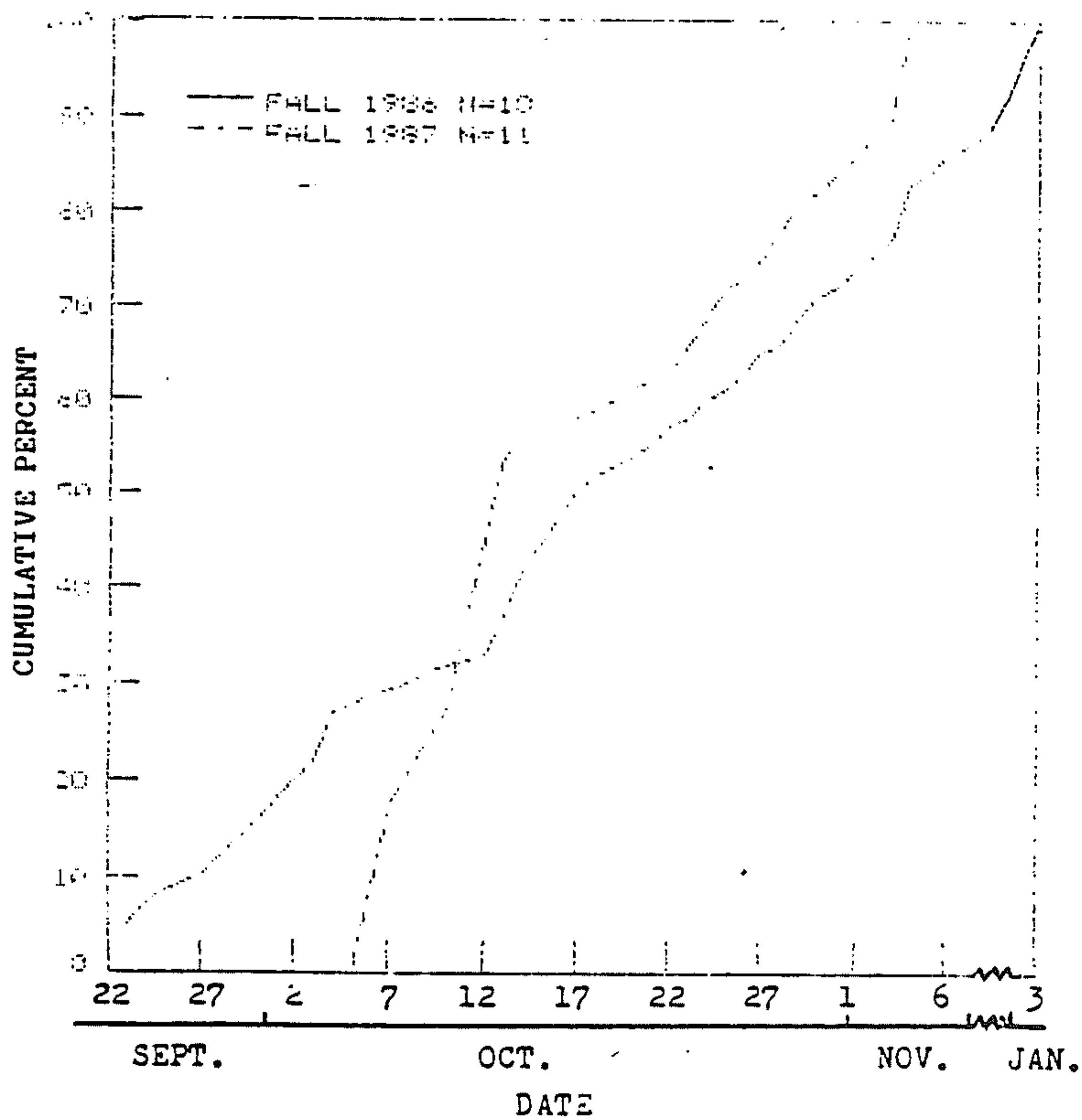


Figure 5. Cumulative percent of radio-collared deer migrating from summer range by date.

Sierra crest did not appear to migrate earlier than those summering at lower elevations. In both years, all deer known to migrate along the south slope of the Glass Mountains spent between 1 and 41 days on HA-I, remaining there until as late as mid-November before migrating further east. Here, a south-facing slope provided snow free areas of abundant browse. Once the deer left HA-I, movement generally was gradual, with deer taking as long as 15 days to reach wintering areas.

WINTER RANGE

Home range sizes for radio-collared deer on the winter range averaged 85 ha (range = 31-154 ha). During the dry winter of 1986-87, 19 of 22 radio-collared deer occupied higher elevation transition range west of their respective wintering areas. All utilized large stands of pinyon pine between 2,135-2,470 m, where they fed extensively on a large crop of pinyon nuts. Light to moderate snow conditions made pinyon nuts readily available throughout the entire winter. Home range sizes on transition range averaged 295 ha (range = 172-384 ha). Deer remained on transition range until approximately mid-March, after which time 16 radio-collared deer moved east an average of 11 km to lower portions of the winter range presumably in search of herbaceous spring forage.

During the winter of 1986-87, three radioed does, all of which were captured on Casa Diablo Mountain in January 1986, never returned to this wintering area (Figure 2). Two of these does spent the entire winter approximately 8 km northwest of Casa Diablo Mountain on transition range near the south end of Banner Ridge. These two does were the first radio-collared deer to migrate in spring 1987, on 20 and 26 March, departing directly from Banner Ridge. The other doe, which migrated along the north side of the Glass Mountains during the 1986 fall migration, traveled only as far as the Sagehen Meadow area where she spent the entire winter. In the spring of 1987, this doe migrated to her summer range directly from the Sagehen Meadow area on 7 April.

In fall of 1987, deer were monitored until 15 December. At this time, only 2 of 11 radio-collared deer had returned to the wintering areas where they were captured. The other 9 occupied transition range west of wintering areas, as they did during the winter of 1986-87.

SUMMER RANGE

Deer from the Casa Diablo herd occupied approximately 2,000 km of summer range throughout west central Mono County, primarily along the east slope of the Sierra Nevada (Figure 2). Fifteen of 22 radio-collared deer which migrated to the west of the Casa Diablo winter range summered on the east slope of the Sierra Nevada, from the Deadman Creek drainage north to lower Twin Lake (Figure 6, Appendix Figure 3). Twelve of these 15 deer summered within a 22 km area, from Grant Lake north to Lee Vining Canyon. A total of 22 non-radioed, ear tagged deer were observed along the east slope of the Sierra Nevada during the summers of 1986 and 1987 (1 June-1 October) (Appendix Figure 2). Radio-collared deer which summered on the east slope of the Sierra occupied home ranges located at an average elevation of 2,547 m (range = 2,135-2,960 m).

Four radio-collared deer summered east of Hwy 395 from the Mono Craters south to O'Harrel Canyon in the Glass Mountains at an average elevation of 2,515 m (range = 2,195-3,050 m). In addition, 10 non-radioed, ear tagged deer were observed east of Hwy 395 between 1 June and 1 October 1986 and 1 June and 1 October 1987 (Appendix Figure 2). Three radio-collared deer summered to the west of the Sierra crest, one in Madera County at Beasore Meadow near Chilkoot Lake, one in Yosemite National Park near Tuolumne Meadows, and one in the upper San Joaquin drainage near Shadow Lake (Appendix Figure 4). Four radio-collared deer, all from Marble Creek, summered on the west slope of the White Mountains directly above the winter range.

Marked deer from the same wintering area occupied portions of summer range in "family groups". This was most evident in deer from Chidago Flat in which 12 of 14 marked animals were found on the same summering area in Lee Vining Canyon. Conversely, marked deer from the same wintering area were also found to disperse to opposite ends of the summer range (Figure 6). For example, one doe from the Blind Spring Hills summered at the southern end of the herd range near the Deadman Creek drainage while another summered at the northern end of the range near lower Twin Lake. Gruell and Papez (1963), also found this to be true of deer in northeastern Nevada, where all deer wintering together did not summer together.

Marked deer from several different wintering areas were found to

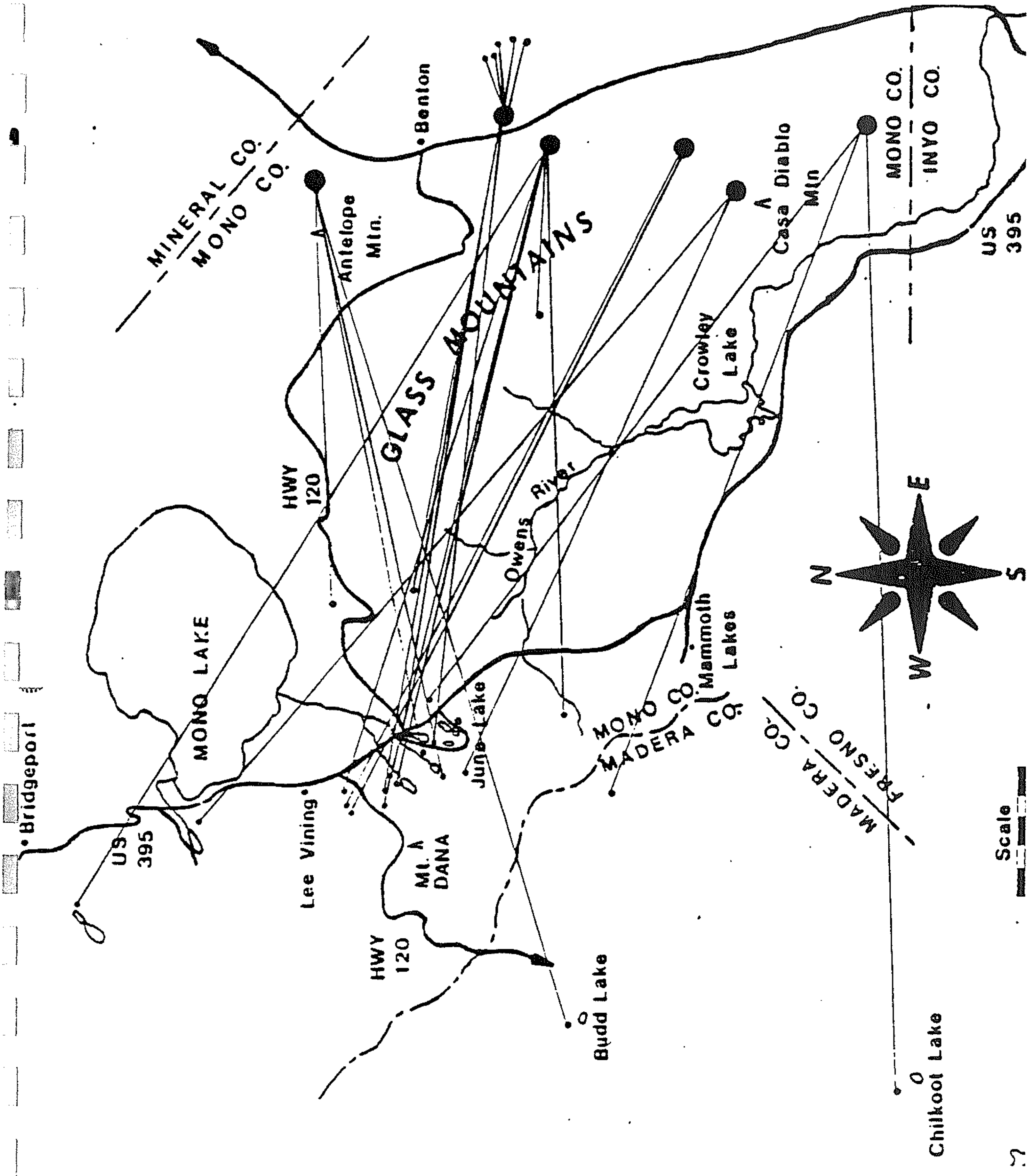


Figure 6. Movements of radio-collared deer marked on wintering areas (large circles) and subesquently found on summer ranges (small circles).

occupy summer range of close proximity and even to have overlapping home ranges. Three radio-collared does, two from Chidago Flat and one from Blind Springs, had overlapping home ranges of 34-111 ha in Lee Vining Canyon on the east slope of the Sierra. Two does, one from Marble Creek and one from Blind Springs, had overlapping home ranges in Bohler Canyon, also located on the east slope of the Sierra.

Many fawning areas or "population centers" were identified on the east slope of the Sierra (Figure 7, Appendix Figure 5). Population centers are described as an aggregation of propagation units where single pregnant does find adequate food, water, and cover to rear fawns (Bertram 1984).

All 16 radio-collared deer monitored for two successive years exhibited strong site fidelity to summer range areas by returning to the same summer range locations in 1987 as in 1986.

SUMMER HABITAT UTILIZATION

Home ranges for deer summering on the east slope of the Sierra Nevada averaged 100 ha (range = 34-167 ha). Quaking aspen riparian habitat was the major type most utilized by radio-collared deer from the Casa Diablo herd. Fourteen of the 15 monitored does which summered on the east slope of the Sierra Nevada mountains were found to have summer ranges typically consisting of a mosaic of different habitat types centered around some portion of a riparian area. Seven of these does utilized quaking aspen riparian vegetation occurring along stream channels winding through open areas of Great Basin sagebrush and montane chaparral. These riparian areas were an average of 25 m wide (range = 15-100 m). Deer most often selected portions of these riparian areas having from 80-405 aspen trees per ha within the 2.5-15 cm DBH size class and dense multilayered understory vegetation. These areas provide shade and thermal cover, but more importantly hiding cover, particularly for fawns. Understory vegetation typically consisted of several different grass species, aspen shoots, willow, snowberry, wild rose, and corn lily (*Veratrum californicum*). Willow and snowberry where the most abundant understory species making up 40 and 25 percent of understory vegetation respectively. The overstory canopy in these areas consisted of an average of 282 aspen trees per ha with an average DBH of 23 cm and average heights

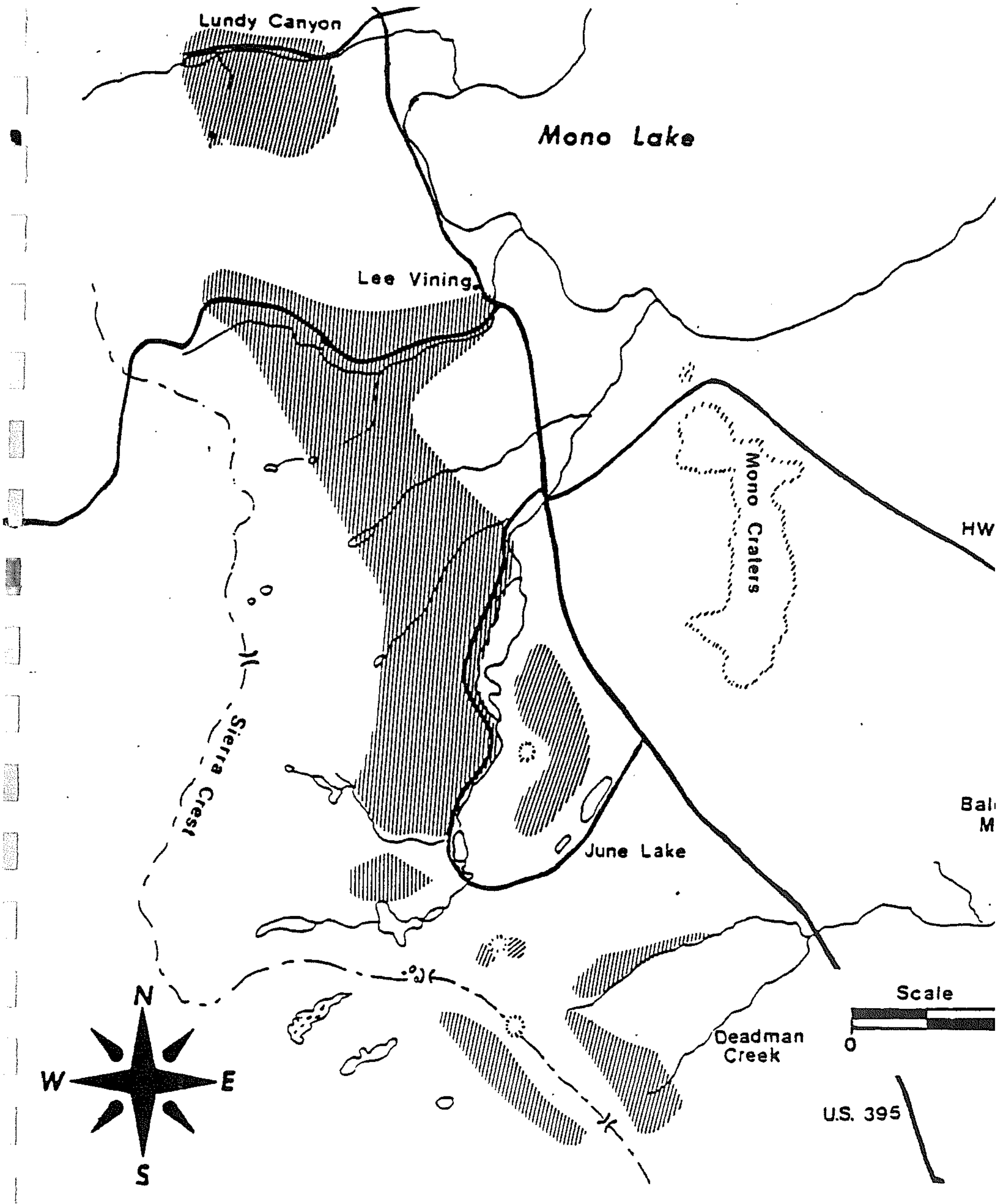


Figure 7. Locations of major fawning areas, Cast Diablo deer herd.

of 9 m.

Seven deer had home ranges including mixtures of both meadow and aspen riparian habitat types. Home ranges of these deer typically consisted of a portion of a large aspen grove and nearby associated meadows. All seven deer expanded their home ranges to include nearby Great Basin sagebrush and montane chaparral areas once meadow and aspen understory vegetation began to senesce, in late August of 1986 and in late June of 1987.

Three deer which summered east of Hwy 395 and south and east of Mono Lake had home ranges approximately 2 times larger than those that summered on the east slope of the Sierra Nevada. These does had summer home ranges averaging 384 ha in size which consisted primarily of Jeffrey pine and Great Basin sagebrush habitat types. Limited water distribution throughout the Jeffrey pine habitat type may have caused these does to range over a larger area. One doe, which summered east of Mono Mills (Figure 6), was observed drinking from a sheep watering trough 1.9 km west of the center of her home range. Another doe consistently was observed on her summer home range located approximately 2 km from the nearest water source. These does utilized large, open stands of Jeffrey pine consisting of an average of 243 trees per ha. Understory vegetation consisted primarily of 1-1.5 m high big sagebrush and bitterbrush.

MORTALITIES

Five of the original 23 radio-collared deer (22%) marked during January-March 1986 on the Casa Diablo winter range were killed by mountain lions (Figure 8, Appendix Figure 6). The first, from Truman Meadows, was killed on HA-I on 26 April 1986. Her carcass was found buried under about 5 cm of dirt and litter in a large opening of Great Basin sagebrush. Two does were killed by mountain lions on 29 January 1987 on pinyon-juniper transition range in the Banner Ridge area. Both carcasses, which were found approximately 8 km apart, were mostly consumed and buried at the base of pinyon trees. One doe was killed by a mountain lion on 20 March 1987 on the Blind Spring Hills wintering area. Her carcass, which was buried in a sandy draw, was found to be almost entirely eaten. A fifth doe was killed by a mountain lion while

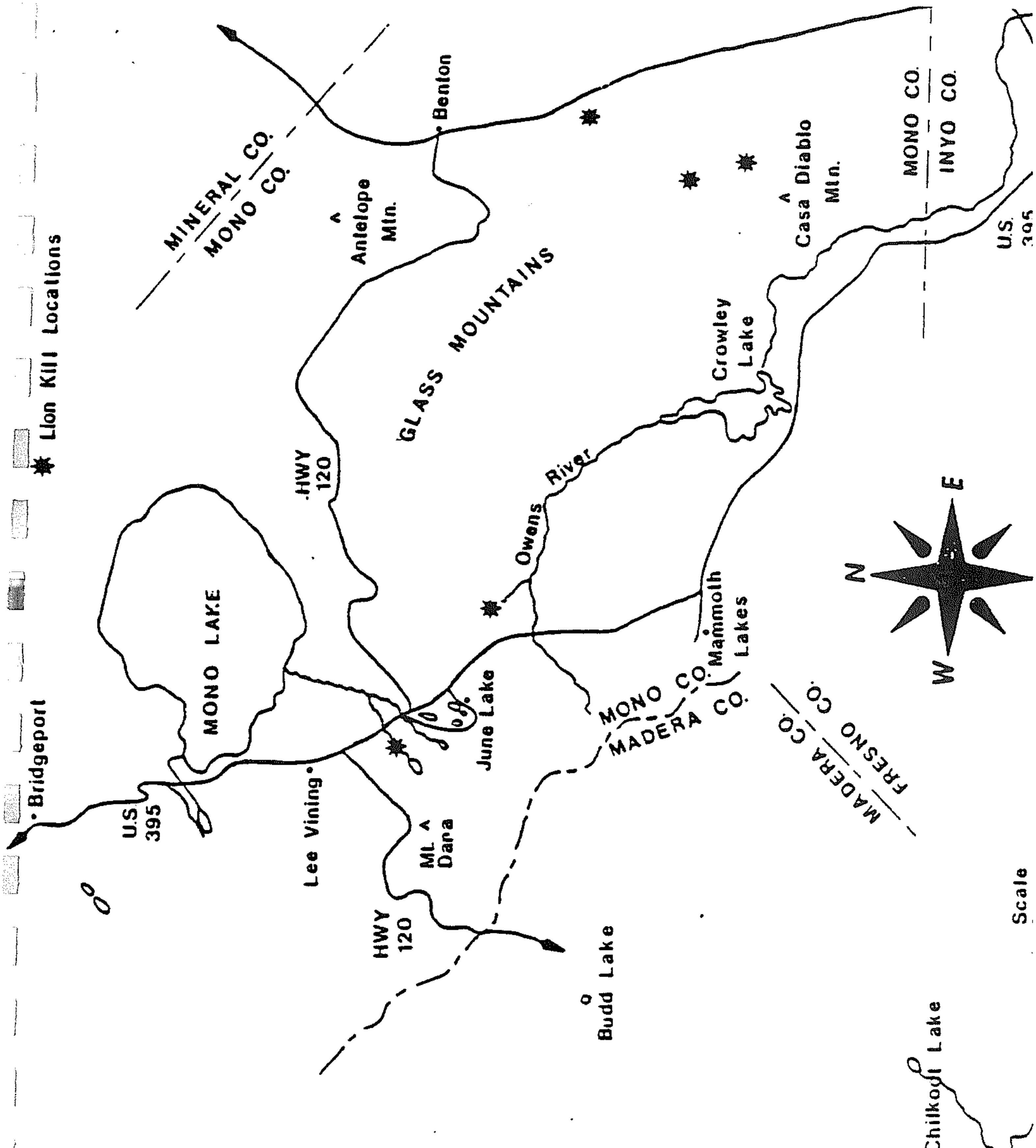


Figure 8. Locations of five radio-collared does killed by mountain lions.

on her summer range sometime during October 1987. Her carcass was found buried in willows on Parker Creek. Two additional does died while on their summer ranges; the cause of death was undetermined.

DEER HERD COMPOSITION COUNTS

Post season composition counts have been conducted over the last eight years on the Casa Diablo winter range. Fawn:doe ratios have averaged 49:100 and buck:doe ratios 9:100 (Table 2). During this study, post season composition counts were conducted on 7 January 1986, 6 January 1987, and 8 January 1988. In 1988, fawn:doe ratios were the lowest ever recorded (36:100).

Spring composition counts were conducted on the Casa Diablo winter range from the ground in April of 1986 and 1987. In 1986, fawn:doe ratios were 21:100 and 39:100 in 1987.

Deer herd size has been estimated at approximately 1,500 animals over the last several years using a ratio estimation method (Anderson et al. 1974), a technique utilizing annual buck harvest figures and herd composition data.

TABLE 2. Results of Casa Diablo Deer Herd Spring and Fall Composition Counts per 100 Does, 1980-1988

YR	Fall		Fall Sample	Spring	Spring Sample
	Bucks	Fawns		Fawns	
1980-81	13	58	---	47	---
1981-82	10	54	353	50	---
1982-83	7	41	403	28	---
1983-84	8	37	526	46	---
1984-85	7	43	366	42	191
1985-86	15	61	444	21	153
1986-87	6	60	293	39	602
1987-88	6	36	940	--	---

DISCUSSION

MIGRATION CORRIDORS

The Glass Mountains, which extend in a westerly direction from the center of the Casa Diablo winter range, provide a source of orientation for deer as they migrate to and from wintering areas. Two major migration corridors, one along the north slope and one along the south slope of the the Glass Mountains were identified. Twenty-one of 27 radio-collared deer, representing all six subwintering areas, utilized the corridor on the south slope of the Glass Mountains during the spring and fall migrations of 1986 and 1987. It is believed that this corridor is used to such an extent because of its southerly aspect. South aspects typically are the first places to become snowfree in late winter (Garrott et al. 1987). Thus, snow does not appear to form an impediment to migration or to retard spring growth as it often does on the north slope of the Glass Mountains. In addition, this corridor was the shortest and the easiest way for most radio-collared deer to travel to and from wintering areas.

Two radio-collared does, both from the Truman Meadows wintering area, utilized different migration corridors during consecutive spring periods. In 1986, both does migrated along the south slope of the Glass Mountains, but in 1987 both used the north slope. Although the south slope is not the shortest route between winter and summer ranges for deer from Truman Meadows, it is the easiest route offering the most suitable conditions in years of above average snowfall (eg., 1986). In early April of 1986, due to snow free conditions, plant phenology was found to be much in advance and forage availability much greater along the south slope of the Glass Mountains than the north slope. Thus, in 1986 both does took advantage of these conditions by migrating along the south slope. In the dry year of 1987, snow cover on the north slope of the Glass Mountains was much lighter than normal in April, resulting in an earlier thaw and greater forage availability than in 1986. Hence, both does migrated along the north slope where they were able to take advantage of abundant forage while at the same time migrating a shorter distance to their summer ranges.

The fact that both radio-collared does have learned to utilize two migration corridors may be a form of opportunism (Geist 1982). In both cases, these animals were able to take advantage of abundant food sources brought about by ecological and climatic factors.

By traveling along the north slope of the Glass Mountains during the spring of 1987, these does were able to minimize expenditures of energy and nutrients on maintenance by migrating a shorter distance while at the same time maximizing resources for reproduction (Geist 1982).

Radio-collared deer utilized two major migration corridors after departing HA-I. One of these extends to the west around the south slope of White Wing Mountain and over San Joaquin Ridge (Figure 3). Deer crossed San Joaquin Ridge using several passes with the majority of movement confined to Deadman Pass. These passes, located at elevations between 2,960-3,195 m, can be considered as the link between east and west side Sierra seasonal ranges. Assuming that the radioed sample of deer is representative of the entire population, about 200 deer from the Casa Diablo herd cross San Joaquin Ridge to gain access to west side summer ranges. Several hundred deer from another eastern Sierra herd (the Sherwin Grade herd) which winter in Round Valley about 14 km north of Bishop, are also known to cross San Joaquin Ridge to gain access to their west side summer ranges (Kucera, Unpubl.).

Migration between winter and summer ranges of individual radio-collared deer were quite variable. Deer summering west of the Sierra crest were found to migrate as far as 120 km between winter and summer ranges. Those deer summering in the White Mountains had up slope migrations between winter and summer ranges of 1-3 km.

HOLDING AREAS

Deer from the Casa Diablo herd utilized three major holding areas during the spring and fall migrations of 1986 and 1987. Elevational, topographical, and vegetative features of these holding areas are quite similar. All three holding areas are located at approximately the same elevation, between 2,134-2,439 m, and all generally are situated at the base of south and east facing slopes. Vegetative composition on all these holding areas consists of a mixture of Jeffrey pine and Great Basin sagebrush habitat types.

Deer generally occupied holding areas for a longer period during the spring than in the fall. Fourteen deer utilized both HA-I and HA-II in the spring of 1986, and one monitored doe was found to occupy all three holding areas.

Much of the land in which holding areas are located is administered by the United States Forest Service. Therefore, these lands are managed for a variety of different uses including recreation, grazing, and logging. About 15% (4 km) of land in HA-I is in private ownership, most of which includes meadow areas along the Owens River that are used primarily for cattle grazing. A small portion of land at the northern corner of HA-III is also in private ownership where a small subdivision exists.

Winter logging of Jeffrey pine has been conducted over the last several years throughout the south and west portion of HA-I. Logging practices typically have included pre-and post-commercial thinning of trees < 20 cm DBH with an average spacing of 5 m between trees. Thus, many dense pockets of Jeffrey pine which provide the best hiding and escape cover for deer have been eliminated throughout this holding area. Several studies have identified the importance of dense hiding and escape cover for deer, especially during hunting season (Dasmann and Taber 1956, Sweeney et al. 1971). On fall holding areas of the North Kings herd, dense cover is a necessary and major component during hunting season (Bertram and Rempel 1977).

Conversely, thinning of dense stands of Jeffrey pine most likely has increased forage production within thinned areas. According to Ffolliott and Clary (1972), this is an acceptable generalization for most forest types. Other research has also indicated that use by deer commonly increases after logging (Wallmo et al. 1976).

No formal evaluation has been conducted concerning the effects of timber management practices on deer use within east side Sierra Jeffrey pine habitats. Therefore, it is difficult to postulate whether these practices have actually been of benefit to deer. According to Dasmann (1981), there can be too much cover as well as too little. HA-I already contains one large meadow area and vast open areas of Great Basin sagebrush habitat both of which typically provide an abundance of forage. Thus, since forage availability does not appear to be a limiting factor, perhaps it may be of greater benefit to deer if areas of dense Jeffrey pine are maintained.

Throughout most of the Jeffrey pine forest, roads, created primarily for timber harvest have reduced much of the effectiveness of hiding and escape cover by providing easy access to the public. Logging roads have been a major factor contributing to human disturbance on holding areas of the North Kings deer herd (Bertram 1984). Since logging of harvestable timber is conducted only during the winter months, it does not directly conflict with deer use of Jeffrey pine habitats. However, public fuel wood gathering of logging slash and thinned trees are activities which normally coincide with the timing of fall and spring migrations.

SPRING MIGRATION

During the two spring periods studied, little overall variation was found in the overall timing of migration to the summer range (Figure 4). This is despite great extremes in total amounts of snowfall received during the winters of 1985-86 and 1986-87. Garrott et al. (1987) found that the timing of spring migration for deer in Colorado varied annually by as much as 1 month and was related to severity of winter, with deer migrating later after more severe winters. Bertram and Rempel (1977) found migration from the winter range in deer from the North Kings herd to be approximately two weeks earlier following dry winters than winters of normal to above normal precipitation.

In this study, I hypothesize that the consistency in the timing of migration between the two spring periods studied was related to the extreme difference in the severity of winters. Following the wet winter of 1985-86, a heavier than normal snowpack retarded spring growth along the south slope of the Glass Mountains, thus delaying spring migration until early April. After the very dry winter of 1986-87, spring green-up on the winter range did not occur until mid-March due to a lack of mid and late winter precipitation. This was reflected in the movements of 16 deer which moved during March from high elevation transition range to low lying wintering areas where the availability of spring forage was greatest. Deer remained on the winter range until early April when spring green-up at higher elevations along the migration corridor began to occur.

FALL MIGRATION

According to telemetry data, migration to the winter range in fall 1987 was in response to snow storms and the consequent accumulation of snow on the summer range. Snow was also found to be a cause of migration to the winter range in other studies (Dixon 1932, Leopold et al 1951, Gilbert et al. 1970, Moen 1973, Bertram 1984). Loveless (1964) stated that snow depth appeared to be the major reason for deer moving to lower elevations earlier in some years than others.

Because of near drought conditions in 1987, forage on the summer range became of poor quality by mid-July. As a result, deer did not appear to show a strong affinity to summer range areas once fall snow storms began to occur. Instead, deer migrated to mid-elevational transition range along migration corridors where snow accumulation was less and forage quality greater.

In fall of 1986, migration to the winter range was found not to be correlated with inclement weather simply because only one minor fall storm occurred on 24 September. Accordingly, migration was found to be very gradual occurring over approximately a three month period (24 September 1986-3 January 1987. Ultimately, migration to the winter range in 1986 for deer from the Casa Diablo herd probably was caused by declining forage conditions on the summer range. For deer in Colorado, fall movements were also attributed to declining forage quality on the summer range as well as the availability of higher quality forage on the winter range (Garrott et al. 1987). Because 1986 was a very wet year, forage quality on the summer range remained high for a longer period then it would during normal years. Thus, deer showed a greater affinity for summer range areas, as illustrated by the gradual dispersal of radio-collared deer from the summer range.

WINTER RANGE

During the winter of 1986-87, 20 of 23 radio-collared deer returned to the same locations where they were marked on the winter range. However, three radio-collared does never returned to the Casa Diablo Mountain wintering area where they were marked in January of 1986. Two of these does occupied pinyon-juniper transition range between 8-12 km northwest of the Casa Diablo Mountain throughout the entire winter. A third wintered near Sagehen Peak, located on the north side of the Glass Mountains approximately 33 km northwest of Casa Diablo Mountain.

To my knowledge, very little data has been published which documen a lack of fidelity in migratory deer to specific wintering or summering areas. Robinette (1966) cited two instances of belled deer which were

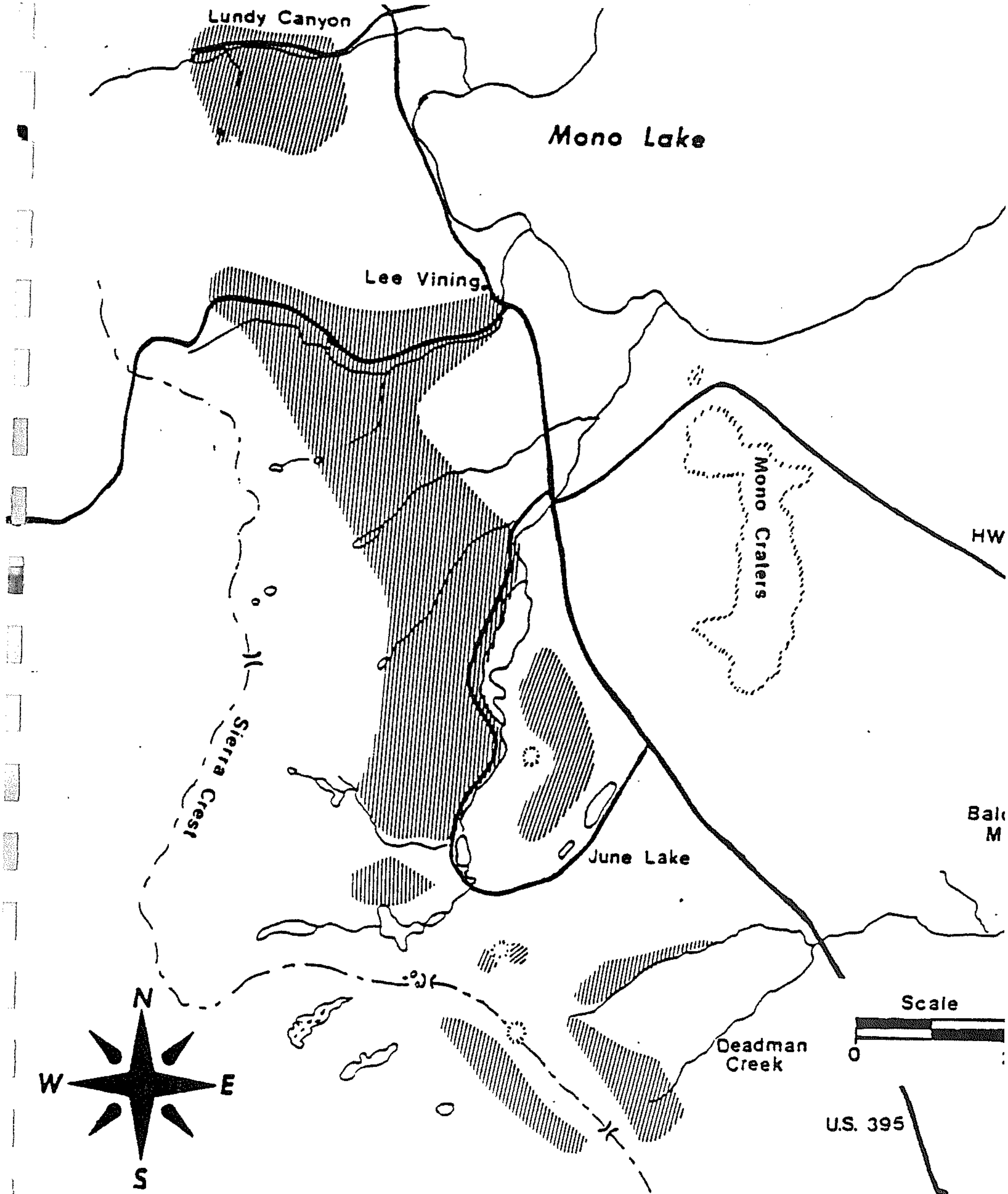


Figure 7. Locations of major fawning areas, Cas: Diablo deer herd.

of 9 m.

Seven deer had home ranges including mixtures of both meadow and aspen riparian habitat types. Home ranges of these deer typically consisted of a portion of a large aspen grove and nearby associated meadows. All seven deer expanded their home ranges to include nearby Great Basin sagebrush and montane chaparral areas once meadow and aspen understory vegetation began to senesce, in late August of 1986 and in late June of 1987.

Three deer which summered east of Hwy 395 and south and east of Mono Lake had home ranges approximately 2 times larger than those that summered on the east slope of the Sierra Nevada. These does had summer home ranges averaging 384 ha in size which consisted primarily of Jeffrey pine and Great Basin sagebrush habitat types. Limited water distribution throughout the Jeffrey pine habitat type may have caused these does to range over a larger area. One doe, which summered east of Mono Mills (Figure 6), was observed drinking from a sheep watering trough 1.9 km west of the center of her home range. Another doe consistently was observed on her summer home range located approximately 2 km from the nearest water source. These does utilized large, open stands of Jeffrey pine consisting of an average of 243 trees per ha. Understory vegetation consisted primarily of 1-1.5 m high big sagebrush and bitterbrush.

MORTALITIES

Five of the original 23 radio-collared deer (22%) marked during January-March 1986 on the Casa Diablo winter range were killed by mountain lions (Figure 8, Appendix Figure 6). The first, from Truman Meadows, was killed on HA-I on 26 April 1986. Her carcass was found buried under about 5 cm of dirt and litter in a large opening of Great Basin sagebrush. Two does were killed by mountain lions on 29 January 1987 on pinyon-juniper transition range in the Banner Ridge area. Both carcasses, which were found approximately 8 km apart, were mostly consumed and buried at the base of pinyon trees. One doe was killed by a mountain lion on 20 March 1987 on the Blind Spring Hills wintering area. Her carcass, which was buried in a sandy draw, was found to be almost entirely eaten. A fifth doe was killed by a mountain lion while

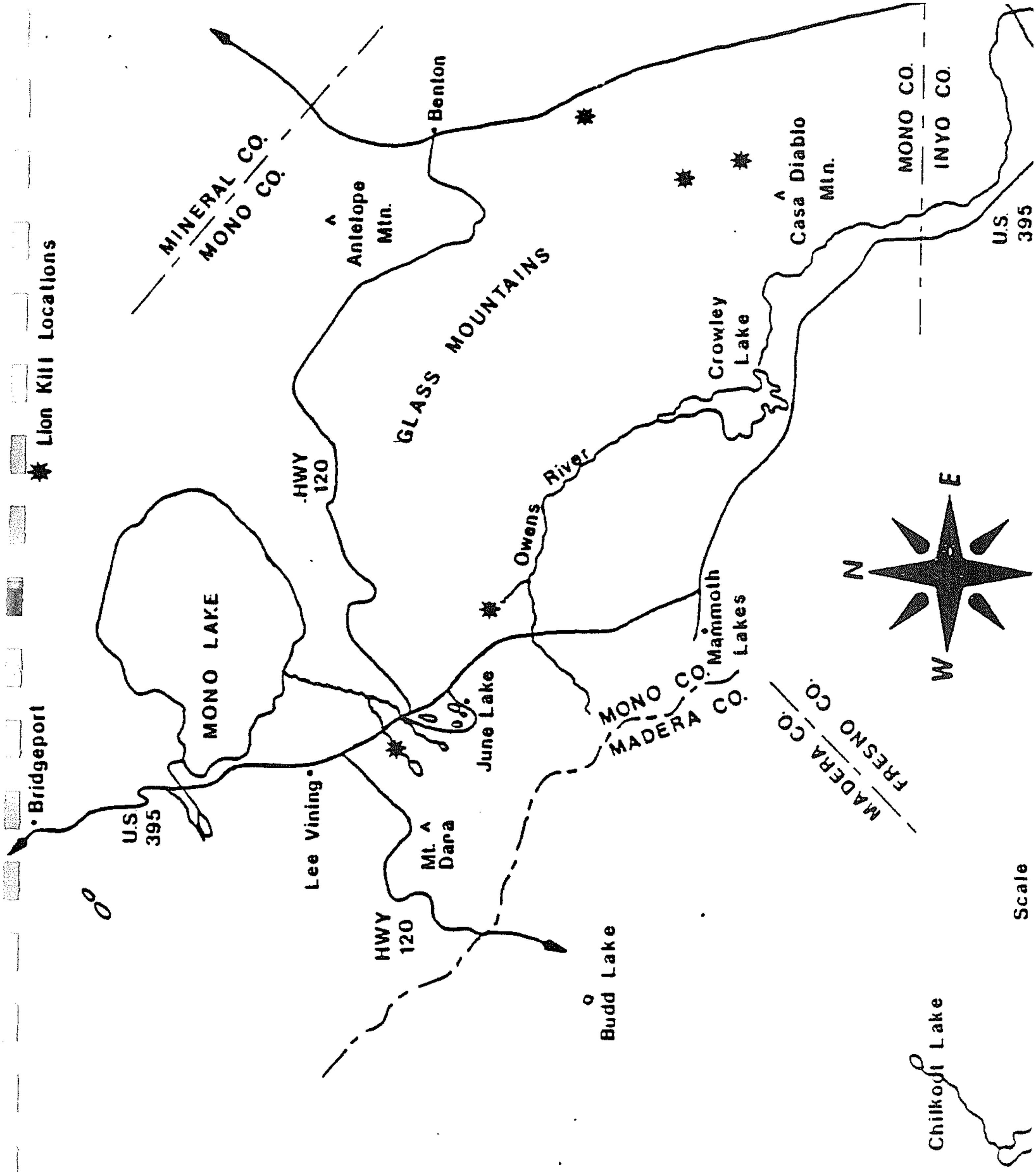


Figure 8. Locations of five radio-collared does killed by mountain lions.

on her summer range sometime during October 1987. Her carcass was found buried in willows on Parker Creek. Two additional does died while on their summer ranges; the cause of death was undetermined.

DEER HERD COMPOSITION COUNTS

Post season composition counts have been conducted over the last eight years on the Casa Diablo winter range. Fawn:doe ratios have averaged 49:100 and buck:doe ratios 9:100 (Table 2). During this study, post season composition counts were conducted on 7 January 1986, 6 January 1987, and 8 January 1988. In 1988, fawn:doe ratios were the lowest ever recorded (36:100).

Spring composition counts were conducted on the Casa Diablo winter range from the ground in April of 1986 and 1987. In 1986, fawn:doe ratios were 21:100 and 39:100 in 1987.

Deer herd size has been estimated at approximately 1,500 animals over the last several years using a ratio estimation method (Anderson et al. 1974), a technique utilizing annual buck harvest figures and herd composition data.

TABLE 2. Results of Casa Diablo Deer Herd Spring and Fall Composition Counts per 100 Does, 1980-1988

YR	Fall		Fall Sample	Spring	Spring Sample
	Bucks	Fawns		Fawns	
1980-81	13	58	---	47	---
1981-82	10	54	353	50	---
1982-83	7	41	403	28	---
1983-84	8	37	526	46	---
1984-85	7	43	366	42	191
1985-86	15	61	444	21	153
1986-87	6	60	293	39	602
1987-88	6	36	940	--	---

DISCUSSION

MIGRATION CORRIDORS

The Glass Mountains, which extend in a westerly direction from the center of the Casa Diablo winter range, provide a source of orientation for deer as they migrate to and from wintering areas. Two major migration corridors, one along the north slope and one along the south slope of the the Glass Mountains were identified. Twenty-one of 27 radio-collared deer, representing all six subwintering areas, utilized the corridor on the south slope of the Glass Mountains during the spring and fall migrations of 1986 and 1987. It is believed that this corridor is used to such an extent because of its southerly aspect. South aspects typically are the first places to become snowfree in late winter (Garrott et al. 1987). Thus, snow does not appear to form an impediment to migration or to retard spring growth as it often does on the north slope of the Glass Mountains. In addition, this corridor was the shortest and the easiest way for most radio-collared deer to travel to and from wintering areas.

Two radio-collared does, both from the Truman Meadows wintering area, utilized different migration corridors during consecutive spring periods. In 1986, both does migrated along the south slope of the Glass Mountains, but in 1987 both used the north slope. Although the south slope is not the shortest route between winter and summer ranges for deer from Truman Meadows, it is the easiest route offering the most suitable conditions in years of above average snowfall (eg., 1986). In early April of 1986, due to snow free conditions, plant phenology was found to be much in advance and forage availability much greater along the south slope of the Glass Mountains than the north slope. Thus, in 1986 both does took advantage of these conditions by migrating along the south slope. In the dry year of 1987, snow cover on the north slope of the Glass Mountains was much lighter than normal in April, resulting in an earlier thaw and greater forage availability than in 1986. Hence, both does migrated along the north slope where they were able to take advantage of abundant forage while at the same time migrating a shorter distance to their summer ranges.

The fact that both radio-collared does have learned to utilize two migration corridors may be a form of opportunism (Geist 1982). In both cases, these animals were able to take advantage of abundant food sources brought about by ecological and climatic factors.

By traveling along the north slope of the Glass Mountains during the spring of 1987, these does were able to minimize expenditures of energy and nutrients on maintenance by migrating a shorter distance while at the same time maximizing resources for reproduction (Geist 1982).

Radio-collared deer utilized two major migration corridors after departing HA-I. One of these extends to the west around the south slope of White Wing Mountain and over San Joaquin Ridge (Figure 3). Deer crossed San Joaquin Ridge using several passes with the majority of movement confined to Deadman Pass. These passes, located at elevations between 2,960-3,195 m, can be considered as the link between east and west side Sierra seasonal ranges. Assuming that the radioed sample of deer is representative of the entire population, about 200 deer from the Casa Diablo herd cross San Joaquin Ridge to gain access to west side summer ranges. Several hundred deer from another eastern Sierra herd (the Sherwin Grade herd) which winter in Round Valley about 14 km north of Bishop, are also known to cross San Joaquin Ridge to gain access to their west side summer ranges (Kucera, Unpubl.).

Migration between winter and summer ranges of individual radio-collared deer were quite variable. Deer summering west of the Sierra crest were found to migrate as far as 120 km between winter and summer ranges. Those deer summering in the White Mountains had up slope migrations between winter and summer ranges of 1-3 km.

HOLDING AREAS

Deer from the Casa Diablo herd utilized three major holding areas during the spring and fall migrations of 1986 and 1987. Elevational, topographical, and vegetative features of these holding areas are quite similar. All three holding areas are located at approximately the same elevation, between 2,134-2,439 m, and all generally are situated at the base of south and east facing slopes. Vegetative composition on all these holding areas consists of a mixture of Jeffrey pine and Great Basin sagebrush habitat types.

Deer generally occupied holding areas for a longer period during the spring than in the fall. Fourteen deer utilized both HA-I and HA-II in the spring of 1986, and one monitored doe was found to occupy all three holding areas.

Much of the land in which holding areas are located is administered by the United States Forest Service. Therefore, these lands are managed for a variety of different uses including recreation, grazing, and logging. About 15% (4 km) of land in HA-I is in private ownership, most of which includes meadow areas along the Owens River that are used primarily for cattle grazing. A small portion of land at the northern corner of HA-III is also in private ownership where a small subdivision exists.

Winter logging of Jeffrey pine has been conducted over the last several years throughout the south and west portion of HA-I. Logging practices typically have included pre-and post-commercial thinning of trees < 20 cm DBH with an average spacing of 5 m between trees. Thus, many dense pockets of Jeffrey pine which provide the best hiding and escape cover for deer have been eliminated throughout this holding area. Several studies have identified the importance of dense hiding and escape cover for deer, especially during hunting season (Dasmann and Taber 1956, Sweeney et al. 1971). On fall holding areas of the North Kings herd, dense cover is a necessary and major component during hunting season (Bertram and Rempel 1977).

Conversely, thinning of dense stands of Jeffrey pine most likely has increased forage production within thinned areas. According to Ffolliott and Clary (1972), this is an acceptable generalization for most forest types. Other research has also indicated that use by deer commonly increases after logging (Wallmo et al. 1976).

No formal evaluation has been conducted concerning the effects of timber management practices on deer use within east side Sierra Jeffrey pine habitats. Therefore, it is difficult to postulate whether these practices have actually been of benefit to deer. According to Dasmann (1981), there can be too much cover as well as too little. HA-I already contains one large meadow area and vast open areas of Great Basin sagebrush habitat both of which typically provide an abundance of forage. Thus, since forage availability does not appear to be a limiting factor, perhaps it may be of greater benefit to deer if areas of dense Jeffrey pine are maintained.

Throughout most of the Jeffrey pine forest, roads, created primarily for timber harvest have reduced much of the effectiveness of hiding and escape cover by providing easy access to the public. Logging roads have been a major factor contributing to human disturbance on holding areas of the North Kings deer herd (Bertram 1984). Since logging of harvestable timber is conducted only during the winter months, it does not directly conflict with deer use of Jeffrey pine habitats. However, public fuel wood gathering of logging slash and thinned trees are activities which normally coincide with the timing of fall and spring migrations.

SPRING MIGRATION

During the two spring periods studied, little overall variation was found in the overall timing of migration to the summer range (Figure 4). This is despite great extremes in total amounts of snowfall received during the winters of 1985-86 and 1986-87. Garrott et al. (1987) found that the timing of spring migration for deer in Colorado varied annually by as much as 1 month and was related to severity of winter, with deer migrating later after more severe winters. Bertram and Rempel (1977) found migration from the winter range in deer from the North Kings herd to be approximately two weeks earlier following dry winters than winters of normal to above normal precipitation.

In this study, I hypothesize that the consistency in the timing of migration between the two spring periods studied was related to the extreme difference in the severity of winters. Following the wet winter of 1985-86, a heavier than normal snowpack retarded spring growth along the south slope of the Glass Mountains, thus delaying spring migration until early April. After the very dry winter of 1986-87, spring green-up on the winter range did not occur until mid-March due to a lack of mid and late winter precipitation. This was reflected in the movements of 16 deer which moved during March from high elevation transition range to low lying wintering areas where the availability of spring forage was greatest. Deer remained on the winter range until early April when spring green-up at higher elevations along the migration corridor began to occur.

FALL MIGRATION

According to telemetry data, migration to the winter range in fall 1987 was in response to snow storms and the consequent accumulation of snow on the summer range. Snow was also found to be a cause of migration to the winter range in other studies (Dixon 1932, Leopold et al 1951, Gilbert et al. 1970, Moen 1973, Bertram 1984). Loveless (1964) stated that snow depth appeared to be the major reason for deer moving to lower elevations earlier in some years than others.

Because of near drought conditions in 1987, forage on the summer range became of poor quality by mid-July. As a result, deer did not appear to show a strong affinity to summer range areas once fall snow storms began to occur. Instead, deer migrated to mid-elevational transition range along migration corridors where snow accumulation was less and forage quality greater.

In fall of 1986, migration to the winter range was found not to be correlated with inclement weather simply because only one minor fall storm occurred on 24 September. Accordingly, migration was found to be very gradual occurring over approximately a three month period (24 September 1986-3 January 1987. Ultimately, migration to the winter range in 1986 for deer from the Casa Diablo herd probably was caused by declining forage conditions on the summer range. For deer in Colorado, fall movements were also attributed to declining forage quality on the summer range as well as the availability of higher quality forage on the winter range (Garrott et al. 1987). Because 1986 was a very wet year, forage quality on the summer range remained high for a longer period then it would during normal years. Thus, deer showed a greater affinity for summer range areas, as illustrated by the gradual dispersal of radio-collared deer from the summer range.

WINTER RANGE

During the winter of 1986-87, 20 of 23 radio-collared deer returned to the same locations where they were marked on the winter range. However, three radio-collared does never returned to the Casa Diablo Mountain wintering area where they were marked in January of 1986. Two of these does occupied pinyon-juniper transition range between 8-12 km northwest of the Casa Diablo Mountain throughout the entire winter. A third wintered near Sagehen Peak, located on the north side of the Glass Mountains approximately 33 km northwest of Casa Diablo Mountain.

To my knowledge, very little data has been published which documents a lack of fidelity in migratory deer to specific wintering or summering areas. Robinette (1966) cited two instances of belled deer which were found to occupy different summer home ranges during consecutive years. The observed behavior of these three Casa Diablo deer may best be explained by elevational, topographical, and vegetational similarities between the Casa Diablo Mountain wintering area and pinyon-juniper transition range. Why should deer expend extra energy by migrating a further distance to an area that offers similar or perhaps less forage quality and availability? This may be interpreted as another form of opportunism as throughout the winter of 1986-87 deer on transition range were found to feed extensively on an abundant crop of pinyon pine nuts which were made readily available because of below normal snow accumulations. Thus, deer were able to minimize energy expenditures on maintenance by remaining on transition range where resources were of higher density and quality (Geist 1981). As a result deer were able to maintain a high level of nutrition throughout the winter months. This in turn culminated in better animal condition, and thus higher pregnancy and fetal rates among adult does collected on transition ranges (Taylor, Unpubl.).

Throughout much of the Casa Diablo winter range, water appears to be a major factor limiting deer distribution during winter months when succulent forage or snow is unavailable. When available, succulent forage and snow can provide enough water to meet metabolic needs, but free water is required during other times (Wallmo 1981, Dasmann 1981). Portions of the Casa Diablo winter range having limited water availability, such as Chidago Flat and Black Rock, where found to have large areas of seemingly suitable habitat which where virtually devoid of deer.

Water and forage appear to be the primary factors governing the size of winter home ranges. Deer occupying pinyon-juniper transition range had home ranges 2 times larger than deer which utilized other habitat types on low lying wintering areas. On transition range free water was readily available from numerous streams and seeps and, therefore, provided increased opportunity for selective foraging. Thus, deer were able to forage throughout larger areas in search of pinyon nuts and other more desirable plant species. On the North Kings winter range deer occupying Foothill-Woodland types were found to have a slightly larger home range than deer in more diverse habitat types. However, this difference was attributed to cover distribution and its relation to forage and water (Bertram 1984). Throughout most of the low winter range, such as Marble Creek, water distribution is more limited during certain periods and appears to directly influence the size of winte home ranges. This is especially true during October and November when the majority of deer use appears to be concentrated within 1.2 km of water.

The 1987, post-season composition counts conducted on the winter range in January, 1988 revealed the lowest fawn:doe ratios ever recorded for the Casa Diablo herd (36:100). This likely is related to the indire effects of precipitation on forage quality and quantity on the summer rang (Connolly 1981). Because 1987 was one of the driest years on record in eastern Sierra, the quality and availability of preferred forages on the summer range probably declined much earlier than in years of normal precipitation. As a result, fawns were in relatively poor condition when they arrived on the winter range. This was determined subjectively by examining femur bone marrow of 11 road killed fawns (Cheatum 1949). Deer typically accumulate body fat during summer and fall after productive functions generally have been satisfied. If deer cannot obtain high le of quality foods on summer and intermediate ranges during early fall, production of body fat will be diminished. Therefore, deer with limite fat reserves, such as fawns and adult deer from poor quality summer range will succumb more readily while on the winter range once sufficient ene no longer is present for maintaining bodily functions (Short 1981).

A total of 5 radio-collared deer, 22% of the original radioed sampl were killed by mountain lions between 22 April 1986 and 26 March 1987. Lion predation may under certain conditions act to limit prey populations (Hornocker 1976). Because no objective data exists concerning lion-dee relationships on range occupied by the Casa Diablo herd, one can only speculate as to the effects of lion predation on this population.

SUMMER RANGE

Provided the telemetered sample of deer is representative of the entire population and that herd size estimations are fairly accurate, 7 of the Casa Diablo herd summers on the east slope of the Sierra Nevada. Thus, about 1,100 animals occupy summer range east of the Sierra crest throughout south and west-central Mono County, between Mammoth Lakes and Bridgeport.

Telemetry data also indicate that nearly 70% of the Casa Diablo deer herd, some 1,000 animals, summer north of the original administrative boundaries established for the herd by DFG. Therefore, since most all bucks are harvested on the summer range, it is likely that buck kill totals compiled each year for the Casa Diablo herd do not represent the actual number of bucks harvested from the herd. This is supported by the fact that four ear tagged bucks were killed by hunters within the administrative boundaries of the Mono Lake herd. Had these deer not been marked, they would have been included as part of the total kill for the Mono Lake herd. Since the Casa Diablo and Mono Lake herds are thought to share summer range together, it virtually is impossible to determine the true buck harvest for each herd. Consequently, herd size estimations based in part on buck harvest figures become questionable.

Recent changes in buck harvest management strategies in Mono County by DFG has resulted in the split of hunting zone X-9 into zones X-9a and X-9b. Prior to this split, three and possibly four herds in Mono County occupied summer range within the boundaries designated for zone X-9. From telemetry data, it was possible to delineate distinct summer range boundaries for the Casa Diablo herd which were recognizable from those of the Sherwin herd to the south and the East Walker herd to the north. These delineations were used for the purpose of demarcating new zone boundaries which now allow DFG to manage the Casa Diablo and Mono Lake herds as one in zone X-9a.

Radio-collared deer exhibited strong fidelity to individual summer ranges. All occupied the same summer home range in 1987 as in 1986. Others, (Ashcraft 1961, Gruell and Papez 1963, Robinette 1963, Schneegas and Franklin 1972, Bertram 1984, Loft et al. 1984, Garrott et al. 1987), have also reported that deer consistently use the same specific summer range, winter range, and migration routes.

One radio-collared doe was found to shift home ranges after her original one was subjected to heavy use by domestic sheep. The summer home range of this particular doe originally was centered on a small riparian strip near the lower north end of Parker Bench. She arrived on this summer range on 1 May 1987 and was observed several times there until sheep entered the area on 2 July. She immediately abandoned this home range and moved approximately one mile west to an adjacent riparian strip where she remained for the rest of the summer. Similar shifts of home range resulting from destruction of food and cover have also been documented by Robinette (1966).

One other monitored doe which summered in Jeffrey pine habitat was found to shift her home range during early August for two consecutive years. She moved from her original summer home range, which was located i Jeffrey pine forest, to an area devoid of trees that consisted mainly of 1-1.5 m high bitterbrush and sagebrush. This dispersal was apparently don in order to establish a new home range with closer proximity to water an perhaps more adequate fawn hiding cover (Robinette (1966).

Deer occupying summer range in Jeffrey pine habitat had home range slightly larger than deer in other habitats. Again, this may be related t water and its proximity to forage and cover. Pumice soils associated wi h Jeffrey pine forest on the east side of the Sierra generally hold very little water. This is especially true of areas immediately south and east of Mono Lake, where two monitored does summered. These deer were observed to travel several km on a daily basis between feeding and resting, and watering locations.

Water is very likely a factor limiting deer distribution and numbers throughout much of the Jeffrey pine habitat type, especially after sprin growth has desiccated. It also may influence fawn survivability since fawns, which have a greater relative metabolic rate, probably are more sensitive to water deprivation and consequently succumb more quickly to this form of stress than do adult deer (Short 1981).

Undoubtedly, the major reason for deer from the Casa Diablo herd showing such affinity for the east slope of the Sierra Nevada is that it offers the best suitable habitat and conditions for fawning.
Aspen-riparian habitat was the type most often utilized by radio-collared does summering on the east slope of the Sierra. This type is preferred because dense understory vegetation provides important thermal and hiding cover, especially for fawns (Reynolds 1969, Loft et al. 1987). It also preferred because of its close proximity to water and the succulent forag which it provides (Kauffman and Krueger 1984, Loft et al. 1986).

It is estimated that riparian habitats encompass approximately 14,9 ha or 2% of all lands on the Inyo National Forest. Seventy percent of these riparian habitats (10,522 ha) are comprised of wet meadows above 2,440 m (USDA 1987). The fact that 93% of all radio-collared deer summering on the east slope of the Sierra utilized this habitat type, o which comprises a relatively small portion of the total summer range, may indicate that this type is actively selected for by deer.

Livestock grazing occurs on an annual basis throughout most state an federal lands on the east side of the Sierra. Sheep grazing is particularly prevalent throughout most east side summer range habitats occupied by the Casa Diablo deer herd. This is especially true of lands owned by the Los Angeles Department of Water and Power, which mostly are comprised of meadow and aspen-riparian habitats. Direct conflicts in the timing of sheep and deer use occur during both spring and summer periods i many aspen-riparian areas, especially on HA-II and other lands located on the east slope of the Sierra. In those aspen-riparian habitats that have received heavy sheep use on an annual basis, much of the understory vegetation has been severely reduced from grazing and trampling. This, in turn, has affected regeneration and survival of young trees (Loft et al. 1987).

RECOMMENDATIONS

Since seasonal habitats and migration routes utilized by the Casa Diablo deer herd have now been delineated, it is important to maintain and enhance, if possible, the quality of these areas in order to achieve herd management objectives outlined in the Casa Diablo Herd Management Plan (Thomas 1984). Therefore, to assist wildlife and habitat managers in this endeavor some general recommendations regarding habitat maintenance and manipulation of critical use areas are in order.

Holding areas are utilized for up to 6 weeks during both spring and fall migration and therefore efforts should be made to attain adequate high quality forage and cover during these times. Livestock grazing occurs on on all holding areas identified and the location and use periods of some allotments suggest the probability of conflict with deer, especially during spring migration. Thus, the timing and intensity of livestock grazing should be evaluated and provisions made which minimize competition for available forage.

Timber harvest and thinning can have beneficial effects on deer forage production by opening the canopy and stimulating herbaceous growth and browse production. However, thinning of Jeffrey pine forest has eliminated valuable hiding and escape cover, which appear to be of particular importance during the fall. Therefore, it is essential that dense stands of Jeffrey pine be maintained especially on fall holding areas where deer are dependent on this habitat type for cover.

A dense network of logging roads throughout most of the Jeffrey pine forest has reduced much of the effectiveness of this habitat type as hiding and escape cover by increasing accessibility and disturbance to deer. Thus, a program of road closure and rehabilitation is needed to improve habitat conditions and reduce human disturbance throughout areas impacted by past timber harvests.

Water is scarce and poorly distributed throughout much of the Casa Diablo winter range and portions of the summer range, especially in Jeffrey pine and Great Basin sagebrush habitats to the south and east of Mono Lake. As a result, deer use generally is restricted to favorable habitats near permanent water sources. In order to increase deer densities on a herd wide basis, a major management objective of the Casa Diablo herd, it is essential that permanent water sources be developed in unwatered areas. This can be achieved by improving existing water sources and establishing windmills and rainwater collectors, or "guzzlers" (Appendix Figures 7a, 7b, and 8).

Three radio-collared deer occupied summer range on the west side of the Sierra Nevada. These animals were provided access to their west side summer ranges by a migration corridor extending around the south slope of White-Wing Mountain and over San Joaquin Ridge. White Wing Mountain and San Joaquin Ridge have been proposed for nordic ski development in phases IV and V of the Mammoth-June Mountain Ski Area Development Plan. It is essential, if ski development is allowed to occur, that development be intelligently planned when considering the placement of proposed facilities within this migration corridor. Thus, it will be necessary to design studies that would gather more site-specific information regarding deer migration and summer use within areas of proposed ski development. It also is imperative that mitigation be designed that will limit human disturbances associated with such developments during migration periods. For example, this may entail reduction or complete cessation of ski area construction and maintenance activities until migration has been completed. It may also include stringent laws that help to prevent free roaming dogs, a typical problem associated with such developments, from harassing migrating deer.

Other areas of the Casa Diablo deer herd range are the subject of land use proposals which may impact deer habitat. A major geothermal powe plant has been proposed near the Inyo Craters. One such plant exists and several others are proposed for the Casa Diablo Hot Springs area. In addition, there is a proposal for a major resort complex on Doe Ridge near the Mammoth-June Lake Airport. Several hydropower projects exist or are proposed on drainages between June Lake and Bridgeport, some in critical deer habitat. This study has revealed that deer from the Casa Diablo herd use these areas as migration and summer habitats. The effects of these or other projects will depend on the number developed, and where and how they are developed. Therefore, in order to insure the welfare of the Casa Diablo herd it is imperative to evaluate the effects of land use projects on an individual and a cumulative basis.

Since the Casa Diablo and Mono Lake herds essentially have overlapping summer ranges, it may be biologically and administratively sound to designate these herds as one, e.g., the Mono Lake herd. Future telemetry research of the Mono Lake herd will further clarify this issue.

ACKNOWLEDGEMENTS

I gratefully acknowledge the help of the following individuals in this study: J. Davis, T. Russi, A. Lapp, T. Kucera, G. Mulcahy, D. Jones, T. Blankinship, V. Crittenden, D. Burger, B. Manning, pilots D. Landells and L. Goehring. This project was funded through the Calif. Deer Herd Management Plan Implementation Program under Contract 5C-1348, the Bureau of Land Manage., the Mono Cnty. Fines Comm., and the Sacramento Safari Club.

LITERATURE CITED

Anderson, F.M., G.E. Connelly, A.N. Halter and V.M. Longhurst. 1974. A computer simulation study of deer in Mendocino County, Calif Agric. Exp. Status Tech. Bull. 130. Corvallis: Oregon State Univ. 72 pp.

Ashcraft, G.C., Jr. 1961. Deer movements of the McCloud Flats herds. Calif. Fish and Game 47:145-152.

Beasom, S.L., W. Evans and L. Temple. 1980. The drive net for capturing western big game. J. Wildl Manage. 44(2):478-480.

Bertram, R.C., and R.D. Remple. 1977. Migration of the North Kings deer herd. Calif. Fish and Game 63:157-179.

______, 1984. North Kings deer herd study. Calif. Dept. of Fish and Game 203 pp.

Burt, W.H. 1943. Territoriality and home range concepts as applied to mammals. J. Mammal. 24:346-352.

Cheatum, E.L. 1949. Bone marrow as an index to malnutrition. New York Conservationist. 3:19-22.

Clover, M. R. 1956. Single-gate deer trap. Calif. Fish and Game 42:(3) 199-201.

Connolly, G.E. 1981. Limiting factors and population regulation, pp. 245-286 in O. C. Wallmo ed., Mule and black-tailed deer of North America. Univ. of Nebraska Press, Lincoln.

Dasmann, R.F., and R.D. Taber. 1956. Behavior of Columbian black-tailed deer with reference to population ecology. J. Mammal. 37:143-164.

Dasmann, W.P. 1981. Deer range improvement and management. McFarland and Co. Inc. 139 pp.

Dixon, J.S. 1934. A study of the life history and food habits of mule deer in California. Calif. Fish and Game 20:181-282.

Ffolliott, P.F., and W.P. Clary. 1972. A selected and annotated bibliography of understory-overstory vegetation relationships. Tech. Bull. 198, Agric. Exp. Sta., University of Arizona, Tucon. 33p.

Garrott, R.A., G.C. White, R.C. Bartmann, L.H. Carpenter, and A.W. Alldredge. 1987. Movements of female deer in northwest Colorado. J Wildl. Manage. 51(3):634-643.

Geist, V. 1981. Adaptive behavioral strategies, Pages 157-223 in O.C. Wallmo ed., Mule and black-tailed deer of North America. Univ. of Nebraska Press, Lincoln.

______, 1982. Adaptive behavioral strategies, Pages 219-277 in J.W. Thomas and D.E. Toweill ed., Elk of North America ecology and management. Stackpole books.

Gilbert, P.F., O.C. Wallmo, and R.B. Gill. 1970. Effect of snow depth on mule deer in Middle Park, Colorado. J. Wildl. Manage. 34:15-23.

Gruell, G.E., and N.J. Papez. 1963. Movements of mule deer in northeastern Nevada. J. Wildl. Manage. 27:414-422.

Harvey, J.J., and R.W. Barbour. 1965. Home ranges of Microtus ochrogaster as determined by a modified minimum area method. J. Mammal. 46:398-402.

Hornocker, M.C. 1976. The possible influence of the mountain lion on deer populations. Pages 107-109 in G.W. Workman and J.B. Low, eds. Mule deer decline in the west. A symposium. Utah State Univ., Agric Exp. Stn., Logan.

Julander, O., and J.B. Low. 1976. A historical account and present status of mule deer in the west. Pages 3-19 in G.W. Workman and J.B. Low, eds. Mule deer decline in the west. A symposium. Utah State Univ., Agric. Exp. Stn., Logan.

Kauffman, J.B., and W.C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications...a review. J. Range. Manage. 37:430-438.

Leopold, A.S., T. Riney, R. McCain, and L. Tevis Jr. 1951. The Jawbone deer herd. Calif. Fish and Game Bull. 4. 139 pp.

Loft, E.R., J.W. Menke, and T.S. Burton. 1984. Seasonal movements and summer habitats of female black-tailed deer. J.Wildl. Manage. 48(4) 1317-1325.

———, ———, and J.G Kie. 1986. Interaction of cattle and deer on mountain rangeland. J. Wildl. Manage. 48:1311-1316.

———, ———, ———, and R.C. Bertram. 1987. Influence of deer stocking rate on the structural profile of deer hiding cover. J. Wildl. Manage. 51(3):655-664.

Longhurst, W.M., E.O. Garton, H.F. Heady, and G.E. Connolly. 1976. The California deer decline and possibilities for restoration. Annu. Meet. West. Sect. Wildlife Society (Fresno, Calif.) 1976:74-103.

Moen, A.N. 1973. Wildlife ecology: An analytical approach. W.H. Freeman and Co., San Francisco. 485 p.

Pheleps, J.E. 1972. Introduction to conference. Page 1 in G.W. Workman and J.B. Low, eds. Mule deer decline in the west. A symposium. Utah State Univ., Agric. Exp. Stn., Logan.

Poole, D.A. 1976. An overview of big game management. Pages 76-70 in G.W. Workman and J.B. Low, eds. Mule deer decline in the west. A symposium. Utah State Univ., Agric. Exp. Stn., Logan.

Reynolds, H.G. 1969. Aspen grove use by deer, elk, and cattle in southwes coniferous forest. U.S. For. Serv. Res. Note RM-138. 4pp.

Robinette, W.L. 1966. Mule deer home range and dispersal in Utah. J. Wildl. Manage. 30:335-49.

Schneegas, E.R., and G.W. Franklin. 1972. The Mineral King deer herd. Calif. Fish and Game 58(2):133-140.

Short, H.L. 1981. Nutrition and metabolism, pp.99-127. In O.C. Wallmo ed., Mule and black-tailed deer of North America. Univ. Nebraska Press, Lincoln.

Sweeney, J.R., L.R. Marclinton. and J.M. Sweeney. 1971. Response of radic monitored white-tailed deer chased by hunting dogs. J. Wildl. Manage. 35(4):709-716.

Thomas, R.D. 1984. Casa Diablo deer herd management plan. Calif. Fish anc Game 53 pp.

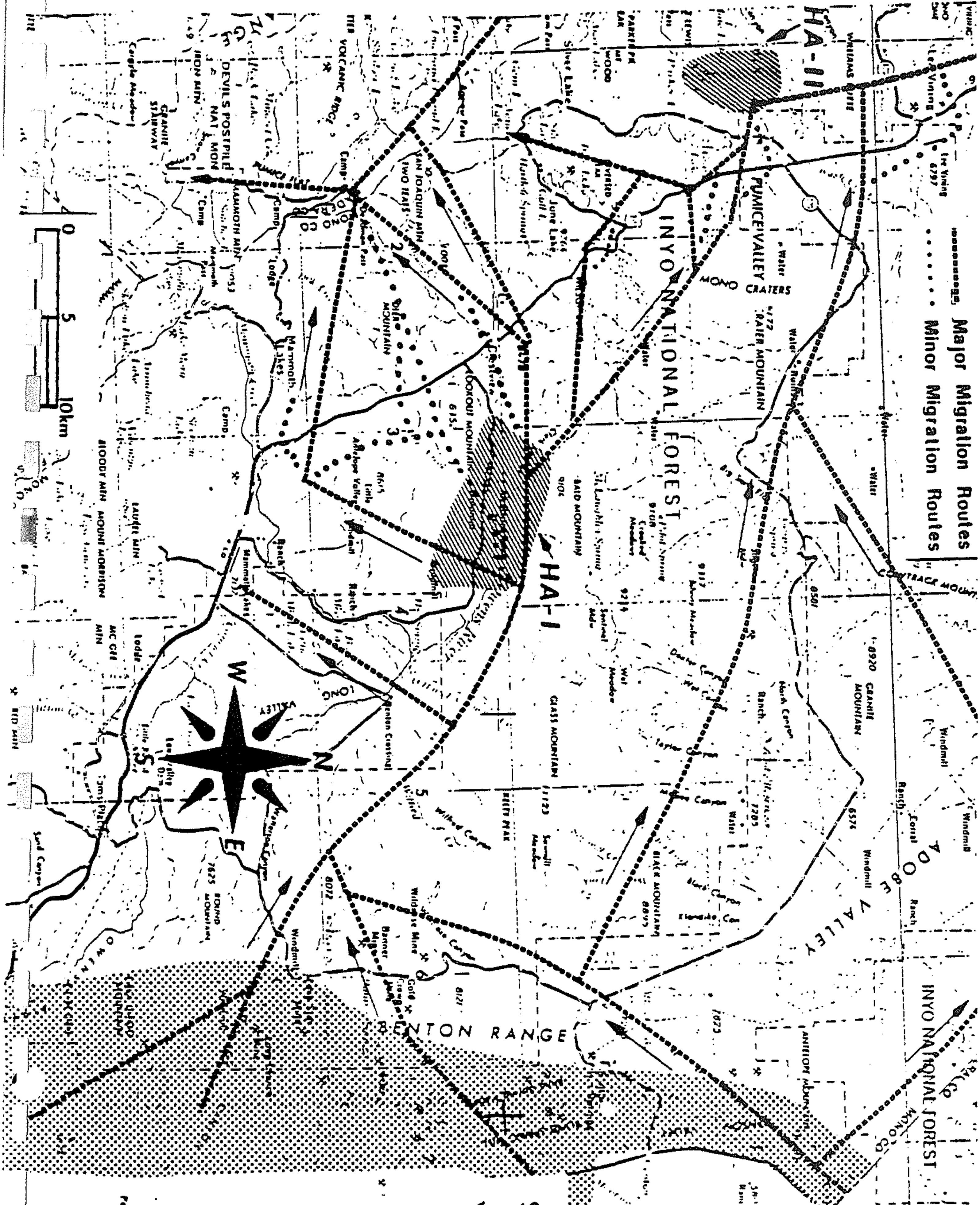
U.S.D.A., 1981. A classification of California vegetation. U.S. For. Serv., Regional Ecology Group, San Francisco CA. 168pp.

_____, 1987. Draft environmental impact statement. Forest land and resource management plan Inyo National Forest. 3:1-131.

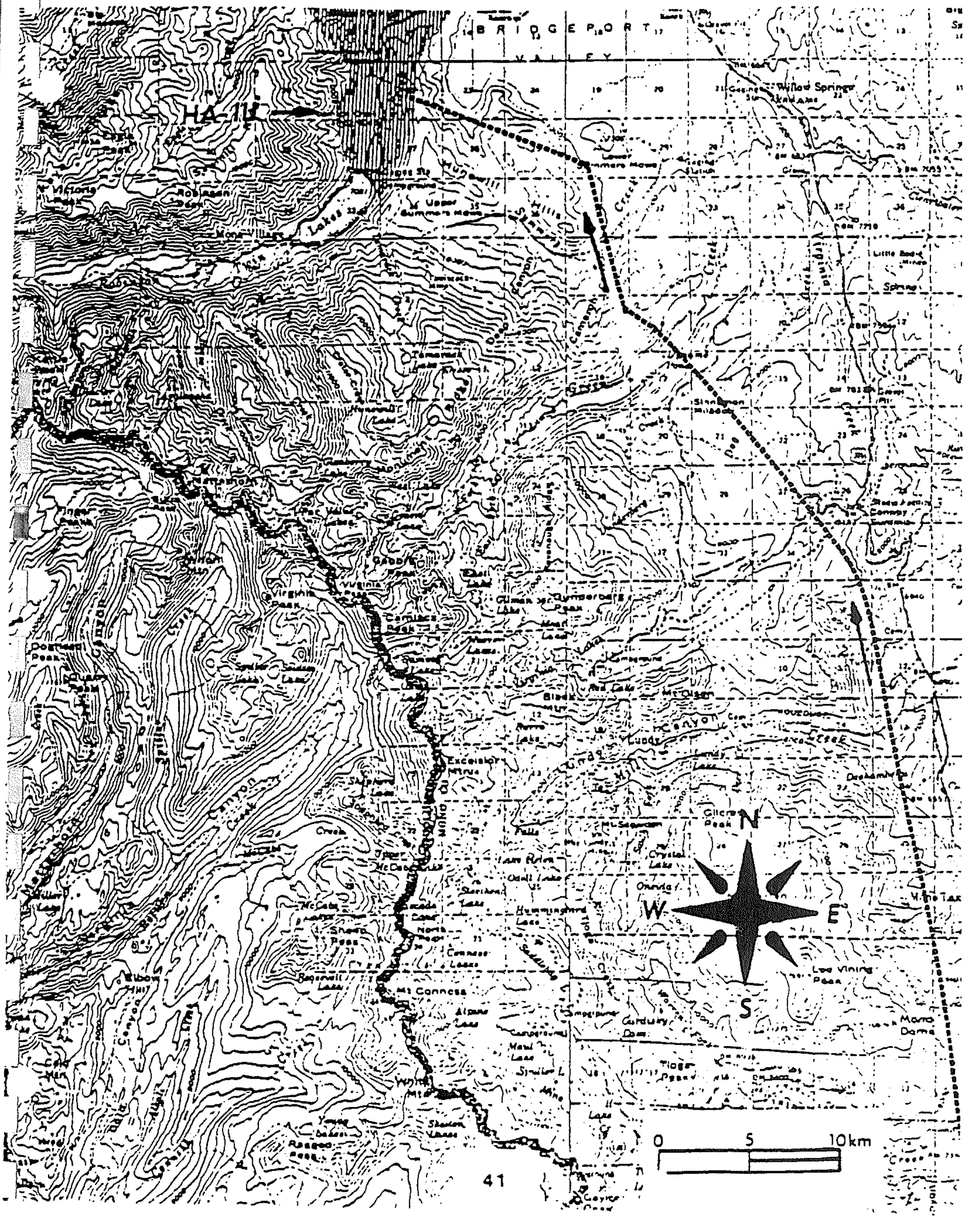
Wallmo, O.C., D.F. Reed, and L.H. Carpenter. 1976. Alteration of mule de habitat by wildfire, logging, highways, agriculture, and housing developments. Pages 37-47 in G.W. Workman and J.B. Low, eds. Mule deer decline in the west. A symposium. Utah State Univ., Agric. Exp. Stn., Logan.

_____, 1981. Mule and black-tailed deer distribution and habits. Pages 1-25 in O.C. Wallmo, ed. Mule and black-tailed deer of North America. Univ. Nebraska Press, Lincoln.

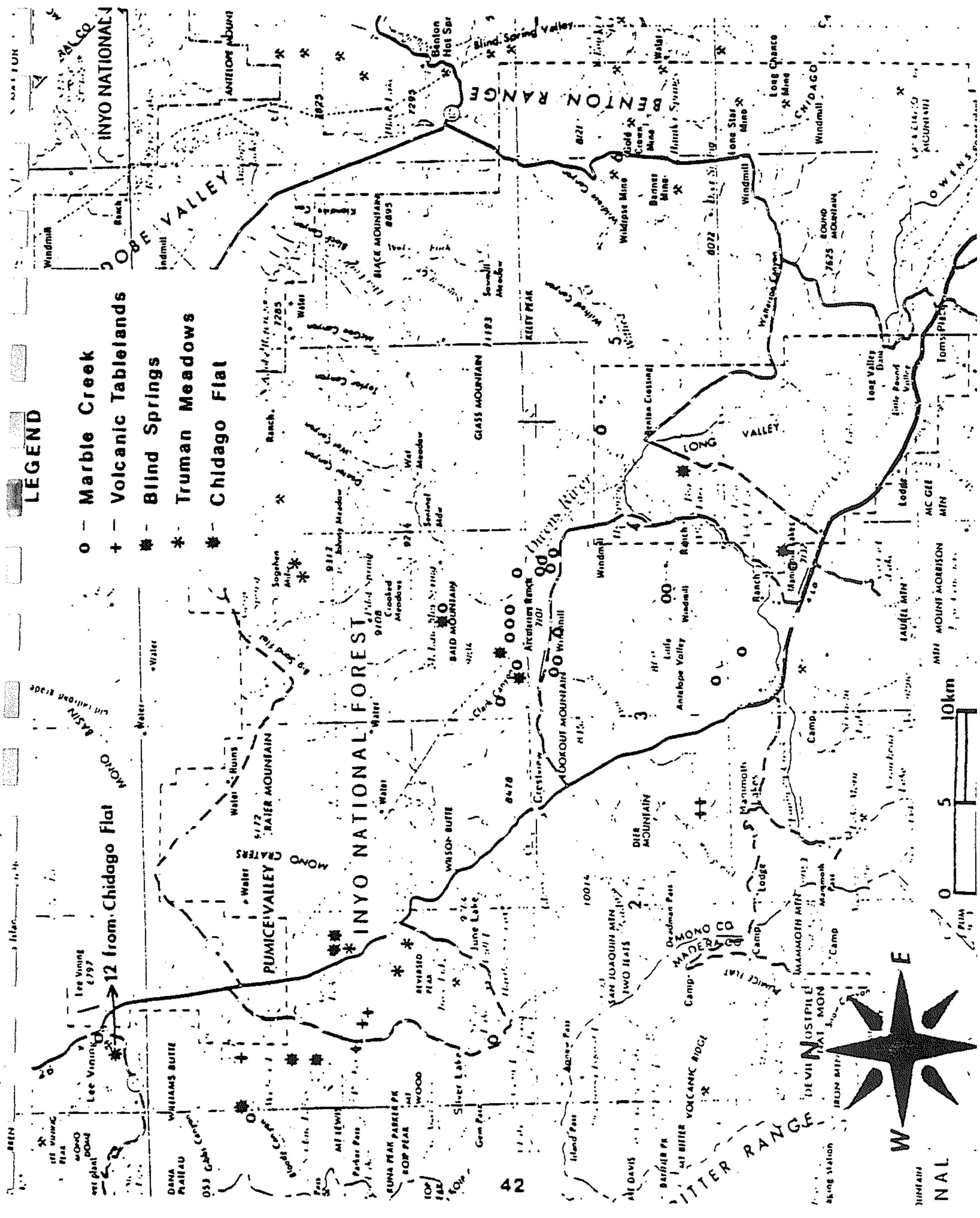
Appendix Figure 1a Locations of migration routes ... the Casa Diablo deer herd.



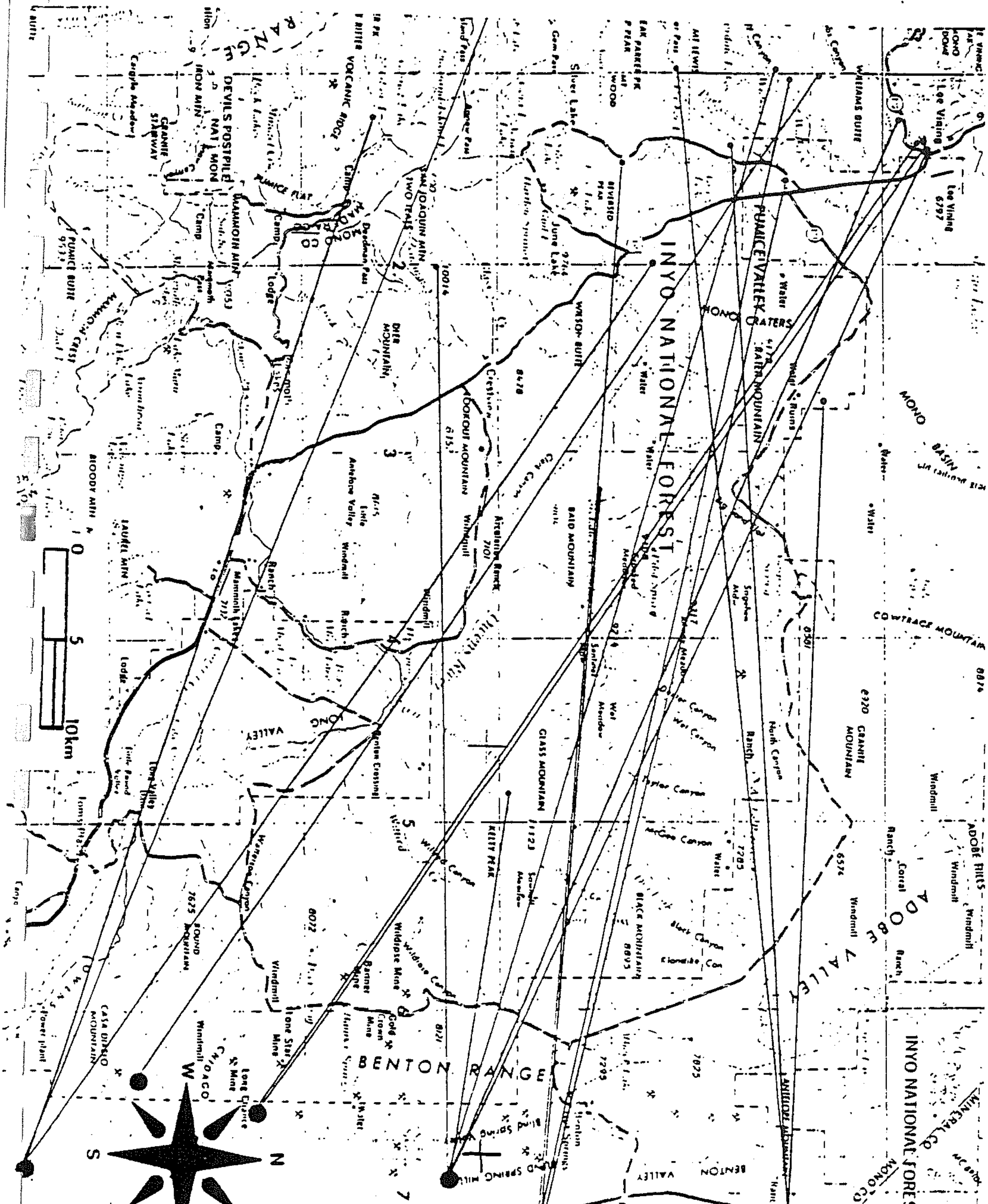
the Casa Diablo deer herd.



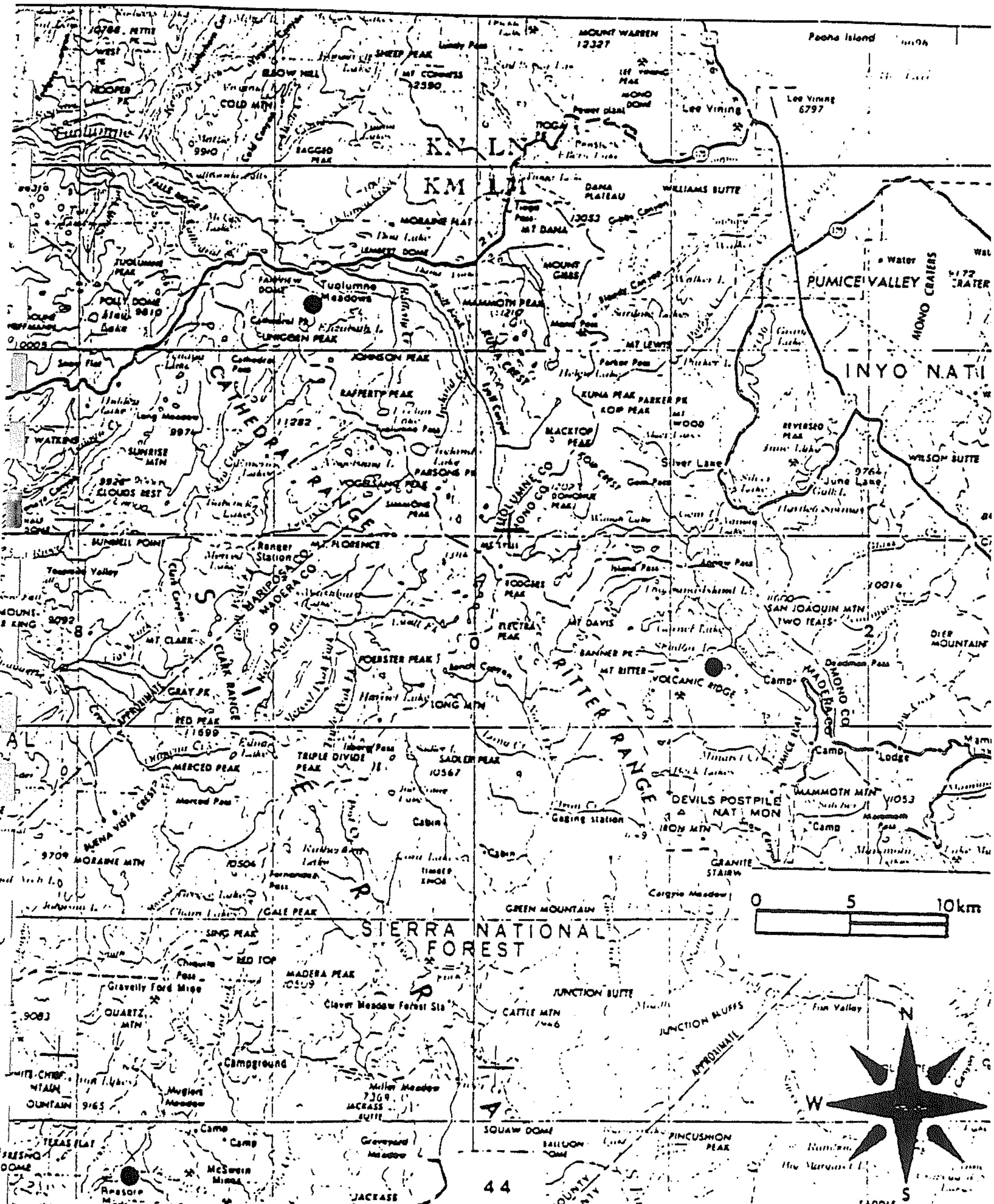
west of the Casa Diablo winter range during the spring and fall migrations of 1986 and 1987, and the summers of 1986 and 1987



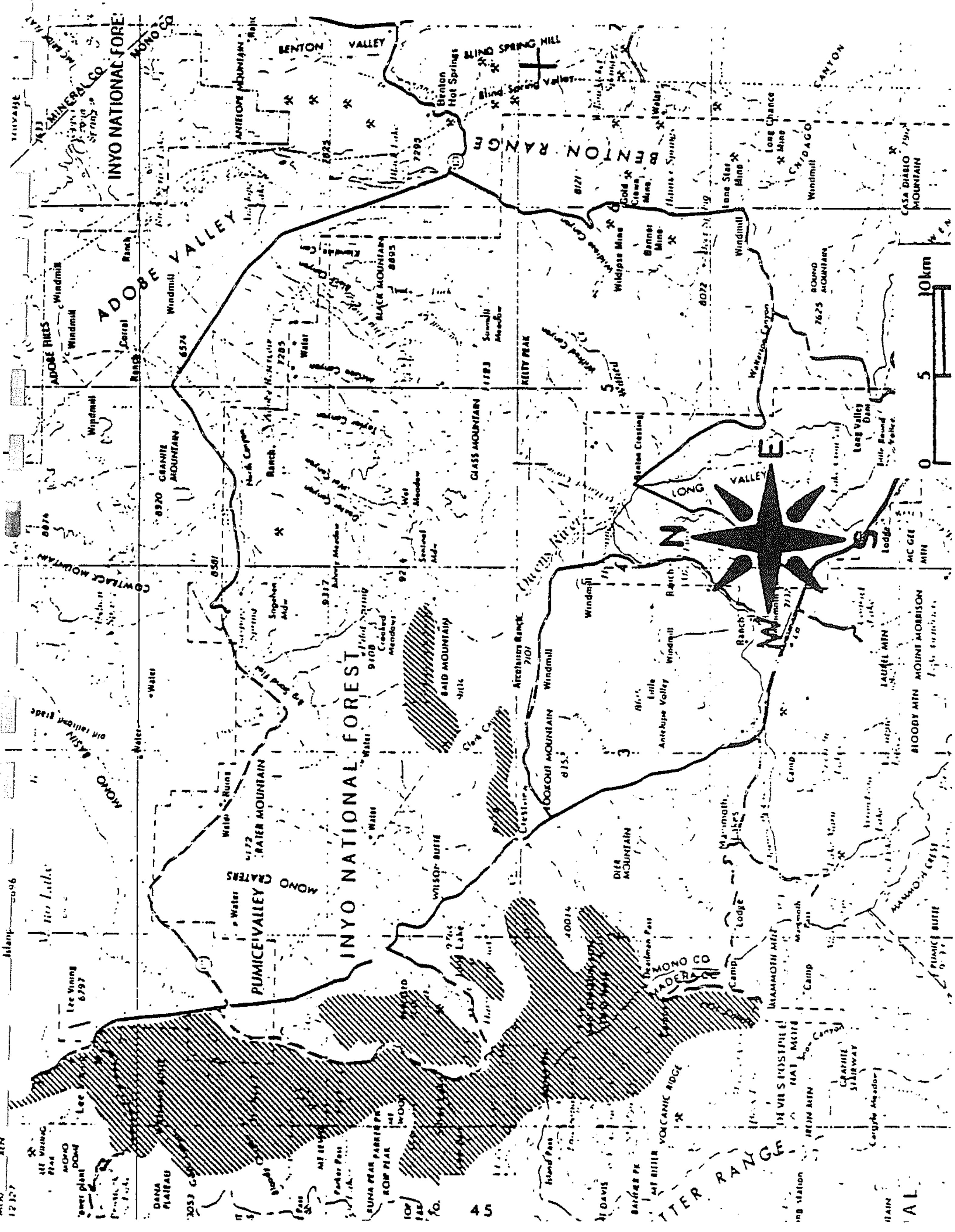
areas (large circles) and subsequently located on the summer range (small circles).



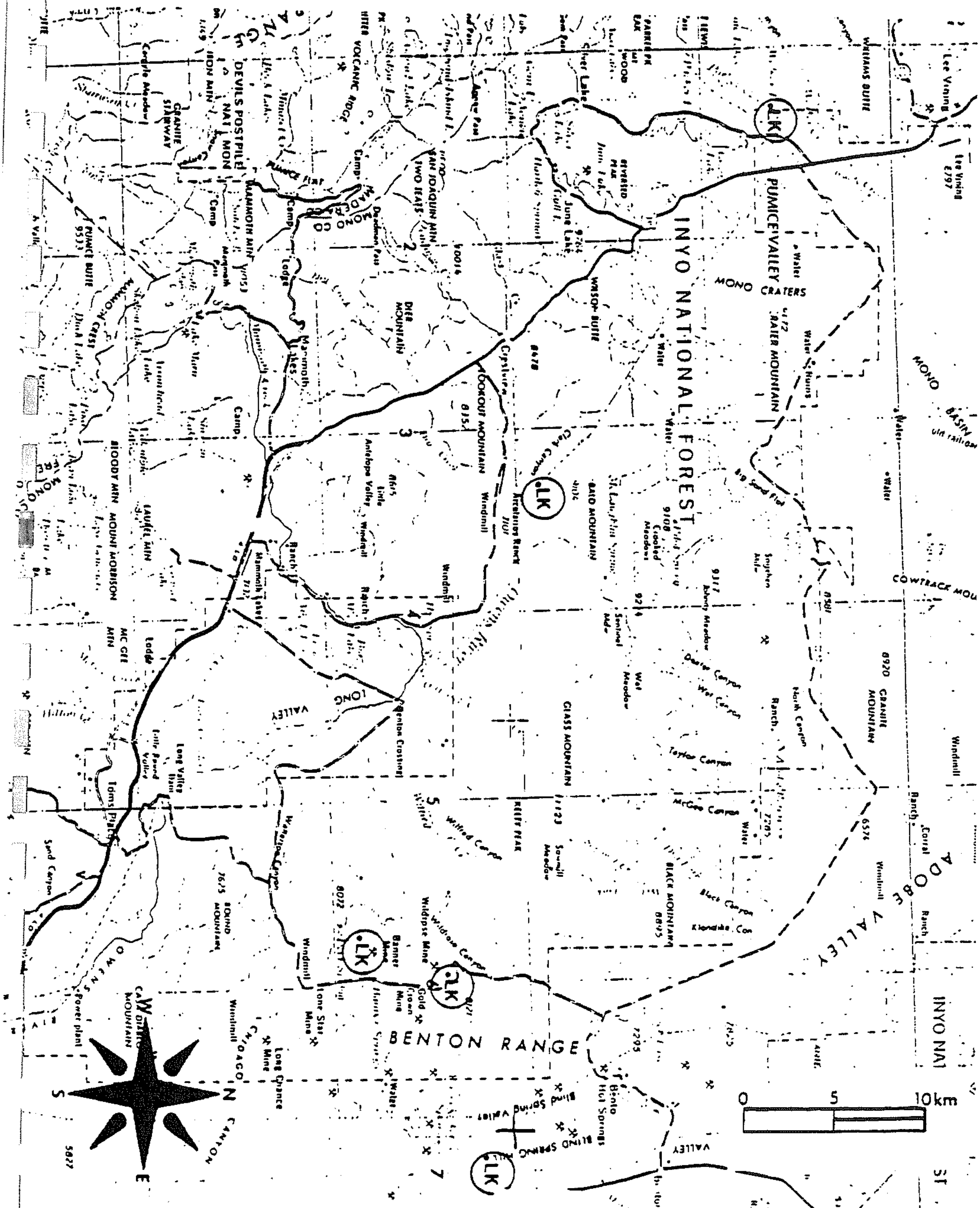
Appendix Figure 4 Summer range locations of three radio-collared does west of the Sierra crest, Casa Diablo deer herd.



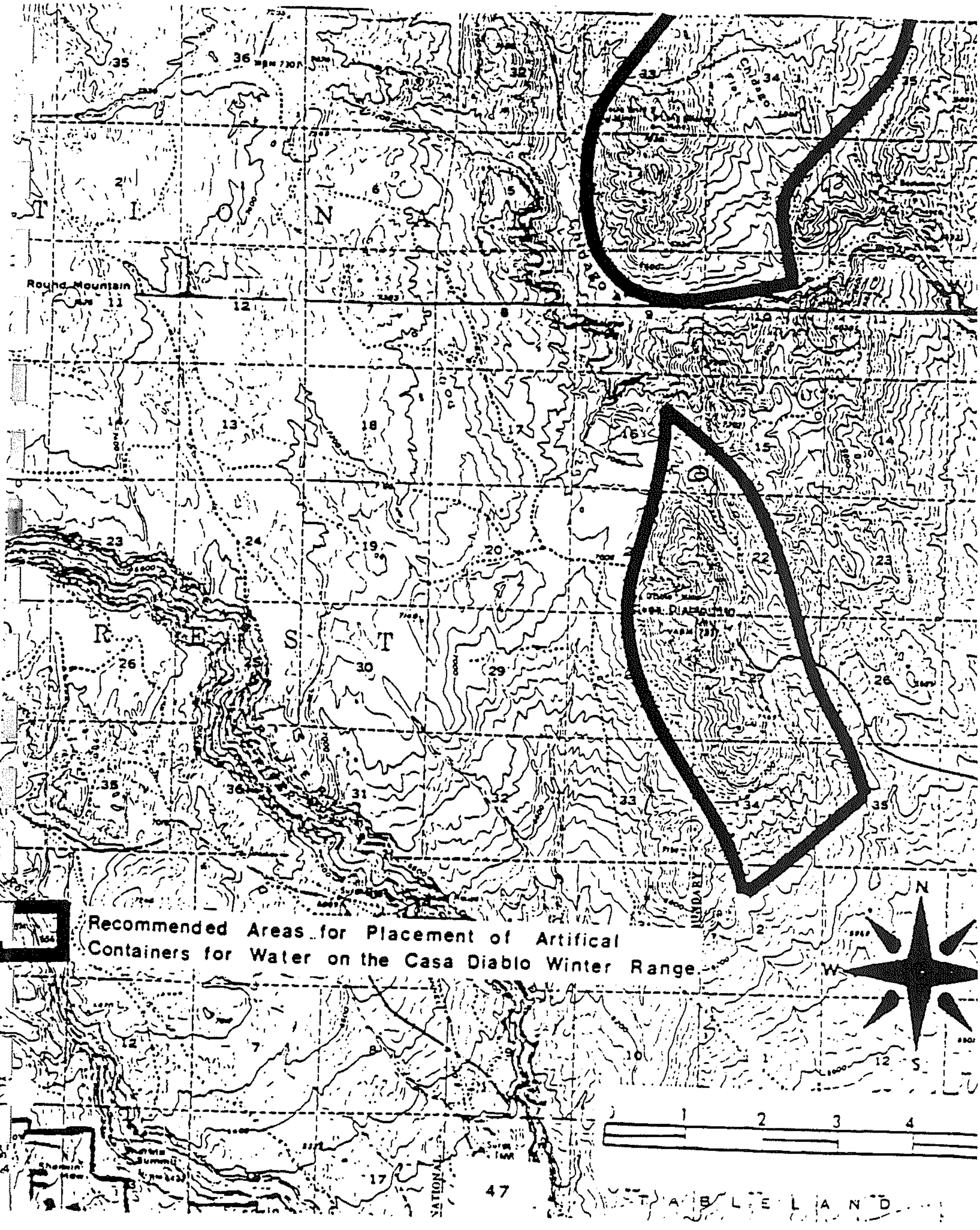
herd.


ADOBE VALLEY
BENTON VALLEY
BLIND SPRING HILL
Benton Hot Springs
Blind Spring Valley
BENTON RANGE
INYO NATIONAL FOREST
MINERAL CO
MONO CO
ANTELOPE MOUNTAIN
BLACK MOUNTAIN
GLASS MOUNTAIN
GRANITE MOUNTAIN
COWTRACK MOUNTAIN
KELTY PEAK
LONG VALLEY
Long Valley Dam
Benton Crossing
BALD MOUNTAIN
LOOKOUT MOUNTAIN
PUMICE VALLEY
MONO CRATERS
WILSON BUTTE
DEER MOUNTAIN
MONO BASIN
Lee Vining
Mammoth Lakes
MAMMOTH MTN
MAMMOTH CREST
LAUREL MTN
MOUNT MORRISON
BLOODY MTN
MC GEE MTN
ROUND MOUNTAIN
CASA DIABLO MOUNTAIN
CHIDAGO
CANYON
DEVILS POSTPILE
VOLCANIC RIDGE
DANA PLATEAU
10km
0
5
N
S
E

lions, Casa Diablo deer herd.

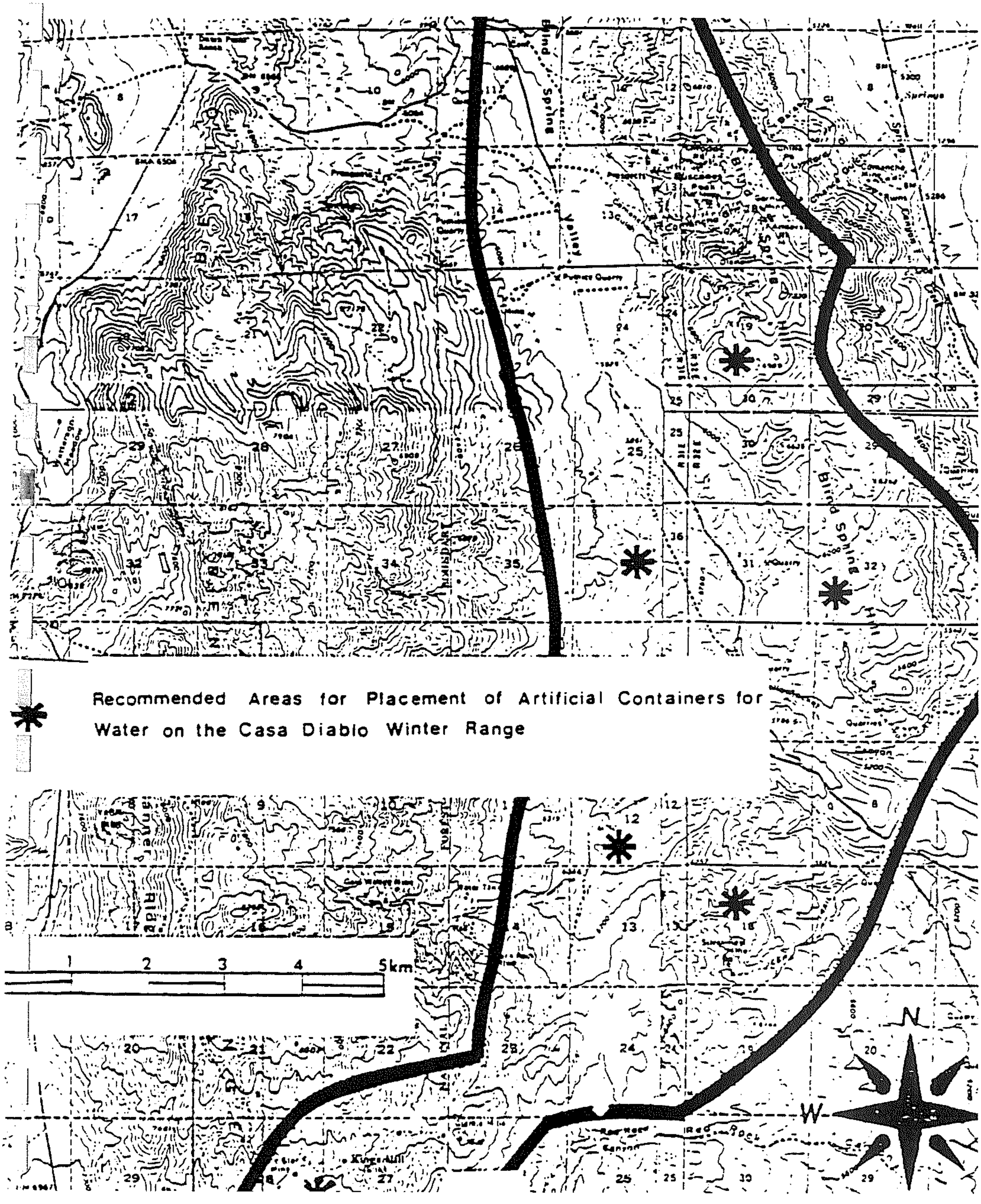


establishment of rainwater collectors and guzzlers necessary for providing permanent water.

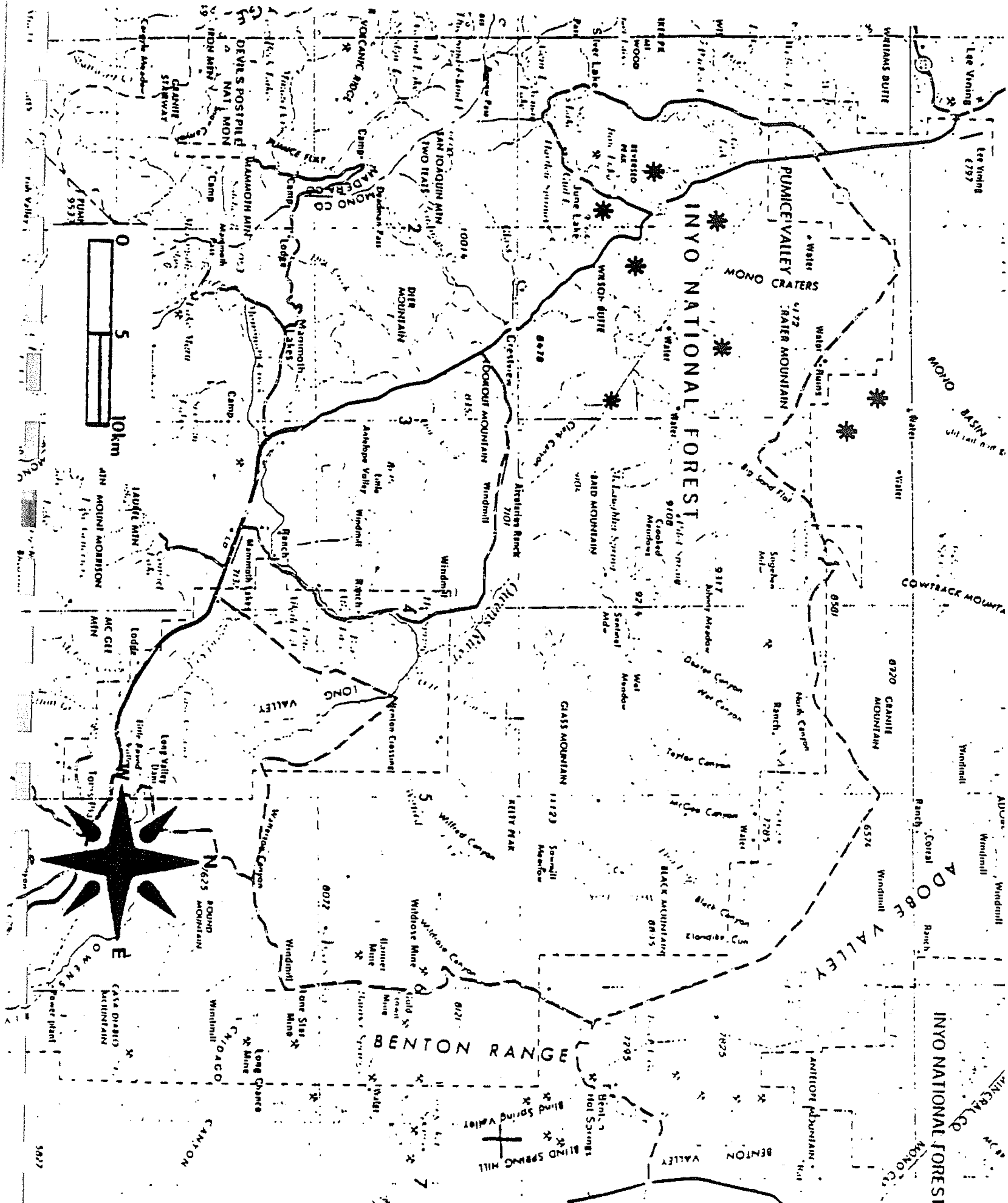


Recommended Areas for Placement of Artifical Containers for Water on the Casa Diablo Winter Range

Appendix Figure 7b   Recommended areas on the Casa Diablo winter range for establishment of rainwater collectors and guzzlers necessary for providing permanent water.



Appendix Figure 6 Recommended areas on the ... for establishment of rainwater collectors and guzzlers necessary for providing permanent water.



APPENDIX F

SCENARIO FOR CUMULATIVE DEVELOPMENT

APPENDIX F: SCENARIO FOR CUMULATIVE DEVELOPMENT

1. EXISTING DEVELOPMENT

The land use discussion in Chapter 3, Section 3.3.7.1.2, lists a number of developments in the Project vicinity which contribute to environmental impacts. Among the existing facilities, MP I is the only one which pumps from a geothermal reservoir. The Town of Mammoth Lakes, not specifically listed as a nearby land use in Chapter 3, has about 5,000 permanent residents and up to 30,000 inhabitants on a busy winter weekend. It is located about three miles west of the Project site.

2. REASONABLE FORESEEABLE DEVELOPMENT

2.1 GEOTHERMAL DEVELOPMENT

Three geothermal projects in addition to PLES I have been proposed on private lands in the project vicinity. They are:

Mammoth Pacific II & III: This project consists of two 12 MWe (net) geothermal projects under consideration for the Magma lease, immediately north of the PLES I site. Each plant would be similar to the Proposed Project.

Mammoth Chance Unit I: This project, currently under litigation after having been approved on appeal by the Mono County Board of Supervisors, is a 10 MWe (net) geothermal project near Mammoth Creek opposite Hot Creek Hatchery. It would have an air cooled binary power plant.

A number of people have suggested that there is a real threat of massive development of geothermal projects in Long Valley. This cumulative scenario does not anticipate such development for the following reasons.

The existing and proposed geothermal developments described above are tied to special sales contracts known as Standard Offer Number 4 contracts authorized under the Federal Public Utilities Regulatory Policies Act of 1978 (PURPA) and developed through the California Public Utility Commission (CPUC). PURPA and the CPUC require electrical utilities to purchase electricity from small producers such as Pacific Energy, holding such contracts for the price which the utility avoids by not having to build additional generating capacity. The basic purpose is to provide economic incentive to developers of alternative energy sources, such as geothermal, in order to broaden and diversify both the nation's and California's energy base and lessen our dependence on foreign oil. Most of the geothermal facilities proposed and/or built in California since 1983 have been tied to Standard Offer Number 4 contracts. In April 1985, however, CPUC suspended the issuance of new Standard Offer Number 4 contracts and development without the benefit of such a contract is not economic under existing and foreseeable energy prices, it is not expected that any new geothermal power plants will be proposed in the Long Valley area within the foreseeable future.

Exploration activities on Federal leases will continue at a very low level in the Mono-Long Valley area for the foreseeable future. Most of the issued leases in the area are committed to two Federal Unit Agreements, the Long Valley East Unit covering 35,036 acres in Lease Block #1 and the Inyo Domes Unit covering 12,947 acres in Lease Block #2, immediately west of Lease Block #1. The PLES I project is located within the Long Valley East Unit areas.

Unit agreements are legal contracts between lessees sharing a common exploration target and the BLM, for the orderly and timely exploration of the area. The unit operator is required to conduct exploration on a set schedule until a developable resource is discovered or until the operator determines that developable resources are not likely to be present. With the completion of the first PLES I production well, the exploration obligations for the Long Valley East Unit have been satisfied. With the exception of the Sandia Deep Hole, no further exploration wells, except of course those already proposed for the above listed projects, are expected to be drilled in the foreseeable future in the unit area.

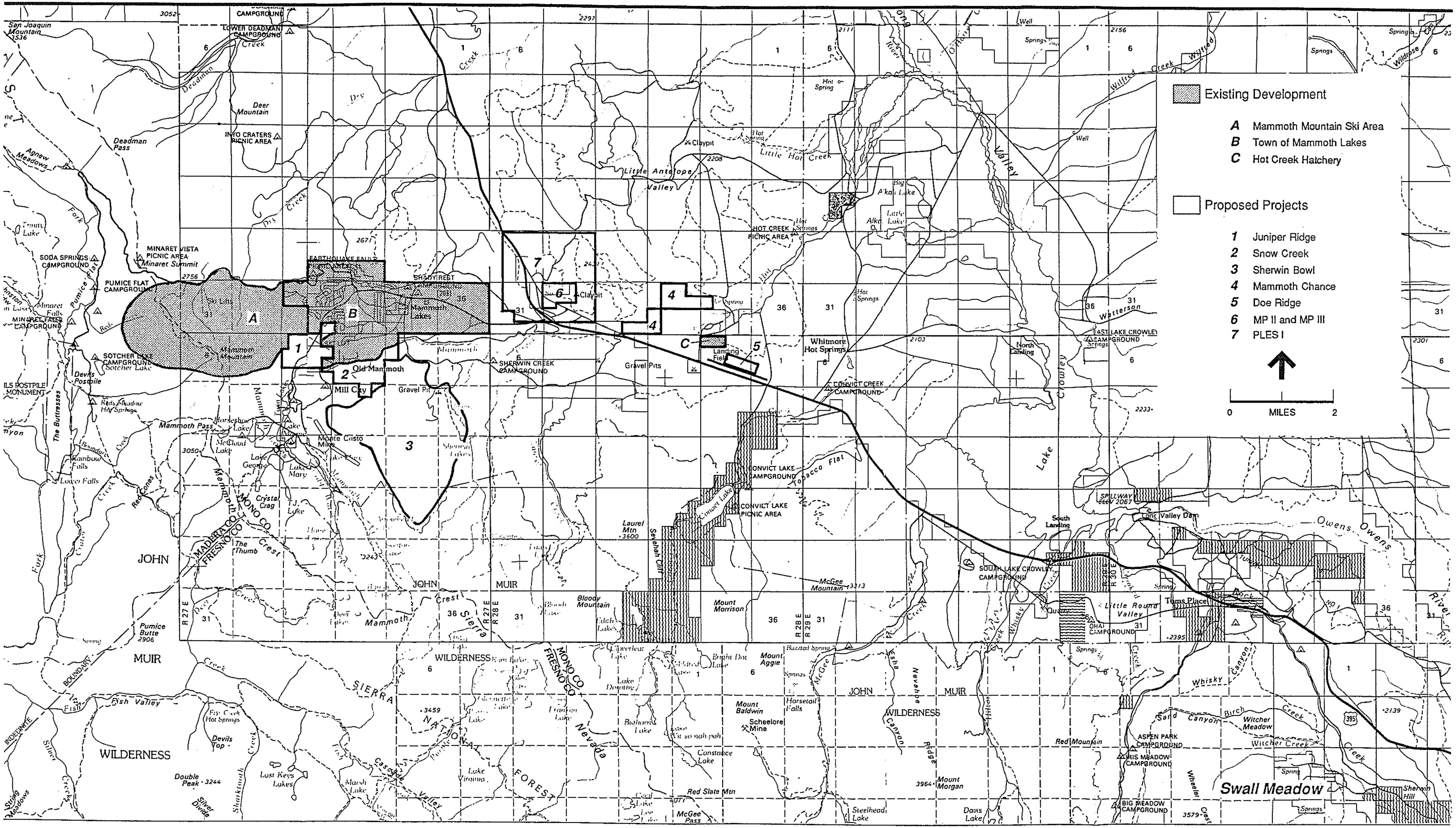
The unit operator for the Inyo Domes Unit has drilled one exploration well (#44-16) to date. Another well will be required to be drilled by August 1, 1988 unless an extension of that obligation is granted by BLM. If the next well is unsuccessful, it is unlikely that the unit operator will drill another well. In that case, the unit agreement would terminate and the lease terms would control development. There is no requirement to drill under the lease terms. Even if a successful well were completed, it is unlikely that foreseeable economic conditions in the energy industry would make it possible to propose a viable power project. In aid of this, the industry is supporting Congressional efforts to provide for extensions of geothermal leases precisely because of the unfavorable energy economic climate and their inability to develop geothermal resources economically. Most likely, the operator would retain the status quo on the lease and not drill additional wells until economic condition change. Therefore, two additional wells, outside the Sandia Deep Hole, are expected in the Mono-Long Valley area in the foreseeable future. No additional power plant proposals are expected.

2.2 NON-GEOTHERMAL PROJECTS

Several proposals for recreational and commercial development near Mammoth Lakes have recently been announced. They include plans for expansion of existing, and development of new, downhill ski facilities, construction of several golf courses, hotels, restaurants, condominium developments, and shops. Not all the rumored projects will necessarily be built, and not all are appropriate for discussion in this document; so, in consultation with the Bureau of Land Management-Bishop Resource Area, Inyo National Forest, Mono County Planning Department, and the Mono County Office of Energy Management, the following list of relevant development projects was identified. Discussion of the cumulative impacts within each environmental resource section is limited to specifically identified projects from the following list which could contribute to a given cumulative impact with respect to the PLES I Project. The locations of the projects, listed below, are shown in Figure F-1. They are:

<u>Doe Ridge</u>: Airport expansion, construction of a hotel, and a golf course have been proposed for the airport area and the ridge east of the airport. Water use at the project has been estimated at 760 cfs.

<u>Sherwin Bowl</u>: Located immediately south of the Town of Mammoth Lakes, this downhill ski area development would include lifts and all appertenant facilities.



SOURCE: ESA, Inc., 1988

FIGURE F-1
Regional Map for Cumulative Analyses

Snow Creek: This project would be located in Mammoth Meadow, between Sherwin Bowl and the developed part of the Town of Mammoth Lakes. It would include a golf course, hotels, condominiums, restaurants, and a convention facility.

Juniper Ridge: This project, located between Mammoth Mountain and the Town of Mammoth Lakes, would expand the facilities associated with Mammoth Mountain skiing. It would include a hotel, condominiums, a ski lodge, and commercial space.

Town of Mammoth Lakes Projects: Golf Course; Mammoth Water District Water Project; and Economic Development Corporation plans for Industrial Center at Old Mammoth School.

3. CUMULATIVE ISSUES DISMISSED

The following projects were evaluated in the cumulative impact assessment in this document; however, for the reason identified for each project, it was determined to be inappropriate to analyze the potential cumulative hydrologic impacts from these projects with respect to the proposed PLES I project.

3.1 UNOCAL AND SANTA FE POWER PLAN PROJECTS

Neither Unocal nor Santa Fe has announced any plans to construct a power plant using geothermal fluid in the near future and exploration efforts have ceased. No power contracts are likely to be available within the next few years, and startup would not occur until at least five years after that. Therefore, it would be unreasonable, particularly without reservoir data in those lease areas, to assume project size production, temperatures depths, flowrates, and time scale for the purpose of estimating cumulative impacts.

3.2 TOWN OF MAMMOTH LAKES GEOTHERMAL DISTRICT HEATING PROJECT

Though the town appears likely to receive appropriate funding for such a project and has acquired significant exploration data, deeper drilling would be required to reach fluids with appropriate temperatures. For such a project, both temperature and available fluid are related and required design parameters. The scale (i.e., project size and flow required) of an initial test phase project is dependent upon a number of other factors such as production and injection well locations, realistic demand and growth potential, and users available within a suitable radius of the projection wells. Many of these would be pure guesswork at this time and without sound bases to use in calculating hydrologic impacts. It is possible that a pilot project startup could occur within five years, but the flowrate of geothermal fluid would be orders of magnitude less than required for a 10 MW power plant.

3.3 TOWN OF MAMMOTH LAKES WATER SUPPLY WELLS AND GOLF COURSE

These projects are not included in the cumulative hydrologic analysis for three reasons: 1) Neither project has specific criteria for actual use; and 2) the PLES I project would not draw a significant amount of shallow fresh water relative to these projects; and 3) The PLES I project is not believed to produce from the same aquifers. It is not appropriate to attempt an analysis without some evidence of hydraulic communication between them. The shallow groundwater use at Casa Diablo is specifically for fire protection and landscaping only. Much of the irrigation water will likely return to the same groundwater source. See Chapter 2 on proposed use and Chapter 4 on effects.

There is some speculation that the town water wells in question generate the freshwater aquifer supplying Hot Creek Hatchery springs. If both freshwater and thermal components were influenced by one or more projects some combined effect on the springs is possible. However, such theories are not supported by data since hydraulic communication between any of the three features is not established. Further, attempts to quantify the potential for cumulative impacts would be impossible in the absence of such data.

APPENDIX G

GRO ORDER NUMBER 4:

GENERAL ENVIRONMENTAL PROTECTION REQUIREMENTS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 4

Effective August 1, 1975

GENERAL ENVIRONMENTAL PROTECTION REQUIREMENTS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.2, 270.34(k), 270.37, 270.41, 270.42, 270.43, 270.44, and 270.76. Lessees shall comply with the provisions of this Order. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. References in this Order to approvals, determinations, or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representative.

All data submitted under this Order shall be available for inspection in accordance with the Freedom of Information Act of 1966 (P.L. 89-487), as amended in 1974 (P.L. 93-502), except information such as geological, geophysical, reservoir, trade secrets, and financial data and interpretations of such data, maps, and related files for which a lessee requests proprietary status; provided that such status is determined by the Supervisor to be warranted and is approved by appropriate officials of the Department of the Interior.

Protection of the environment includes the lessee's responsibility to: conduct exploration and development operations in a manner that provides maximum protection of the environment; rehabilitate disturbed lands; take all necessary precautions to protect the public health and safety; and conduct operations in accordance with the spirit and objectives of all applicable Federal environmental legislation and supporting executive orders.

Adverse environmental impacts from geothermal-related activity shall be prevented or mitigated through enforcement of applicable Federal, State, and local standards, and the application of existing technology. Inability to meet these environmental standards or continued violation of environmental standards due to operations of the lessee, after notification, may be construed as grounds for the Supervisor to order a suspension of operations.

The lessee shall be responsible for the monitoring of readily identifiable localized environmental impacts associated with specific activities that are under the control of the lessee. Monitoring of environmental impacts may be conducted by the use of aerial surveys, inspections, periodic samplings, continuous recordings, or by such other means or methods as required by the Supervisor. Due to the differing natural environmental conditions among geothermal areas, the extent and frequency of such monitoring activities will be determined by the Supervisor on an individual basis. In the event the Supervisor determines that the degree and adequacy of existing environmental protection regulations in certain areas are insufficient, the Supervisor may establish additional and more stringent requirements by the issuance of field orders or by modifying existing orders.

Lessees shall provide for acquisition of environmental baseline data as required in accordance with 30 CFR 270.34(k) for a period of one year prior to submission of a plan for production. Techniques and standards to be used by the lessee for meeting these requirements shall receive prior approval by the Supervisor.

1. Aesthetics. The lessee shall reduce visual impact, where feasible, by the careful selection of sites for operations and facilities on leased lands. The design and construction of facilities shall be conducted in a manner such that the facilities will blend into the natural environmental setting of the area by the appropriate use of landscaping, vegetation, compatible color schemes, and minimum profiles. Native plants or other compatible vegetation shall be used, where possible, for landscaping and revegetation.

2. Land Use and Reclamation. Operating plans shall be designed so that operations will result in the least disturbance of land, water, and vegetation. Existing roads shall be used where suitable. Entry upon certain environmentally fragile land areas, as designated by the surface management agency, may be either seasonally restricted or restricted to special vehicles or transportation methods which will minimize disturbance to the surface or other resources as specified by the Supervisor and surface management agency.

Operating plans shall provide for the reclamation and revegetation of all disturbed lands in a manner approved by the Supervisor and the appropriate surface management agency. Land reclamation may include preparation and seeding with prescribed wildlife food and plant cover or improved and acceptable substitutes thereof which will equal or enhance the food values for indigenous wildlife species and domesticated animals. Temporary fencing for such reclaimed areas may be required to facilitate restoration thereof.

The lessee shall at all times maintain the leased lands in a safe and orderly condition and shall perform the operations in a workmanlike manner. The lessee shall remove or store all supplies, equipment, and scrap in a timely and orderly fashion.

Operations under a geothermal lease shall not unreasonably interfere with or endanger operations under any other lease, license, claim, permit, or other authorized use on the same lands.

3. Public Access. The public shall have free and unrestricted access to geothermal leased lands, excepting however, where restrictions are necessary to protect public health and safety or where such public access would unduly interfere with the lessee's operations or the security thereof. The lessee shall provide warning signs, fencing, flagmen, barricades, or other safety measures deemed necessary by the Supervisor to protect the public, wildlife, and livestock from hazardous geothermal or related activities.

4. Recreation. Recreational values shall be adequately protected through planning and designing of site development to minimize the aesthetic degradation of the particular recreation area. The lessee shall generally be restricted from surface locations for drilling and other lease operations within 61 metres (200 feet) of established recreation sites and access routes thereto. However, the lessee may relocate a recreational site and/or access routes thereto when approved by the Supervisor with the concurrence of the land management agency.

5. Slope Stability and Erosion Control. Operations shall be conducted in such a manner so as to minimize erosion and disturbance to natural drainage. The lessee shall provide adequate erosion and drainage control to prevent sediments from disturbed sites from entering water courses for soil and natural resource conservation protection.

Mitigating measures to lessen environmental damage may include reseeding of disturbed soils, chemical stabilization, and dust and erosion control on well sites, roads, and construction areas.

All operating plans shall give proper consideration to the potential hazards of slope instability. Where potentially unstable ground conditions exist, design of proposed roads, drill sites, and surface facilities shall be approved by and constructed under the supervision of a qualified engineer or engineering geologist satisfactory to the Supervisor.

6. Biota. The lessee shall conduct all operations in such a manner as to afford reasonable protection of fish, wildlife, and natural habitat. The lessee shall take such measures as are necessary for the conservation of endangered and threatened species of flora and fauna as set forth in applicable executive orders, regulations, and State or Federal legislation such as the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. When such species would be adversely affected by the lessee's operations on the leased lands, the lessee shall implement those measures necessary to minimize or eliminate such adverse effects and to protect the flora and fauna as specified by the Supervisor in accordance with recommendations by appropriate Federal and State agencies. Such measures may be in addition to provisions set forth in the lease or accompanying stipulations.

The Supervisor may receive information from recognized experts that a delicate balance of flora and/or fauna exists in the area of operations or proposed operations. Upon receiving such notice, the Supervisor will request timely advice and assistance from appropriate Federal and State agencies regarding: (1) an assessment of the status of flora and fauna in the area which may be adversely affected by operations, and (2) advice as to reasonable mitigating measures appropriate to minimizing or preventing adverse trends in populations, growth, vegetative recovery, or repopulations in potentially affected flora and/or fauna. Based on timely receipt of advice from appropriate agencies, the Supervisor will direct the lessee to take appropriate measures to minimize significant adverse trends in flora and fauna. Such measures may include, but not be limited to, revegetation with grasses, shrubs, or other vegetation of high forage values desirable for habitat, replacement of fauna where lost, replacement of water supply, or sources where destroyed.

Where the lessee's operations have destroyed significant flora and/or fauna or their natural habitat and replacement by natural processes will not take place in a normal growth cycle, the lessee shall take reasonable measures to replace those species or their habitat with the same or other acceptable species or habitat as directed by the Supervisor. The Supervisor's requirements shall be based on recommendations and advice received from appropriate Federal and State agencies.

7. Cultural Resources Preservation. The lessee shall exercise due diligence in the conduct of his operations to protect and preserve significant archaeological, historical, cultural, paleontological, and unique geologic sites. The lessee shall not disturb any known cemetery or burial ground of any group or culture.

Previously unknown sites uncovered by the lessee shall be immediately reported to the Supervisor, and operations on the particular site shall cease until said site can be assessed for its archaeological value and preservation. Necessary controls and remedial actions for the protection and preservation of cultural resources shall be issued on an individual site basis by the Supervisor as warranted.

The preservation, restoration, maintenance, and nomination of all resources for purposes of the National Register of Historic Places shall be in accordance with the provisions of Executive Order 11593 (36 FR 8921) entitled, "Protection and Enhancement of the Cultural Environment," or any amendments thereto.

8. Subsidence and Seismicity. Surveying of the land surface prior to and during geothermal resources production will be required for determining any changes in elevation of the leased lands. Lessees shall make such resurveys as required by the Supervisor to ascertain if subsidence is occurring. Production data, pressures, reinjection rates, and volumes shall be accurately recorded and filed monthly with the Supervisor as provided in 30 CFR 270.37. In the event subsidence activity results from the production of geothermal resources, as determined by surveys by the lessee or a governmental body, the lessee shall take such mitigating actions as are required by the lease terms and by the Supervisor.

If subsidence is determined by the Supervisor to present a significant hazard to operations or adjoining land use, then the Supervisor may require remedial action including, but not limited to, reduced production rates, increased injection of waste or other fluids, or a suspension of production.

A. Surveys. All required surveys shall be second order or better and shall be conducted under the direct supervision of a registered civil engineer or licensed land surveyor using equipment acceptable by the National Ocean Survey for second order surveys. All such work shall be coordinated with the county surveyor of the county in which the surveys and bench marks are to be established. Level lines and networks shall be tied to available regional networks.

Adjusted survey data shall be filed with the Supervisor within 60 days after leveling is completed. Any lessee having a commercially productive geothermal well or wells shall participate in cooperative County/State subsidence detection programs. All survey data filed with the Supervisor shall be available to the public.

B. Bench Marks. One or more wellsite bench marks shall be required at each completed well prior to prolonged production and said bench marks shall be located in a manner such that there is a minimal probability of destruction or damage to said bench marks. Wellsite bench marks shall be tied to existing regional networks. Additional bench marks between the wellsites and the regional network shall be at 0.8-km (one-half mile) intervals or as otherwise specified by the Supervisor. These bench marks shall be resurveyed during well production operations on a periodic basis as determined by the Supervisor.

Acceptable bench marks include, but are not limited to, a brass rod driven to refusal or 9 metres (about 30 feet) and fitted with an acceptable brass plate or a permanent structure with an installed acceptable brass plate.

C. Reservoir Data. Initial reservoir pressure and temperature shall be reported to the Supervisor in duplicate on Well Completion or Recompletion Report (Form 9-330C) for all completed wells within 30 days after the completion of measurements or tests conducted for the purpose of obtaining such data. Initial production test data including steamwater ratio, surface pressure and temperature, quality, and quantity of well effluent shall also be filed with the Supervisor on Form 9-330C within 30 days after a well is completed.

D. Seismicity. The installation of seismographs or other like instruments in producing geothermal areas for the purpose of detecting potential seismic activity may be initiated from time to time by appropriate public agencies. Lessees shall cooperate with the appropriate public agencies in this regard. The lessee and the appropriate public agency should take care not to unreasonably interfere with or endanger each other's respective operations. The Supervisor shall coordinate such detection programs between the appropriate public agency conducting the program and the lessee.

Where induced seismicity caused by the production of geothermal fluids is determined to exist by the Supervisor, then the Supervisor may require the lessee to install such monitoring devices as necessary to adequately quantify the effects thereof. If induced seismicity is determined to represent a significant hazard, the Supervisor may require remedial actions including, but not limited to, reduced production rates, increased injection of waste or other fluids, or suspension of production.

9. Pollution, Waste Disposal, and Fire Prevention. The lessee shall comply with all applicable Federal and State standards with respect to the control of all forms of air, land, water, and noise pollution, including the control of erosion and the disposal of liquid, solid, and gaseous wastes. The Supervisor may, at his discretion, establish additional and more stringent standards. Plans for disposal of well effluents must be approved by the Supervisor before any implementation action is undertaken. Immediate corrective action shall be taken in all cases where pollution has occurred.

The lessee shall timely remove or dispose of all waste including human waste, trash, refuse, and extraction and processing waste generated in connection with the lessee's operations in a manner acceptable to the Supervisor.

The lessee shall provide safeguards to minimize potential accidental fires and shall instruct field personnel in fire-prevention methods. The lessee shall maintain fire-fighting equipment in working order at strategic locations on the leased lands.

A. Pollution Prevention. In the conduct of all geothermal operations, the lessee shall not contaminate any natural waters and shall minimize adverse effects on the environment.

(1) Liquid Disposal. Liquid well effluent or the liquid residue thereof containing substances, including heat, which may be harmful or injurious and cannot otherwise be disposed of in conformance with Federal, State, and regional standards, shall be injected into the geothermal resources zone or such other formation as is approved by the Supervisor.

Toxic drilling fluids shall be disposed of in a manner approved by the Supervisor and in conformance with applicable Federal, State, and regional standards.

(2) Solid Waste Disposal. Drill cuttings, sand, precipitates, and other solids shall be disposed of as directed by the Supervisor either on location or at other approved disposal sites. Containers for mud additives for chemicals and other solid waste materials shall be disposed of in a manner and place approved by the Supervisor.

(3) Air Quality. Noncondensible gases such as carbon dioxide, ammonia, and hydrogen sulfide may be vented or ejected into the atmosphere, provided, however, that the volume and the measured concentration of such vented gas or gases shall not exceed applicable Federal, State, or regional air pollution standards. Copies of each permit issued by the appropriate air pollution control agency and the reports required thereunder shall be submitted to the Supervisor.

(4) Pits and Sumps. Pits and sumps shall be lined with impervious material and purged of environmentally harmful chemicals and precipitates before backfilling. In no event shall the contents of a pit or sump be allowed to contaminate streams, lakes, and ground waters. Pits and sumps shall be constructed in a manner and in such locations so as to minimize damage to the natural environment and aesthetic values of the lease or adjacent property. When no longer used or useful, pits and sumps shall be backfilled and the premises restored to as near a natural state as reasonably possible. Temporary fencing of unattended pits and sumps to protect wildlife, livestock, and the public may be required by the Supervisor and the surface management agency.

(5) Production Facilities Maintenance. Production facilities shall be operated and maintained at all times in a manner necessary to prevent pollution. The lessee's field personnel shall be instructed in the proper maintenance and operations of production facilities for the prevention of pollution.

B. Inspection and Reports. Lessees shall comply with the following pollution inspection and reporting requirements.

(1) Pollution Inspections. Drilling and production facilities shall be inspected daily by the lessee. Appropriate preventative maintenance shall be performed as necessary to prevent failures and malfunctions which could lead to pollution. Wells and areas not under production shall be inspected by the lessee at intervals prescribed by the Supervisor. Necessary repairs or maintenance shall be made as required.

(2) Pollution Reports. All pollution incidents shall be reported orally within 18 hours to the appropriate Geothermal District Supervisor and shall be followed within 30 days thereof by a written report stating the cause and corrective action taken.

C. Injection. The use of any subsurface formation, including the geothermal resources zone for the disposal of well effluent, the residue thereof, or the injection of fluids for other purposes such as subsidence prevention shall not be permitted until the lessee has submitted a plan of injection covering the proposed injection project and has subsequently received the Supervisor's written approval thereof.

(1) Plan of Injection. The plan of injection shall include the quantity, quality, and source of the proposed injection fluid; the means and method by which the fluid is to be injected; a structure map contoured on the intended injection zone; and cross-sections showing producing well locations and the proposed injection well location(s).

(2) Injection Report. The lessee shall file in duplicate with the Supervisor a Monthly Water Injection Report in a form approved by the Supervisor. The subject report shall be filed on or before the last day of the month following the month in which the injection took place.

(3) Inspection. Injection wells and facilities shall be inspected by the lessee at intervals as prescribed by the Supervisor to ascertain that all injected fluids are confined to the approved injection zone. A spinner survey, a radioactive tracer survey, and a cement bond log may be required on each injection well within 30 days after injection begins. The lessee shall furnish to the Supervisor two legible exact copies of any and all such surveys and logs. In the event of a casing failure, inadequate annular cement, or other mechanical failure, the lessee shall without unreasonable delay repair, suspend, or abandon the well. Where failure occurs in a zone which may damage surface or fresh water aquifers, injection shall immediately cease.

(4) New Wells. The drilling of new injection wells in accordance with an approved plan of injection shall be in conformance with the provisions of GRO Order No. 2. An Application for Permit to Drill, Form 9-331C, shall be filed in triplicate and approved for each injection well.

(5) Conversions. The conversion of an existing well to an injection well in accordance with or modification of an approved plan of injection shall be in conformance with the requirements of GRO Order No. 2. The lessee shall demonstrate to the satisfaction of the Supervisor by appropriate testing and logging that the well is mechanically sound and suitable for injection purposes. A Sundry Notice, Form 9-331, shall be filed in triplicate and approved for each conversion.

10. Water Quality. The primary responsibility for water quality and pollution control has been delegated to the States where such States have standards approved by the Environmental

Protection Agency. Such State standards must meet basic Federal requirements prohibiting the deterioration of waters whose existing quality is higher than established water quality standards. The lessee shall comply with the State water quality control organization's standards in such States as have federally-approved standards. The Supervisor, at his discretion, may establish additional and more stringent standards.

The lessee shall file, in duplicate, a detailed water analysis report for all completed geothermal wells within 30 days after completion and annually thereafter or as otherwise specified by the Supervisor. Unless otherwise prescribed by the Supervisor, such analyses shall include a determination of arsenic, boron, radioactive content, and radioactivity of the produced fluids. In the event that a health hazard exists, the Supervisor shall require appropriate health and safety precautions, periodic monitoring, or the suspension of production.

11. Noise Abatement. The lessee shall minimize noise during exploration, development, and production activities. The method and degree of noise abatement shall be as approved by the Supervisor.

The lessee shall conduct noise level measurements during exploration, development, and production operations to determine the potential objectionability to nearby residents as well as the potential health and safety danger due to noise emissions.

Noise level measurements and accompanying data shall be filed with the Supervisor. Such data shall provide the basis for operational and noise control decisions by the Supervisor and shall be based on an assessment of the noise relative to Federal or State criteria including adjustments for the area involved, meteorological conditions, and the time of day of the noise occurence.

The lessee shall comply with Federal occupational noise exposure levels applicable to geothermal activity under the Occupational Safety and Health Act of 1970 as set forth in 29 CFR 1910.95, which are incorporated herein by reference, or with State standards for protection of personnel where such State standards are more restrictive than Federal standards.

A. Measurement Condition. Outdoor noise measurements shall be made at least 3 metres (10 feet) from structures, facilities, or other sound reflecting sources and approximately 1 metre (3 feet) above ground level. Extreme weather conditions, electrical interference, and unusual background noise levels shall be avoided or given due consideration when measuring sound levels.

B. Measurements. The lessee shall monitor and measure noise levels using an octave band noise analyzer with an A-weighted frequency response or a standard sound level meter that conforms to the requirements set forth in USA Standard Specifications for General Purpose Sound Level Meters USASI S1.4-1961 or the latest approved revision thereof. Bandpass filters shall conform to the requirements of USASI S1.11-1966. The lessee shall measure noise level frequency distribution as required by the Supervisor. Sound levels shall be measured in conformance with the USA Standard-Method for the Physical Measurement of Sound USASI S1.2-1962.

C. Criteria. In the absence of more restrictive criteria as may be established in this paragraph, the lessee shall 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 the Supervisor's approval if written permission is first obtained by the lessee from all residents within 0.8 km (one-half mile).

D. Assessment. The lessee shall be responsible for taking such noise level measurements as are deemed necessary by the Supervisor. The background noise level shall serve as the criterion for the rating and assessment, by the Supervisor, of the objectionableness of noise emission from a particular source. The background or ambient noise is defined hereby as the minimum sound level at the relevant place and time in the absence of the source noise and shall include consideration for the type of land use, the season, atmospheric conditions, and the time of day.

E. Attenuation. To attenuate objectionable noise, the lessee shall utilize properly designed muffling devices as required by the Supervisor.

F. Relationships. Reference levels and relationships for noise measurements shall be as follows:

(1) Reference sound pressure for airborne sounds shall be 20 MN/m (20 micronewtons per square metre).

(2) Reference power shall be 10-12 watts.

(3) Sound levels shall be measured using a standard Sound Level Meter with an "A" frequency response characteristic (weighting network).

(4) Sound level meter controls shall be set for as uniform a frequency response as possible when measuring sound pressure levels.

(5) Octave band noise levels shall be reported in equivalent A-weighted levels.

G. Record of Sound Measurements. The Supervisor may require sound level measurements during drilling, testing, and producing operations. Such measurements shall be filed in duplicate with the Supervisor and shall include the following data:

(1) Date, time, and location.

(2) Name of observer.

(3) Description of primary noise source emitter under test.

(4) Kind of operation and operating conditions.

(5) Description of secondary noise sources including location, type, and kind of operation.

(6) Type and serial numbers on all microphones, sound level meters, and octave band analyzers used. Length and type of microphone cables.

(7) Position of observer.

(8) Direction of arrival of sound with respect to microphone orientation.

(9) Approximate temperature of microphone.

(10) Results of maintenance and calibration tests.

(11) Weighting network and meter speed used.

(12) Measured overall response and band levels at each microphone position and extent of meter fluctuation.

(13) Background overall response and band levels at each microphone position with primary noise source not operating.

(14) Cable and microphone corrections.

(15) Any other pertinent data such as personnel

exposed directly and indirectly, time pattern of the exposure, atmospheric conditions, attempts at noise control, and personnel protection.

Reid T. Stone
Area Geothermal Supervisor

APPROVED:

Russell G. Wayland
Chief, Conservation Division

APPENDIX H

EVALUATION OF S. S. PAPADOPULOS HYDROLOGIC REPORT

cc [handwritten names] D. Wildell, D. Carey, D. Campbell
NL 1008 3.3

DRAFT

MINUTES

LONG VALLEY HYDROLOGIC ADVISORY COMMITTEE (LVHAC) REGULAR MEETING JANUARY 12, 1989

The January 12th meeting of the LVHAC was called to order by the Director of Energy Management, Mono County, Dan Lyster, at approximately 1:00 p.m. at the Mammoth Lakes Fire Department conference room. The list of individuals in attendance and their respective agency/company affiliations are as follows:

Ted Van de Sande	California Fish & Game
Christopher Farrar	US Geological Survey
Curtis Milliron	California Fish & Game
Robert Habel	California Div. of Oil & Gas
Dick Thomas	California Div. of Oil & Gas
Brent Lamkin	BLM-Bishop
Cheryl Closson	California Energy Commission
Dan Lyster	Mono County
Mike Walker	Pacific Energy/Mammoth Pacific
Jack Barnett	Bonneville Pacific
Mark Ziegenbein	BLM-Bishop
Don Campbell	Mesquite Group
Thom Heller	USFS-Mammoth
John Eastman	Town of Mammoth Lakes
Dan Paranick	Mono County
Dick Dahlaren	California Trout
Michael Jarvis	Mammoth Times
Gudmundur Bodvarrson	Private Consultant for Mono Co.
Ellen Hardebeck	Great Basin APCD
Andrea Lawrence	Mono County
Rob Willis	Miller & Wood Ranch Co.
Timothy Durbin	Papadopulos and Associates
Claudia Stone	Papadopulos and Associates

I. DISCUSSION OF MINUTES OF NOVEMBER 9, 1988, REGULAR MEETING

The minutes as proposed and circulated were discussed. The date of the meeting was corrected to show November 9, 1988, and the name of Ted Van de Sande, from the California Department of Fish and Game, was added to the list of attendees. With those minor corrections, the minutes were accepted and approved by the committee.

II. DISCUSSION AND POSSIBLE ACTION ON LVHAC SUBMITTING A COMMENT LETTER TO MONO COUNTY AND BLM REGARDING THE EFFECTIVENESS OF HYDROLOGIC MONITORING IN LONG VALLEY

Dan Lyster explained to the committee that following the November 9, 1988, meeting of the committee, efforts were made to prepare and forward a letter to the Mono County Board of Supervisors and the Bureau of Land Management (BLM) concerning the effectiveness of the hydrologic monitoring effort. California Department of Fish and Game representatives objected to the sending of the proposed letter because they were not in attendance at the November 9 meeting and did not have an opportunity to discuss this proposed expression of the committee's feelings with respect to this subject matter. Further, their objection stated that the proposal to forward such a letter was not placed before the committee in a proper way by advanced notice and identification as an agenda item.

Dan explained that he then felt it best to delay action on this agenda item until the next meeting of the HAC. Hence, it is scheduled for the HAC to discuss the proposed letter today. It was also pointed out by Dan that this agenda item could perhaps best be discussed after the committee had heard the presentations in connection with agenda item III. Therefore, at this point in time, the committee turned its attention to agenda item III.

III. PRESENTATION AND DISCUSSION OF METHODOLOGY USED BY MR. TIM DURBIN (PAPADOPULOS AND ASSOCIATES) IN PREPARING THE "SECOND" PAPADOPULOS REPORT

Dan asked California Fish and Game and Mr. Curtis Milliron to take the lead with respect to this agenda item. Curtis indicated that the presentation would be made by Tim Durbin and Claudia Stone. Claudia explained that she had taken all of the information which was available concerning geology and hydrology in the area and converted it into a conceptual model. She stated that Durbin then turned it into a math model. Claudia explained that she tried to put all she could find and all that was know and written about into a conceptual model.

The geologic information available is incomplete, particularly concerning stratigraphy and structures. Geologic units of interest are the Bishop Tuff and the Early Rhyolites. The elevation of the top of the Bishop Tuff and the thickness of the Bishop Tuff vary. The top of the Bishop Tuff is perhaps weathered and permeable. The center of the Bishop Tuff is dense and permeability must rely upon secondary permeability. This secondary permeability could be closed off with clays or minerals which might have been deposited in the opening of the fractures.

All of the above variabilities can also apply to the Early Rhyolites. There is a question of what affect these changes have on the hydrologic system. Water moves from its metaoric source, perhaps through ring fractures, through the system and then must come out of the ground-water system. The questions are how and where.

1. Evaporation

2. Ground-water discharge to the surface

3. Ground water leaving the area

Claudia stated that the USGS says that none of the water goes out of the Owens Valley as ground-water discharge, so if you subtract evaporation and transpiration, the remainder must be discharged to the surface water. The USGS contour maps do not deflect at faults, so faults are not effective in controlling ground-water flow. The map primarily represents the cold water system. The question is, "Is this also true of the deeper geothermal system?"

Claudia then asked the question, "What do bore holes tell us about the thermal system?"

1. To date, an upflow zone has not been identified.

2. Temperature profiles at M-1 (not Bonneville Pacific's M-1) show two thermal systems. It's in the younger rhyolite and the rubbly top of the Bishop. At M-1, the higher zone is hotter than the deeper zone. Bore holes across the dome vary some with respect to gradient--some without a gradient, some are very hot, some are not so hot.

3. Chemical geothermometers indicate 220°C+ at well #3416 near Inyo Crater and at Shady Rest. Some wells have been drilled and find a hip in the temperature gradient, but no shoulder. Other wells show both hips and shoulders on a plot of temperature gradients. Question: Is there greater than 220°C in an upwelling zone, and can we locate it?

Geology has been published by the USGS, Bailey and others. Some experts have mapped but not released their data. Much geophysics has been done. It has been a place to try new techniques, because it is a known geothermal area. Norquest, in 1987, did magneto-telluric work. Resistivity can vary with heat or clay. He found two lows that connected together form a horseshoe-shaped anomaly that swings around the dome. He defined the west side of the horseshoe as being an anomaly because of heat, and the east side of the horseshoe as being an anomaly because of clay.

Geochemistry shows the same source of water everywhere. Isotopes show that the fluids have been flowing through basement rock. So there are questions:

1. What controls the flow in the thermal aquifers?

2. Is there hydrologic continuity between the upper and lower thermal systems?

In the thermal zone, Claudia stated that there are indications that the lower zone is hydrologically continuous under the dome. With respect to the upper zone, the Bishop Tuff, it is not continuous in the western mote to the south mote, although there is upwelling in both areas on faults which occur, but this movement of thermal fluids may not be large and may not be important.

So Claudia indicated that her model has a major upwelling of fluids in the west mote near the resurgent dome, and then her model moves 220°C water from the west around to the south mote. She justifies this based in part on the magneto talluric work and data from the Shady Rest well.

With respect to the shallow thermal zone, water comes around the corner, so to speak, and a component discharges in springs, but much of it rises out into the Crowley Basin. Bishop Tuff water comes around the corner, discharges along a little hot creek, then moves east and is diluted and cooled before discharging. The upflow from the Bishop Tuff is basically in the Shady Rest area.

Tim Durbin then presented the mathematic model that he developed from Claudia's conceptual model. He decided to use a uniform lateral flow. Durbin went on to explain he assumed two horizontal layers, the horseshoe-shaped aquifer and an aquifer with a total thickness of 700 meters. He provided for the two-layered aquifer water flow and heat to move by flow and conductivity. He indicated there was not enough temperature data to describe a three-dimensional model system, so he had to make several assumptions. His study, thus far, shows that the temperature affects are much less than the hydrologic affects.

A discussion followed where there seemed to be general consensus that temperature is really not a problem with respect to the developers. The Papadopulos study, however, did find water level declines based on their many assumptions at the springs, because when analyzing the Pacific Energy efforts, the injection was into the lower aquifer. They show in their model no vertical movement from those injected fluids into the shallower aquifer, hence it was a depletion in the model to the fish hatchery and other springs.

1. Monitoring is to learn of changes. He believes that monitoring can and should be done to determine if there are changes and what is the nature of those changes.

2. Monitoring is to determine if adverse changes are occurring and if you can then respond and reverse those changes.

There was a long discussion and exchange of ideas between committee members and Mr. Durbin, particularly focusing on statements in the Papadopulos report and statements made by Mr. Durbin in the past concerning the effectiveness or the lack of effectiveness of monitoring. Durbin finally stated that he thinks that monitoring is very important and that monitoring can measure changes, and with that monitoring, the system will be better understood. Without the monitoring tool, we will never be able to better understand the system.

The committee concluded in their discussions that Tim's statement in the Papadopulos report does not accurately indicate his current position. Tim responded by indicating that what he was trying to say, and did not elaborate in the Papadopulos report, was that monitoring in and of itself would not reverse adverse impacts. He believed that modeling should be occurring now so that the system could be better understood and so that changes observed by the monitoring program could be inserted into a model.

He was further concerned that monitoring in and of itself did not assure that responsible government agencies would respond to the changes observed and require that actions be taken to reverse those changes. If the regulatory body did not act in a timely manner but perhaps procrastinated for many years, perhaps tens of years, then the impact of the development which was monitored could be widespread in the system, and potentially could not be reversed.

The committee then determined that it would send a letter to the Board of Supervisors and BLM officials. Dan asked that comments be back to him as to what should be contained in the letter by January 27. He indicated he would then send out the proposed letter to the committee for approval.

In conclusion, Dan stated that he is trying to schedule the next meeting of the LVHAC for some time in March. He will be in contact with committee members as to the time of that meeting.

Respectfully submitted,

Jack Barnatt

COUNTY of MONO

ENERGY MANAGEMENT DEPARTMENT

HCR 79, Box 221
Mammoth Lakes, CA 93546
(619) 934-6704, Ext. 403

DANIEL L. LYSTER
Director

April 3, 1989

Mr. Mike Ferguson
Bureau of Land Management
873 N. Main Street
Suite 201 Room 1310
Bishop, CA 93514

Dear Mr. Ferguson,

Recently the California Department of Fish and Game (DFG) and their hydrology consultant, S.S. Papadopulos & Associates, Inc. (specifically, Mr. Timothy J. Durbin, Western Regional Manager), have alleged that the monitoring program established by the Long Valley Hydrologic Advisory Committee (LVHAC) will not be effective in detecting changes in the Long Valley hydrothermal system caused by geothermal development before irreversible detrimental impacts to the Hot Creek Hatchery or Hot Creek Gorge springs have occurred. The LVHAC, composed of numerous regulatory agencies and many knowledgeable geothermal resource experts, strongly disagrees with the comments made by DFG and their consultants. The consensus of LVHAC members is that DFG's consultant, Mr. Tim Durbin, is alone in his opinion that monitoring would not be effective in detecting changes prior to the onset of adverse impacts. His analysis reflects a lack of understanding of the Long Valley hydrothermal system.

The LVHAC, as an advisory group, concludes that the proposed monitoring program will be effective. The LVHAC contends that any significant change will not only be detected, but can be reversed or mitigated to a level of insignificance with respect to impacts at the Hatchery or Hot Creek Gorge springs.

The hydrothermal system monitoring program and mitigation processes embodied in the Mono County, the Bureau of Land Management (BLM), and the Division of Oil and Gas (DOG) permit conditions are designed to reduce to insignificance the possibility of impacts to sensitive hydrothermal features; primarily the Hot Creek Fish Hatchery and Hot Creek Gorge springs. Monitoring the hydrothermal system at numerous points is required to detect potentially adverse changes so that mitigation measures can be implemented before changes reach the sensitive springs. This hydrothermal system monitoring program establishes baseline data collection requirements and detects changes caused by geothermal project operations before they can affect hydrothermal features of concern. The program also provides information to permitting agencies to select and implement appropriate mitigation measures to prevent hydrothermal changes from migrating away from the production field torward the sensitive hydrothermal features and to monitor the effectiveness of implemented mitigation. The data to be collected are basically those specified by LVHAC, supplemented with some project-specific requirements additionally imposed by regulatory agencies.

The monitoring program is progressive, that is, the results of initial monitoring may prompt the establishment of additional monitoring sites and possibly the drilling of additional wells. It is designed to provide documentation of movement of hydrologic system changes away from the project areas toward features of concern.

A number of geothermal resource experts familiar with the Long Valley hydrothermal system were asked to review the Papadopulos report. A summary of their conclusions with regard to the effectiveness of the planned monitoring program and potential mitigation measures is provided below.

> <u>U.S. Geological Survey, Michael L. Sorey: letter to the Bureau of Land Management, June 27, 1988.</u>
>
> "A properly conceived and implemented hydrologic monitoring program should be capable of determining what the actual response is. More importantly, such monitoring provides for early detection of changes in reservoir conditions within project areas and between these areas and the thermal springs. The Papadopulos report suggests that temperature changes in thermal springs could take place only after the development period is over and hence monitoring cannot provide protection against such impacts. This situation should not occur, however, if reservoir temperature changes in and around project areas are detected by the monitoring program in the early stages of development, and suitable mitigation measures are then implemented."
>
> <u>California Division of Oil and Gas, M.G. Mefferd (State Supervisor), letter to the Mono County Board of Supervisors, October 25, 1988.</u>
>
> "The need for systematic hydrologic monitoring became apparent when geothermal development was proposed in the

Long Valley Caldera. The formation of the LVHAC was proposed by the Director of Energy Management of Mono County and has since been formed with representatives from the State of California, Mono County, Town of Mammoth Lakes, geothermal operators, and local developers. A subcommittee of experts has been formed and has developed a monitoring program in the area of concern, to detect any significant changes in the hydrology. The Division is a member of the subcommittee. The Division feels that the monitoring program in the area of concern will detect any significant changes and allow the permitting agencies adequate time to alleviate any problems caused by the geothermal development."

California Division of Oil and Gas, Robert S. Habel: letter to Mono County Energy Management Department, November 21, 1988.

"The Division requires monthly production/injection reports for the Casa Diablo geothermal field, and has been monitoring this data since the geothermal field first produced. This information is stored on computer and is used to evaluate field performance. Field performance may indicate possible problems in the geothermal reservoir."

"It is the Division's opinion that not only our current monitoring program, but the proposed monitoring program is very important in detecting changes in the geothermal reservoir. The changes in the reservoir may or may not effect the springs feeding the fish hatchery or Hot Creek Gorge, but we may never know if the geothermal system is not monitored. It is also the opinion of the Division, that the proposed production from the Mammoth Pacific II Power Plant will not cause changes in the geothermal reservoir which will adversely affect the springs feeding the fish hatchery or Hot Creek Gorge."

Berkeley Group, Inc., Draft PLES I Geothermal Project, Environmental Impact Statement/Environmental Impact Report Supplement, September 1988.

"A regional program for monitoring effects from existing and proposed geothermal power plants and other relevant projects has been developed by LVHAC and put into effect and, based on information obtained through monitoring programs required by the BLM, will provide guidelines for detection limits and trigger point limits which would initiate revised pumping plans, hatchery mitigation, and power plant shutdown. While monitoring will not, in and of itself, mitigate adverse cumulative impacts, it would provide an opportunity to identify hydrology changes as they occur and would allow sufficient time for appropriate remedial mitigation measures to be implemented, if necessary."

<u>Mesquite Group, Inc., Summary Analysis of the CDF&G Papadopulos - Report, May 26, 1988.</u>

"Monitoring of the production reservoir, whether through the production and injection wells themselves or through observation wells, such as Well No. 65-32 (drilled especially for this purpose at Casa Diablo), is designed to detect very small temperature or pressure changes. The purpose of monitoring is to observe changes in the reservoir <u>far in advance</u> of these changes migrating away from the production area, so that effective mitigation measures can be implemented. Neither the project operator nor the responsible regulatory agencies would allow even close to a 30 degree Celsius decline in the temperature of the production reservoir to occur without requiring the implementation of reservoir mitigation measures and the drilling of additional monitoring wells to ensure that none of the impacts predicted by this "Papadopulos" model would occur."

<u>Mesquite Group, Inc., Comments to the Bureau of Land Management on the Draft PLES I Geothermal Project Environmental Impact Statement/Environmental Impact Report Supplement, Nov. 4, 1988.</u>

"Drastic changes such as those predicted by the Papadopulos model would be detected at Casa Diablo itself almost immediately. Mr. Durbin fails to recognize the ability to control pressure distributions and/or temperature by reorienting production/injection patterns. He also fails to recognize the conductive reheating potential of the massive volume of hot rock between Casa Diablo and the Hatchery area."

"Papadopulos postulates that this cooled injection zone will eventually migrate with the regional flow to the Hatchery area. Migration calculations in the <u>Draft EIS/EIR Supplement</u> also indicate that the cooled injection zone could reach the Hatchery area in about 100 years, <u>if</u> the zone maintains its integrity. However, it was noted that the cooled zone could not really migrate intact, but rather would tend to sink deeper into the reservoir, and would be reheated by the hot reservoir rock as it moves from west to east."

<u>Barnett Intermountain Water Consulting, Jack A. Barnett; letter to Mono County Energy Mangement Department, November 23, 1988.</u>

"We write to urge you to bring to the Board of Supervisors for Mono County, and any other regulatory body that you feel appropriate, our strong belief that (1) the current monitoring program is in fact, adequate, (2) it will be effective in monitoring any changes that might occur in the hydrologic system, and (3) changes can be reversed by appropriate reservoir management practices.

We believe that assertions made to this regard by the California Department of Fish and Game and their consultant, Papadopulos, are just simply wrong. We believe that the preponderance of evidence and the opinion of all experts involved leads anyone investigating the allegations made to conclude that their assertions are not based upon an understanding of hydrologic systems, geothermal resource development, and most importantly, the hydrology of the Long Valley."

California Energy Commission, Cheryl Closson; letter to Chairman of LVHAC, March 10, 1989.

"On January 12, 1989, Mr. Durbin made a presentation on the S.S. Papadopulos work to the Long Valley Hydrologic Advisory Committee (LVHAC). The LVHAC developed the monitoring program currently being implemented by the U.S.G.S. and funded by Mono County and the California Energy Commission. At this meeting, Mr. Durbin essentially reversed his contention that monitoring would be ineffective and instead stressed the policy/decision-making end of mitigating potential impacts from geothermal development."

"The issue was shifted from the technical consideration of whether monitoring can indeed detect changes in the system, to whether the policy-makers will act on information provided to them to mitigate potential effects. This change in emphasis is significant since the monitoring program, as outlined, is completely separate from any policy actions taken by the various agencies having jurisdiction over development. The LVHAC monitoring program is meant to be, and has always been, represented as being advisory information only, to be used by the regulators in whatever manner they choose in making policy decisions."

"As a member of LVHAC, I completely support the monitoring program as a means for early detection of any changes in the hydrologic system, whether natural or in response to any development in the Long Valley Caldera. I also believe that it is imperative that the LVHAC make a formal statement in response to the S.S. Papadopolus report(s) and to Mr. Durbin's ever-changing contentions about the effectiveness of monitoring as a tool in mitigating possible effects of geothermal development in the Long Valley Caldera."

To summarize the aforementioned technical opinions on the effectiveness and importance of monitoring the hydrothermal system in Long Valley, Rob Willis (Miller and Wood Ranching), a member of the LVHAC who is not, by profession, a hydrologic expert puts the issue in a very straightforward, succinct perspective: "I feel very strongly, as I think everyone does, that monitoring is our only real means of possibly detecting changes and preventing damage. Whether we have direct proof that monitoring is effective or not, I think we have to monitor and interpret data as a measure of common sense."

The LVHAC provides the information contained herein from an advisory standpoint only. The committee acknowledges and respects your role as an agency with permitting authority over the development of geothermal resources in Mono County and, accordingly, does not request any specific action pursuant to this letter; merely that you take this information under advisement.

If you have any questions regarding this letter in particular or regarding any functions of the LVHAC in general, please contact me at (619) 934-6704.

Sincerely,

Dan Lyster

Dan Lyster
Chairman, LVHAC

cc: LVHAC Members

DL/djh

Mesquite Group, Inc.
P.O. Box 1283
221 North Harbor Blvd., Suite K
Fullerton, California 92632
(714) 738-8224

JUN 23 1988

FILE COPY

May 26, 1988

Mr. Donald C. Liddell
Special Counsel
Pacific Enterprises
6055 East Washington Boulevard
Commerce, California 90040

Subject: Analysis of Report "Evaluation of Impacts of Geothermal Development Within Long Valley", prepared for California Department of Fish and Game by S. S. Papadopulos & Associates, Inc., dated May 9, 1988.

Dear Don:

In response to your request of last Friday, Mesquite Group, Inc. has reviewed the subject report and offers three levels of comment. The first attachment is a summary discussion of what we consider to be major flaws in the report's basic premises and conclusions. The second attachment is a paragraph-by-paragraph, detailed critique highlighting all the statements (minor and major) in the report which we believe deserve comment or correction. The discussion which follows provides an overview of our analysis:

(a) The Papadopulos report employs a simple energy balance model of the Long Valley geothermal system which is quite different from the models used by other investigators.

(b) The report's principal conclusion, that the heat in the system will be severely depleted by the planned geothermal development, is meaningless because numerous erroneous assumptions are used in defining the model and because the calculations are carried to unrealistic extremes.

(c) The heat storage assumed for the modeled geothermal system is extremely small, 186 times smaller than the U. S. Geological Survey estimate for the Long Valley caldera. Correcting this assumption alone changes the model's predictions such that a <u>maximum</u> decline of only 2.0°C in Casa Diablo reservoir temperature is predicted, which would result in <u>no</u> discernable effect on the Fish Hatchery springs or the Hot Creek gorge springs.

(d) The heat inflow to the system allowed in the model is limited to the equivalent of the current outflow from the springs at the Hatchery and Hot Creek. This is also unrealistically small.

(e) The "predicted" 150°C temperature decline of the Casa Diablo reservoir fails to recognize that the power plants would become uneconomical to operate after a 30±°C decline, and, if the model were correct, would be shut down after only four years of operations. Correcting this misconception would reduce the model's "predicted" <u>reservoir</u> temperature declines at the fish hatchery by a factor of five, to only 1.4 or 6.8°C. (However, note that a temperature decline at the hatchery reservoir would result in only a fractionally small change in the temperature of the Hot Creek headsprings supplying the hatchery. See comment (g) below).

(f) This same modeling would "predict" that the existing Mammoth-Pacific Unit I would have already produced a 6°C temperature decline in the Casa Diablo reservoir during its four years of operation when, in fact, no decline in reservoir temperature has occurred.

(g) The implied worst-case 34°C temperature decline of the springs at the Fish Hatchery is impossible because the hottest spring flows at only 16°C, and fails to recognize that the geothermal component of the springs is only 2 to 5 percent. The correct interpretation of the predicted <u>worst-case</u> temperature change of the Fish Hatchery <u>springs</u> is only 0.7°C to 1.7°C. (However, note that these temperature changes occur <u>only</u> if the lack of validity of the heat storage and inflow assumptions of the modelers is ignored. See comments (c) and (d) above.)

(h) The report's contention that monitoring will not detect adverse impacts until irreversible changes have begun at the Hatchery fails to recognize that monitoring <u>at the source</u> (i.e., Casa Diablo) will detect very small changes <u>at the source</u>, and that any significant temperature decline will be mitigated in the field <u>long before</u> changes of the magnitude predicted by the model are allowed.

In conclusion, we believe the Papadopulos report employs a simplistic model of the Long Valley geothermal system which utilizes erroneous assumptions and carries the calculations to absurd extremes. As a consequence, its predictions of significant heat depletion due to geothermal development are meaningless. If the input data and assumptions were "corrected", the results would predict no discernable impact to the Fish Hatchery from operation of the Casa Diablo geothermal projects.

In our opinion, there is still enough uncertainty about critical parameters that the ability of such a simple model to accurately reflect the Long Valley geothermal system is highly suspect. Those of us (including Dr. Sorey) who are much more familiar with the Long Valley geothermal system, and familiar with more complex heat balance models (thermal simulators), do not believe we can create a definitive model as yet. Only additional production experience and monitoring will allow us to obtain the necessary data to construct a credible numerical model of the entire Long Valley geothermal system.

Sincerely,

Don A. Campbell

(JB) for Don A. Campbell

DAC:cv

Attachments (2)

cc: Owen Olpin, O'Melveny & Myers
Todd Littleworth, Pacific Enterprises
Dwight Carey, Environmental Management Associates, Inc.
Mike Walker, Pacific Energy

MESQUITE GROUP, INC.'S SUMMARY ANALYSIS OF THE REPORT "EVALUATION OF IMPACTS OF GEOTHERMAL DEVELOPMENT WITHIN LONG VALLEY"

(Prepared for California Department of Fish and Game by S.S. Papadopulos & Associates, Inc., May 9, 1988)

May 26, 1988

The underlying premise for this report's energy balance model of the Long Valley geothermal "system" is quite simple, i.e., the change in the quantity of heat stored in the system is equal to the rate of heat inflow into the system minus the rate of heat extracted from the system. This approach is very different from that used by prior investigators of this problem, but theoretically could be valid if appropriate model constraints and inputs are used. However, because of numerous erroneous assumptions used to define the geothermal system for the model, and because of the extremes to which the calculations are taken, the results of the modeling effort are meaningless and, worse, very misleading.

The Papadopulos modelers assume, without explanation, that the Long Valley geothermal system has a total volume of $3.55x10^9m^3$ (Table 2). Given their stated assumption regarding the average temperature of the system, and an assumed porosity and heat capacity of the rock (which are not stated), the total stored heat which can be extracted from the system is purported to be only $1x10^{17}$ calories (page 2). The modelers also run a second case in which they assume that the "available" reservoir in three of the four blocks in the model is only ten percent of that used in the first case, or $1.43x10^9m^3$ (which results in a total of only $0.40x10^{17}$ calories in storage) (page 20). For both cases, they assume that the only heat available to recharge the geothermal system is that quantity of heat which is currently estimated to be discharged by the Hot Creek Fish Hatchery and Hot Creek gorge springs (page 19).

Taken together, these two assumptions produce a modeled result which has no validity. First, the "modeled" available heat in storage assumed is extremely small. The U.S. Geological Survey (USGS), in Circular 790, estimated that the mean reservoir thermal energy of the Long Valley caldera was $186x10^{17}$ calories, or 186 times that said to be available by Papadopulos. The USGS value is based on a mean reservoir volume for the caldera of $136x10^9m^3$, nearly 40 times that assumed for the basic model. If the USGS estimate of <u>wellhead</u> thermal energy is compared to the report's second case, the result ($46x10^{17}$ calories) is still 115 times the stored heat assumed by the modelers. Circular 790 also specifically states that the estimates of heat in the reservoir do "not consider possible resupply of heat from below or from the sides.... and are thus considered minima" (page 19).

The modelers' decision to limit the heat available for recharge of the system to that heat which currently leaks out of in the form of thermal springs, while also severely limiting the size of the geothermal reservoir, clearly produces a result which conflicts with the available data for Long Valley as well as most other commercially developed geothermal reservoirs in the world. Classic geothermal convection systems involve the upward flow of heated water, usually along faults, which spreads out laterally once it reaches a permeable horizontal zone, eventually sinking at some distance from the upward plume as it cools. Cooling occurs because of conductive heat losses to surrounding water and rock, mixing with cooler waters and, sometimes, boiling at discharge points. Such a system need not have any discharge of geothermal fluid in order to sustain substantial convective flow, and the system may have the potential for very substantial flows even if it is essentially static. All that is required is the imposition of a pressure release point, such as a well. Many of the major commercially developed geothermal reservoirs in the world had little or no thermal fluid discharge prior to development. If their thermal energy recharge was limited to pre-existing thermal spring discharges, then most of these reservoirs would have been exhausted long ago. The point is that by both limiting the size of the system and limiting the recharge of heat to the system to that discharged by a few of the existing thermal springs, the heat available for consumption is quite small. Realistically, the model must either allow for the influx of substantially more heat to the producing reservoir from below and/or the sides, or the reservoir must be expanded to include this additional reservoir within the system model. In either case, the resulting "corrections" for Long Valley would dramatically reduce the "predicted" rate of temperature decline in the reservoir. Using the values for heat in place of the previous paragraph, the model would predict temperature declines in the Casa Diablo reservoir after 30 years of operation (the economic life of the project) of only 1.2 to 2.0°C, which would result in no discernable change in the temperature of the reservoir under the Fish Hatchery or Hot Creek gorge.

The implausible assumptions used in the modeling exercise are compounded by running the model to extremes, with the result that very misleading conclusions are reached. For example, the Casa Diablo cases (see Figures 4 and 5) predict that after only 20 years, the temperature of the Casa Diablo geothermal reservoir would decline in temperature by 150°C! The reality is that a 30±°C degree decline in reservoir temperature would make the plants uneconomic to operate and they would be shut down (after only four years of operation under the model). If this were to occur (which we do not predict), the model would predict temperature declines in "Block 4" (the Fish Hatchery) of less than 1.4°C (Figure 4 case) or 6.8°C (Figure 5 case) after 150 years.

Even assuming that the model correctly predicts responses (which is clearly not the case), the modelers imply that the springs at the Fish Hatchery will decline a maximum of 34°C in temperature. Since the hottest spring at the Hatchery (AB) is only 16°C and the normal cold springs are about 11°C, a 34°C decline is obviously impossible. More realistically, the model predicts a maximum 34°C decline in the underlying geothermal reservoir. Since the average geothermal water contribution to the Hatchery springs flow is two to five percent, the average predicted temperature decline of the springs even under this worst case would be only 0.7 to 1.7°C. If the plants stopped operating after a 30°C temperature decline at Casa Diablo, then the model would predict a maximum decline in the Fish Hatchery springs of only 0.1 to 0.3°C. For the reasons given in the paragraph above, we clearly do not believe that the temperature of the Casa Diablo reservoir will decline by 30°C, and thus do not believe that even this small change in the Hatchery Springs will occur.

Both cases modeled indicate that the Mammoth Pacific I project should already have caused a 6°C decline at Casa Diablo. This has not happened, of course, and further demonstrates the invalid nature of the model. The first rule of numerical modeling is to "history match" actual experience. If the model cannot match the actual, then predictions from it are meaningless.

Finally, the report's statement that "Monitoring will not detect adverse impacts until after irreversible changes have begun to occur (page 21)" is also unrealistic. Monitoring of the production reservoir, either through the production and injection wells themselves or through observation wells, such as Well No. 65-32 (drilled especially for this purpose at Casa Diablo), is designed to detect very small temperature or pressure changes. The purpose of monitoring is to observe changes in the reservoir far in advance of these changes migrating away from the production area, so that effective mitigation measures can be implemented. Neither the project operator nor the responsible regulatory agencies would allow even close to a 30°C decline in the temperature of the production reservoir to occur without requiring the implementation of reservoir mitigation measures and the drilling of additional monitoring wells to ensure that none of the impacts "predicted" by this model would occur.

In summary, the report presents a very simple energy balance model of the Long Valley geothermal system which produces meaningless results because it uses erroneous assumptions regarding the heat stored in the geothermal reservoir and the available heat recharge to the system, and because the modeling calculations are carried to implausible extremes. In addition, the report's statement that monitoring would not be able to detect changes in the reservoir until it was too late to protect the Hot Creek Fish Hatchery is equally invalid, in that it presupposes that temperature changes much greater than those which would force the abandonment of the project would be completely ignored by the operators and regulatory agencies. Both these parties would implement mitigation measures long before the predicted temperature decline could actually occur.

MESQUITE CRITIQUE OF "EVALUATION OF IMPACTS OF GEOTHERMAL DEVELOPMENT WITHIN LONG VALLEY"
(as Prepared for California Department of Fish and Game
by S.S. Papadopulos & Associates, Inc., May 9, 1988)

May 26, 1988

Page	Paragraph	Report Statement	Mesquite Comment or Correction
1	1	MP I on line in 1985	Actually 1984
1	2	"water will be injected back into the geothermal reservoir"	A fundamental premise of the model is that the injected water cools the prodution reservoir. This is not really so at Casa Diablo - Hydraulic communication is believed to exist, but residual cooled water is actually injected below the production interval - There is currently no pressure gradient sufficient to cause injected water to return to the production reservoir - Direct injection of cooled residual water into fractured geothermal reservoirs is almost always avoided (world wide) due to the potential for early breakthrough

Page	Paragraph	Report Statement	Mesquite Comment or Correction
2	2	Natural heat replenishment = 5.0×10^7 cal/sec (Sorey, 1975)	Cannot find Sorey, 1975 reference - Sorey, 1976 states number is 6.9×10^7 cal/sec - This is only the surface discharge rate based on Lake Crowley chemistry, an indirect measurement subject to considerable uncertainty - It is probably a minimum, but does not account for much larger conductive losses to cold groundwaters and rock, any "downward legs" of convection cells and losses out of the Caldera - It has no direct relationship to heat available for production in the Caldera
2	2	Stored heat = 1×10^{17} cal.	Unable to locate source for this number, but probably is near - surface only (i.e., the lateral flow portion of the lateral flow model) - It probably does not consider heat in the deep/western "parent" resource - U.S.G.S. number is 186 times as great for Long Valley
2	2	Potential yield is 1.5×10^8 cal/s	Should be $1.\underline{6} \times 10^8$ cal/s

Page	Paragraph	Report Statement	Mesquite Comment or Correction
3	1	Site-specific studies of project areas and how they fit into and interact with the regional system have not been made	There are more than 100 technical papers published concerning the Long Valley hydrothermal system, many of which relate specific Casa Diablo and Mammoth Chance data to the system - The author(s) do not appear to be familiar with the literature data base, citing only the EIR's and two early Sorey references for data (Sorey, 1985 is also referenced, but not apparently used)
7	1	"The crest of the dome is down faulted into a graben by northwest trending faults"	There are at least three and possibly four major grabens transcending the dome - The authors ignore these structural barriers to flow except to justify reducing the effective reservoir volume in the model when it suits them
7	2	Bishop Tuff thickness ranges from 0.5 km in the southwest to 2.5 km in the north and northwest	Tuff is about 1400 m thick at RGI 66-29 (southeast central Caldera), 900 m thick at Casa Diablo, and 400 m thick at Union 44-16 (western Caldera)

Page	Paragraph	Report Statement	Mesquite Comments or Correction
7	2	Average bulk porosity of upper two units is 0.35	This is much too high for these types of rocks - The rhyolites at Casa Diablo have virtually no matrix porosity and probably less than 10% fracture porosity - An assumption of porosity this high is required to reproduce the heat content values of the model
8	3	Entire "Faulting" discussion	Does not recognize the predominance of Basin and Range type normal faulting (horsts and grabens) which pervade the Caldera

Page	Paragraph	Report Statement	Mesquite Comment or Correction
9	1	Entire paragraph	This is outdated description of lateral flow model - Current model expressed by attached Figure (Sorey, 1987) includes upwelling from deep western source region
9	1	Thermal waters flow within upper unit and discharge either as spring flow or subsurface inflow to Crowley	Lateral flow model (old and current) includes downward convection of cooled thermal waters - Not all thermal waters discharge in anyone's model (except Papadopulos') - No credit is given for subsurface inflow to Crowley in the modeling
9	2	0.25 m^3/s or 5.0 x 10^7 cal/s discharge	Same comment as page 2, paragraph 2 - Farrar, 1986 gives number of $0.25 m^3/s$ for Hot Creek Gorge springs alone - There is additional substantial discharge between Hot Creek and Crowley

Page	Paragraph	Report Statement	Mesquite Comments or Correction
10	1	"The "isolated system" conceptual model is implausible"	It is apparent that the author(s) have no clear idea of what constitutes the "lateral flow" model versus the "isolated system" model, as they freely intermix features of both to suit elsewhere in their report - The author(s) apparently read the draft EIR (BGI's Appendix), but do not appear to be familiar with the final DEIR written comments submitted by PEn (GeothermEx, Cascadia, Mesquite) favoring the "isolated system" model - Calling something "implausible" does not constitute proof or evidence

Page	Paragraph	Report Statement	Mesquite Comments or Correction
11	1	"Implausible or troublesome postulations" must be made to reject the "logic" that project thermal waters must eventually migrate to Hot Creek	(1) Discharge of thermal waters may occur not only via surface springs, but may dissipate through conductive heat losses to rock and colder waters, may mix with colder water, may boil, may sink as the downward cooled leg of a convection cell and may leak through the southern Caldera boundary towards Bishop (via Rock Creek and the Bishop Tuff) - (2) Thermal waters <u>must</u> move by a very circuitous path to yield the temperature distributions seen at Casa Diablo and Mammoth Chance - (3) Three convective cells (i.e., "isolated systems"), each confined to a graben (Casa Diablo, Mammoth Chance, Hot Creek) actually fit the observed data quite well in Mesquite's opinion

Page	Paragraph	Report Statement	Mesquite Comments or Correction
11	2	Entire paragraph	Natural convective geothermal systems in the classic case have both upflow (hot water) and downflow (cooled water) regions, and no surface discharge is required - Some geothermal reservoirs are essentially static (except for conductive heat fluxes), having potential for flow, but not actually flowing at significant rates until pressure is decreased at some point, say by drilling a well - At Casa Diablo heat is discharged at the surface by conduction and by MP I production, the Casa Diablo Geyser, Meadow spring, Colton spring and several other springs and fumarolic flows. Additional heat is lost to surrounding colder waters and rock, and probably convects downward within the Casa Diablo Graben in an "isolated system" - It does not have to flow laterally to Hot Creek - The 4×10^5 cal/s local heat discharge value is unsubstantiated by reference, but has no significance anyway

Page	Paragraph	Report Statement	Mesquite Comments or Correction
13-17	All	Entire model	Technically correct for the most part, but only works if the correct input values and constraints are used - There is no requirement that <u>surface</u> outflow equal total inflow in geothermal systems: it is a minimum, but not a maximum - <u>Ignores</u> conductive heat fluxes to and from rock and water surrounding the reservoir - As formulated, the author(s)' equations are not quite correct because the temperature values (T_R, T_{IW}, T_{p1}, T_{p2}) would have to be input in degrees Kelvin; to use degrees Celsius, the temperature terms would have to incorporate a reference temperature; in practice this is what the author(s) have done, using 0°C as the reference temperature

Page	Paragraph	Report Statement	Mesquite Comments or Correction
17	1	Last reservoir (Block 4) includes Fish Hatchery springs	Warm springs at the Hatchery are actually in Block 3
18	1	Blocks 2, 3, 4 receive heat from local upward convection as well as lateral inflow originating from Block 1 (Casa Diablo)	These assumptions mix features of the "lateral flow" model with those of the "isolated system" model - If the authors want to subscribe to the lateral flow model then the "correct" assumption would be that <u>all</u> the heat flows first into Block 1 and then laterally into each successive block
19	1	Table 2	There are no 200°C temperatures in the Caldera east of Shady Rest - Casa Diablo (Block 1) should be 170°C and each successive block should be colder

Page	Paragraph	Report Statement	Mesquite Comments or Correction
19	1	Reservoir thickness of 300 m	Casa Diablo reservoir is about 100 m thick - The shallow hydrothermal reservoir system further east is poorly defined, but probably is less that 100 m thick everywhere - A thicker reservoir would have to incorporate the hot intervals in the underlying Bishop Tuff, but these intervals definitely do not constitute the production source at Casa Diablo
19	1	"The total upward water inflow equals the total spring discharge listed in Table 3 because the cumulative upward inflows equal the local spring discharge"	This is a fundamental misconception (for all the reasons previously stated) which forces the model to its negative conclusion - Obviously if you take heat out of the system at a much higher rate than you allow it to flow in and you assume a small initial storage (relative to the extraction rate), the system will cool off - It is more reasonable and in keeping with the evidence to date to assume that pressure drawdown due to production will cause a compensating increase in convective inflow to Block 1

Page	Paragraph	Report Statement	Mesquite Comments or Correction
19	1	"Water inflow is assumed to be distributed equally to the individual reservoir blocks"	See comment page 18, paragraph 1
19	1	Table 3	The upflow volume used equals that attributed by the author to the Hot Creek and Fish Hatchery springs - What happened to Casa Diablo Geyser, Meadow, Colton and the "large" underground flow to Crawley?
20	1	Figure 4, "production was terminated after 20 years because of excessive decline in average reservoir temperature"	In reality, if the temperature declined this much the power plants would shut down in about 4 years, after a 30±°C decline (not a 150°C decline) - This would obviously eliminate most of the downstream effects (i.e., Block 4 would change less that 1.5°C) - Also implies that MP I alone should have caused a 6°C decline at Casa Diablo already.

Page	Paragraph	Report Statement	Mesquite Comments or Correction
20	2	"Thermal waters occur within limited depth intervals .... and may be confined laterally within faults"	If the faults are confining and basically run north-south, how does water travel laterally from block to block in the model? This "isolated system" concept was used by the author(s) to justify reducing the block size in what is essentially a "lateral flow" model
20	2	"Temperature predictions were made for the case where the reservoir volumes for Blocks 2, 3, and 4 were 10 percent of those indicated in Table 2	Why was Block 1 also not reduced? It is actually more realistic to reduce all of them, but reducing Block 1 would probably have resulted in such an immediate precipitous decline in temperature at Casa Diablo that the unreasonableness of the other assumptions would have been obvious to the casual reader
21	1	Figure 5	See comments page 20, paragraph 1 - A 34°C decline in the hydrothermal reservoir at the Hatchery (Block 4) does not translate to a 34°C decline in "Hatchery" spring temperature - only 2±% of Hatchery spring flow is geothermal

Page	Paragraph	Report Statement	Mesquite Comments or Correction
21	2	"Monitoring will not detect adverse impacts until after irreversible changes have begun to occur"	Monitoring in Block 1 would detect such extreme changes almost immediately
24, 25	All	All conclusions	Totally meaningless because of the simplistic nature of the model and the many erroneous input assumptions
Table 1	N/A	MP I Heat Extraction = 1.4×10^{7} cal/s	Should be <u>2</u>.4 x 10^{7} cal/s
Table 2	N/A	Upward water inflow (m^3/s) = 13.00×10^{-2}	Should be 14.4×10^{-2} m^3/s if derived from Table 3 130 kg/s (specific gravity of 200°C water is about 0.9, not 1.0)
Table 3	N/A	Springs in Hat Creek gorge Heat Discharge (cal/g)	Should be H<u>o</u>t Creek and (cal/<u>s</u>)

cc. D. Campbell

JUN 20 1988

Berkeley Group Incorporated

RECEIVED
JUN - 6 1988
D. C. LIDDELL

June 3, 1988

Don Liddell
PLES
6055 East Washington Blvd.
Commerce, CA 90040

Dear Don:

I have talked with Don Campbell about the Papadapoulous & Associates Report, and he indicated that you would like to have a short critique from us also.

You asked for my opinion about PAI. My experience with Stavros Papadopoulous is limited, but I have always held him in high regard technically. I do not know the people in the Davis, CA office and have never seen any of their technical geothermal publications, if they have any.

Our critique including my modeling qualifications, and an invoice are attached. If you have any questions or wish to discuss the report further, please don't hesitate to call.

Best Regards,

Ron Schroeder

R.C. Schroeder

RCS/sc

Memorandum:

June 3, 1988

Critique of "Evaluation of Impacts of Geothermal Development Within Long Valley", by S.S. Papadopoulous and Associates Inc. May 9, 1988

General

The Papadopoulous & Assoc. Inc. (PAI) model is overly simplistic, uses numerous incorrect assumptions, and has several specific errors in the data. The three basic assumptions in the report are:

1. The heat budget of the southern caldera is given by the amount of heat that is lost to surface springs by convection.
2. The Long Valley geothermal system is defined by rectangles shown in the author's Figure 3, with thickness of 300 meters.
3. The behavior of the geothermal system can be characterized by the average temperatures of the PAI rectangular volumes.

None of these assumptions is meaningful for analysis of production and injection of geothermal fluids.

The comment that "Berkeley Group describes a conceptual model that consists of an isolated local geothermal system" is wrong in fact and substance. Our models utilized infinite reservoir assumptions. However, we correctly examined local effects of production of hot fluids and injection of cool fluids. We also recognized the limitations of such models and the probability of local convection within fault controlled regions.

The question posed by PAI in their report "... where does the heat and water discharge ..." suggests a lack of experience in analyzing the evolution of hydrothermal systems, particularly when major faults exist. Their total neglect of the heat budget available from the reservoir rocks during re-injection further indicates their lack of understanding of the physics of geothermal systems. Their use of average reservoir temperatures over large volumes to analyze the behavior of the system during localized production and injection is totally inadequate.

The authors discuss the geologic history of the region, apparently to indicate their knowledge of the area, but they put that local and regional geological, stratigraphic and structural data to no use in their modeling. Likewise, with the exception of the previously published data on spring discharge values, they use only generalized hydrologic information in the definition of their model. This may be the reason for their incorrect contention that the temperature of the Fish Hatchery Springs is directly related to the geothermal reservoir average temperature. Their use of Sorey's estimate for recharge to their rectangular volumes constitutes the smallest possible value that anyone would conceivably use.

Considerable time, effort, and funds have been expended by a number of government agencies and private companies in analyzing the evolution and present state of the Long Valley hydrothermal system (1-7), the potential for generating power from the resource, and the likely environmental effects of such power production (8, 9, 10). The PAI report has not been prepared with a comparable amount of effort or expertise.

Particular

In addition to the erroneous assumptions previously referred to, there are numerous specific errors of fact or omission. The number used for surface discharge of heat given by Sorey should be 6.9×10^7 cal/s, not 5×10^7 (2). A value of 0.35 for the porosity of any of the lithologic units in Long Valley is much too high.

The heat yield from a geothermal reservoir during production and injection is primarily dependent upon the heat stored in the local reservoir rocks, not the surficial heat discharge from the regional system. The 1.1×10^8 Cal/s calculated by PAI is irrelevant in an analysis of power production. If a surficial heat balance determined potential power production, then <u>none</u> of the existing major geothermal power plants could have operated. As examples consider (11, 12, 13).

	MWe	Yrs in operation	
Wairakei	< 160	25	
Geysers	<2000	25	
Larderello	> 365	20	
Cerro Prieto	> 200	10	
Matskawa	> 20	27	
Reykyavik	> 10	55	(used primarily for direct heat)

<u>None</u> of these resources have had surficial heat discharge that even approximates the amount of heat removed for production of geothermal power. PAI has grossly underestimated the amount of heat available for power production by neglecting stored heat in the rocks, cooling of fluids as they move through lower temperature rocks to surface springs, and movement along and within faults.

PAI assumes a lateral flow model and does not take into account known faults and their effects on the geothermal system. Mike Sorey of the USGS has indicated that the simplistic lateral flow model is not adequate (14). The upwelling of hot fluid along the faults that run perpendicular to the assumed lateral flow direction contributes a major amount of fluid to the present MP I power plant. This major source of recharge maintains the current plant (approximately 8 MW) with no measureable temperature or pressure decrease, which is ignored by PAI. It is circulation in the major faults that must be included in any heat balance model - i.e., upwelling of hot fluid along some faults and sinking of cooled fluid along others. It is the vertical convection of fluids that plays a major role in all liquid-dominated geothermal systems. As D. White of the USGS has correctly noted, "Hot springs are a common but not universal indication of hot-water convection systems" (15).

Qualifications (R.C. Schroeder)

Geothermal resource research, 1972 to present.

Leader of Geothermal Reservoir Research group 1975-1980 (LBL).

Geothermal Resource Consultant, 1980 to present.

Developed heat depletion model for geothermal reservoir with both porous and fractured rocks (with P. Kasameyer) (1973 to 1975).

Developed finite difference model for heat transfer with scale deposition (1974).

Developed distributed two-phase geothermal reservoir simulators SHAFT78, SHAFT79 (with K. Pruess and others, 1975 to 1981).

Developed two-phase wellbore simulation models for both steady state and transient flow (with C. Miller and others, 1976 to present).

Developed multiple feedpoint model for analysis of two-phase geothermal reservoirs and wellbore logs (1987 to present).

Developed analysis models for transient geothermal well testing (1975 to present).

Developed anisotropic model for analysis of geothermal reservoir tracer tests (1986 to present).

References

1. Sorey, M.L., 1985. Evolution and Present State of the Hydrothermal System in Long Valley Caldera. Journal of Geophysical Research, vol. 90, pp. 11219-11228.

2. Sorey, M.L., R.E. Lewis, and F.H. Olmstead, 1978. The Hydrothermal System of Long Valley Caldera, California. U.S. Geological Survey Professional Paper 1044-A, 60 pp.

3. Blackwell, D.D., 1985. A transient model of the geothermal system of the Long Valley Caldera, California. Journal of Geophysical Research, Vol. 90, pp. 11229-11241.

4. Mesquite Group Inc., 1986. Summary of observations supporting a multi-reservoir model of the Long Valley Caldera Hydrothermal System. 12 pp.

5. Mesquite Group Inc., 1987. Public Comments on the MP II & III draft EA/EIR, Hydrology Technical Appendix.

6. Lawrence Berkeley Laboratory, 1987. Proceedings of the Symposium on the Long Valley Caldera: A Pre-Drilling Data Review. LBL-23940.

7. Lawrence Berkeley Laboratory, 1984. Proceedings of the Workshop on Hydrologic and Geochemical Monitoring in The Long Valley Caldera. LBL-20020.

8. Berkeley Group Inc., 1987. Technical Appendix, Hydrologic Study in Mammoth Pacific Geothermal Development Project: Units II & III, Draft EA/EIR.

9. Westec, Inc. 1986. Draft EIR, Mammoth/Chance Geothermal Development Project. County of Mono, 158 pp.

10. Mesquite Group Inc., 1986. Final Report on well SF 35-32, Casa Diablo Geothermal Field Exploration. 56 pp.

References, cont'd.

11. Geothermal Energy, Ed. P. Kruger, C. Otte, Stanford Press, 1973.

12. DiPippo, R. GRC Bulletin, May 1988.

13. DiPippo, R. DOE/RA 28320-1, 1980.

14. Sorey, M. Private Communications, Feb. 1987 to Dec. 1987.

15. White, D.E. Characteristics of Geothermal Resources See Reference 9.

United States Department of the Interior

GEOLOGICAL SURVEY

June 27, 1988

Comments on "Evaluation of Geothermal Development within Long Valley" - a Report by S.S. Papadopulos & Associates, Inc.

Michael L. Sorey
U.S. Geological Survey
Menlo Park, California

At the request of the Bureau of Land Management's Sacramento office, I have reviewed the report cited above. My comments on this report and on the related issues of 1) the effectiveness of hydrologic monitoring in detecting changes in the hydrothermal system due to geothermal production and 2) the effectiveness of proposed mitigation measures to prevent or reduce impacts of geothermal development to acceptable levels are given below.

Papadopulos Report

This report presents an analysis of the changes in stored heat and temperature in part of the Long Valley hydrothermal system between Casa Diablo and the Hot Creek Fish Hatchery resulting from geothermal production at 47 MW over a 20-year period. An energy balance approach is used in which changes in stored heat are computed from the difference between convective heat input and output and net heat outflow from geothermal power production. A continuous reservoir 300 m thick is assumed to extend between Casa Diablo and the Fish Hatchery and this region is subdivided into four blocks, each 300 m thick, for calculating changes in reservoir temperature with time. Hot water inflow to Block #1 at Casa Diablo is set equal to 32.5 L/s at 200°; inflow to each of the other blocks equals 32.5 L/s at 200°C plus the cumulative inflow to the adjacent blocks to the west at temperatures that decline with time with the average temperature of each block. The total hot water inflow to and outflow from the four-block model is thus 130 L/s. The principal conclusions of the report are 1) that heat extraction for geothermal power production at Casa Diablo and Chance Springs (Meadow) will cause large reservoir temperature changes in the production areas (up to 150°C after 20 years) and significant reservoir temperature changes beneath the Fish Hatchery (7° to 67°C after 75 years) and 2) that hydrologic monitoring could not detect adverse impacts before irreversible changes have been created.

To begin with, there is nothing inherently wrong with the energy balance approach utilized in this report. Indeed, the general conclusion that geothermal power production at rates proposed for Long Valley would cause large reservoir temperature declines, in the absence of significant induced inflow of hot water from adjacent regions, is in fact valid. Reference to this matter was made in the EIR for the Mammoth/Chance project (p. 3-32) in terms of a personal communication from me to the affect that only 3 percent of the required heat for the project is stored in the production reservoir beneath the project area. Furthermore, significant changes in reservoir pressure may not occur during development if pressure support is provided by reinjection of produced fluids, but there remains an energy deficit that will cause significant temperature declines unless alleviated by induced inflow of hot water.

The effect of such induced inflow would be to supply heat to the project area from other parts of the geothermal system. Calculations presented on p.2 of the Papadopulos report suggest that even if this were to occur, the potential yield of the geothermal system (1.5×10^8 cal/s from natural convective heat discharge and recoverable heat in storage) is approximately equal to the net heat production rate for the total proposed electric power production of 47 MW, and thus significant impacts to the natural geothermal system are inevitable. Unfortunately, no justification is given for the assumed 1×10^{17} cal of "stored heat that could be mined [by development]". Although published estimates of about 50×10^{17} cal for recoverable heat in the Long Valley geothermal system (Muffler and Williams, 1976; Muffler, 1979) are probably unreasonably large, a more realistic estimate based on recent drilling data from the west moat of the caldera would be about 10 times larger than the value noted in the Papadopulos report.

The controversy that has developed over the impacts of geothermal development on thermal springs at the Fish Hatchery and Hot Creek gorge is due in large part to uncertainty regarding both the degree to which thermal areas between Casa Diablo and Hot Creek gorge are hydrologically connected and the response to development of the geothermal system in the vicinity of each project area. At this stage, no one knows for sure if there is in effect a continuous thermal reservoir between Casa Diablo and Hot Creek gorge or if proposed geothermal developments will induce inflow of hot water from reservoirs at greater depths and/or capture the natural throughflow of thermal water at relatively shallow depths. Answers to these questions are needed before we can predict the magnitude of changes in temperature, pressure, and spring flow rates that could be induced by development. For example, if hot water inflow should occur at Casa Diablo at rates equal to or greater than the natural throughflow rate of 250 L/s (see Sorey and Lewis, 1976; or Papadopulos report, p. 9), temperature drops calculated for Block 1 by the method used in the Papadopulos report would be considerably less than the 150°C value calculated for an inflow of 32.5 L/s.

Potential impacts of geothermal development on thermal springs are best discussed under three possible scenarios that could accompany development. Under scenario (1), there is a natural throughflow of hot water at about 250 L/s moving through the volcanic section between Casa Diablo and Hot Creek gorge. Development at Casa Diablo (and Mammoth/Chance) would lower reservoir pressures sufficiently to capture all the natural throughflow (i.e. redirect it from the thermal springs to the production wells). The resultant reservoir temperature decline in each project area would be considerably less than calculated by Papadopulos & Associates, as discussed above. However, capture of the natural throughflow could result in pressure declines in the vicinity of the thermal springs with resultant declines in spring flow, unless injection wells were located and completed so as to maintain pre-development reservoir pressures near the margins of the project area. Migration of relatively cool injected water toward the thermal springs could eventually cause declines in reservoir temperature beneath the springs. An analysis of this process, included in Appendix I of the joint

EIR/EA for the MP II and MP III projects, suggested that "breakthrough of cool injected fluid is not likely to be a potential threat to existing springs", but the analysis was admittedly very approximate and limited by lack of knowledge of reservoir flow paths. Application of the method used by Papadolpulos & Associates, in which reservoir cooling near the Hatchery results from a decline in the temperature of fluid flow toward the Hatchery from the west, would suggest that cooling of the Hatchery springs could eventually occur under this scenario.

Under scenario (2), the natural throughflow is unaffected by development (or does not exist within a simple lateral flow system at shallow depths), but significant quantities of fluid and heat are induced to flow upward from a deep reservoir beneath the volcanic section into the project area. This is more or less the scenario postulated by the developer at Casa Diablo. This results in the minimum possible impacts at Casa Diablo and at the thermal springs. Using, for example, a value for the recoverable thermal energy in the geothermal system within the southwestern part of the caldera that is ten times the heat stored in Block 1 of the Papadopulos model, the calculated temperature drop in Block 1 assuming this heat could be captured would be only 15°C after 20 years (all other conditions being the same as in the Papadopulos model).

Scenario (3) would be the case assumed in the Papadopulos report - no capture of natural throughflow or heat stored in surrounding regions. Development under these conditions results in the maximum possible declines in reservoir temperature, both in the project areas and beneath the thermal springs. One qualifying point that should be noted is that because the thermal fluid component in the Hatchery springs is small (only a few percent), a given change in the temperature of the thermal reservoir supplying the Hatchery would not cause an identical change in the temperature of the springs. For example, a 30°C change in reservoir temperature should cause about a 1°C change in spring temperature.

Clearly the nature of the response of the geothermal system to development will play an important role in determining the impacts of development on thermal springs. Because this response cannot be adequately predicted at the present time, a prudent course of action has been recommended. This is to set up a monitoring program to accompany development that is capable of detecting changes in the system before they become large and irreversible, and to require mitigation measures in the event that changes are detected by the monitoring program. Measurements of pressure and temperature in production and injection wells are considered part of the monitoring program. Changes in these parameters should provide the first indications that changes in the geothermal system are being induced. Indeed, it is inconceivable that with such monitoring, temperature declines in project areas as large as those postulated in the Papadopulos report could go unnoticed or that significant alteration or cessation in the development scheme would not have been put into effect long before temperature changes became that large. In addition, the most immediate effect of a net energy withdrawl in the project areas should be breakthrough of cooler injected water in production wells. This would occur long before temperature declines occur in the vicinity of the thermal springs. Should an EIS be prepared for the proposed development at Casa Diablo, the issue of reservoir temperature changes within the project area deserves more discussion and analysis than that given so far in Appendix I of the Joint EIR/EA for the MP II and MP III projects.

Effectiveness of the Hydrologic Monitoring Program

A hydrologic monitoring program has been developed by the U.S. Geological Survey, in collaboration with the Long Valley Hydrologic Advisory Committee, to detect impacts of both geothermal and nonthermal groundwater development projects on springs at the Fish Hatchery and Hot Creek gorge. The program became operational on June 1, 1988, with funding provided initially by Mono County. With regard to the existing and proposed geothermal projects at Casa Diablo, this monitoring program covers all aspects of the Plan for Baseline Monitoring approved by the BLM that apply to hydrologic issues, except for compilations of existing data, monitoring of CD supply springs at the Fish Hatchery, and collection of sediment data in streams.

The key elements of the monitoring program are frequent measurements of the discharge characteristics of thermal springs (flow rate, temperature, chemistry) and pressure and temperature in observation wells. The most difficult part of setting up the program is the completion of suitable observation wells. The criteria for such wells is that they be in hydrologic communication with production and injection reservoirs and located between the development field and the thermal springs. Logically, observation wells should first be drilled near the downstream margins of the development field. If no changes attributable to development were found in these wells, additional observation wells would not be needed. If changes were detected and mitigation measures such a relocating production or injection wells failed to reverse these changes, additional observation wells would have to be drilled closer to the thermal springs.

The existing monitoring program includes one observation well (66-32) drilled to a depth of 250 ft at the southeastern edge of the Casa Diablo project area. Although temperature, pressure, and fluid chemical data indicate that this well is in hydrologic communication with the production zone at Casa Diablo (400 to 700 ft), an additional well is needed at this location that taps the deeper injection interval (1000 to 2000 ft), along with well tests to determine the degree of hydrologic connection between both wells and the production and injection wells. Similar requirements for observation well completion and reservoir testing for the Mammoth/Chance project were described in my comments to Dan Lyster, Mono County Energy Management Department, dated January 4, 1988 (copy enclosed).

Successful operation of the monitoring program requires cooperative efforts by the developers, the regulatory agencies, and the agency responsible for conducting and reported on the monitoring. Proper interpretation of monitoring data to discern natural variations from those induced by development may require considerable hydrologic expertise and involve debate between experts. Little experience is available from other areas that could be used to access the likelihood of success of this effort.

We do have the record of over three years of operation of the MP I plant at Casa Diablo during which time no impacts to thermal springs at the Fish Hatchery or Hot Creek gorge have been detected by measurements made by the U.S. Geological Survey. The system response to that development appears to involve no significant decline in reservoir pressure, either due to pressure maintainance by reinjection or the presence of a constant pressure boundary such as a fault that connects the production zone with a deeper, more permeable reservoir. Temperature declines in the vicinity of the injection wells are large (30° - $70^{\circ}C$), but the position of the cold temperature front at distance from these wells is unknown. Considering all the above factors and observations, my opinion at this point is that the existing monitoring program, if augmented by a deeper observation well that taps the injection zone at Casa Diablo and if expanded with additional observation wells drilled closer to the thermal springs as needed, will be adequate to detect changes in the hydrothermal system due to geothermal developments at Casa Diablo.

Effectiveness of Proposed Mitigation Measures

Mitigation measures proposed to prevent or reduce impacts of geothermal developments on thermal springs to acceptable levels are contained in the February 11, 1988, Record of Decision for the PLES I Plan of Operation. The thrust of these measures is to require that additional monitor wells be drilled closer to the thermal springs if changes in the hydrothermal system are detected at closer-in monitor wells and that temporary and permanent modifications in the production/injection scheme be carried out to reverse any changes detected at monitor well locations. If such measures are not effective in stopping the migration of induced pressure or temperature changes through the hydrothermal system toward the thermal springs, the final action would be to discontinue power production.

Overall, I think these mitigation measures in combination with the monitoring program provide an adequate level of protection for the thermal springs. Some qualifying remarks are in order, however. First, I recommend that monitor wells at each location be constructed so as to communicate with both production and injection zones, as discussed in the previous section. Ideally, step-out monitor wells (as noted in measures 1 and 4) should be in place before changes are detected in close-in monitor wells in order to determine the natural level of variation in pressure and temperature away from the project area and to assure that induced changes have not already spread away from the project area. Data gathered from drilling step-out wells would also allow a better conceptual model of the hydrothermal system to be delineated for predictive purposes. To lessen the economic burden this would place on the developer, I suggest waiting until power is on line to require that at least one step out well be drilled in the vicinity of Colton Spring. Finally, there appears to be little latitude for changes in production/injection well locations or depths given present lease boundaries and concerns over premature breakthrough of cooler water. This places even more importance on the early detection of induced changes in monitor wells and serious consideration of curtailment of power production if such changes are observed.

Conclusions

The analysis presented in the Papadolpulos report describes one possible way in which the hydrothermal systems could respond to geothermal development. Other types of response are possible. A properly conceived and implemented hydrologic monitoring program should be capable of determining what the actual response is. More importantly, such monitoring provides for early detection of changes in reservoir conditions within project areas and between these areas and the thermal springs. The Papadolpulos report suggests that temperature changes in thermal springs could take place long after the development period is over and hence monitoring cannot provide protection against such impacts. This situation should not occur, however, if reservoir temperature changes in and around project areas are detected by the monitoring program in the early stages of development, and suitable mitigation measures are then implemented.

United States Department of the Interior

GEOLOGICAL SURVEY

January 4, 1988

Comments on impacts of the Mammoth/Chance geothermal development on thermal springs at the Fish Hatchery and Hot Creek gorge

Michael L. Sorey
U.S. Geological Survey
Menlo Park, California

The following comments are intended to more clearly state my opinions and recommendations regarding potential impacts of the proposed Mammoth/Chance development by Bonneville Pacific Corporation on thermal springs at the Fish Hatchery and Hot Creek gorge. My testimony at the appeals hearing on December 14, 1987, may have cast an overly negative light on the geologic and hydrologic uncertainties which exist and the consequent level of risk that this project poses to the thermal springs. I still maintain that the source and extent of hot water to be produced by this project are poorly known at present and that flow tests conducted by Bonneville Pacific in 1985 did not provide sufficient information in this regard. However, I believe it is possible to proceed with this development in a manner that would avoid significant hydrologic impacts, provided several conditions are met.

The first condition is that one or more observation wells be completed in such a way that they are in hydrologic connection with the production reservoir and located between the production area and the thermal springs. Successful completion of such wells may need to await new subsurface information from exploratory drilling and may require several attempts to drill in different locations and to defferent depths. The responsibility for this work should rest with Bonneville Pacific, whereas the responsibility for verifying that the wells are adequate for the intended purpose should rest with Mono County and the Long Valley Hydrologic Advisory Committee. Wells to monitor the impacts of reinjection may also be required if it is determined that changes induced by reinjection could reach the springs before changes induced by production.

With suitable observation wells in place, flow tests on production wells should be carried out to adequately stress the production reservoir, so as to make possible determinations of the source and extent of the available resource and the potential for lateral migration of induced pressure changes toward the thermal springs. Such tests would require that fluid be reinjected as far as possible from production wells. By comparing the results of such tests with additional tests involving reinjection closer in, it should be possible to delineate the degree of pressure support to be provided by reinjection and the likelihood of premature breakthrough of cooler water in production wells.

Recent consultations with Bonneville Pacific representatives has indicated to me their willingness to meet these conditions, as outlined in their draft proposal for short-term resource testing and monitoring. It is my opinion that if observation well drilling and well testing were properly carried out, a satifactory long-term monitoring program were in place, and mitigation measures set forth in the Conditional Use Permit were enforced as needed, the hydrologic impacts of the Mammoth/Chance development would be relatively minor. The same would be true for the Mammoth Pacific developments at Casa Diablo. Furthermore, information and experience that could be gained if these relatively small-scale projects were allowed to proceed would undoubtably assist in determining potential impacts of larger-scale geothermal developments that may occur on adjacent federal lands.

GeothermEx, Inc.
SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804-5829
(415) 527-9876
CABLE ADDRESS: GEOTHERMEX
TELEX: 709152 STEAM UD
FAX: (415) 527-8164

June 2, 1988

Mr. Michael J. Walker, Manager
Geothermal Operations
Pacific Energy
6055 E. Washington Boulevard
Commerce, CA 90040

Dear Mike:

In response to your letters of May 25 and 31, GeothermEx has reviewed the May 9, 1988 report of S. S. Papadopulos & Associates titled "Evaluation of Impacts of Geothermal Development within Long Valley". A statement of our qualifications to comment on this report, and our comments, follow:

Qualifications of GeothermEx, Inc.

GeothermEx is a U.S. corporation specializing exclusively in providing consulting, operational and training services in the exploration, development, assessment and valuation of geothermal energy. It is the largest and longest-established such organization in the Western Hemisphere. Its 4 principals have advanced degrees in earth sciences and engineering, and 17 to 30 years of domestic and international work experience in geothermal development. The staff consists of geologists, geochemists, geophysicists, drilling engineers, well-test engineers, reservoir engineers, and economic analysts, most of whom have at least 10 years' experience in geothermal energy, petroleum and groundwater development.

To date, GeothermEx has worked for 165 clients and has performed over 500 projects in 33 countries. Our reservoir engineering services typically include conceptual modeling of the geothermal system based on analysis of exploration data, well log and well test analysis, numerical simulation of reservoir and wellbore, field development optimization, field management planning, and economic analysis. Sixty-five reservoir engineering projects including low-enthalpy, single-phase water, two-phase water, steam and hypersaline reservoirs, have been completed.

Twenty-six of these reservoir engineering projects are located in the United States, including a detailed analysis of the Casa Diablo reservoir. The purpose of that study was to evaluate the resource and its potential for future development. In the study the following data were analyzed:

a) a number of short-term well tests performed during June and July of 1984;

b) daily flow and injection rate measurements for the period January to December, 1985;

c) daily water level measurements for the period August to December, 1985;

d) daily records of produced and injected fluid temperatures for the period August to December, 1985;

e) hourly downhole pressure measurements for the period February 1985 to February 1986; and

f) daily production flowrate measurements for the period June 1985 to February 1986.

This study also included the development of a conceptual hydrogeologic model, both on a local and regional scale, based on detailed drilling records, subsurface temperature and pressure distribution and geochemical data.

<u>Comments on the Papadopulos Report</u>

Although, in theory, the Papadopulos model represents a reasonable approach to making "order of magnitude" estimates of the effect of production on future temperature distribution, the results of the modeling are not valid because of erroneous assumptions made concerning both the available recharge to the Casa Diablo area and the amount of heat in storage. It appears that the modelers did not use the extensive information on these parameters which has resulted from public and private drilling and testing programs undertaken in the area. Clearly, these erroneous assumptions have resulted in erroneous modeling results which grossly overestimte temperature declines in aquifers assumed to be located downgradient from the Casa Diablo development.

Our comments on these topics are summarized below:

GeothermEx, Inc.
SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804-5829
(415) 527-9876
CABLE ADDRESS GEOTHERMEX
TELEX: 709152 STEAM UD
FAX: (415) 527-8164

1. Available Recharge

The Papadopulos model assumes a recharge rate to the system of 13.0 x 10^{-2} m^3/s of 200°C water. This is equivalent to 2,380 gallons per minute (gpm). Papadopulos states that this value is equal to the total spring discharge. However, the natural lateral flow through the Long Valley geothermal system has been estimated by Sorey *et al.* (1978) to be approximately 5,000 gpm, based on a boron balance of Lake Crowley and assuming that all the boron is contributed by the hot water reservoir. In Farrar *et al.* (1985), the flow from the Hot Creek Springs is estimated to be 4,300 gpm, based on the measured chloride flux entering Hot Creek.

GeothermEx's 1986 analysis of production data from the existing 12.5 MW (gross) plant showed that there was no evidence of pressure drawdown in the reservoir, although the wells produced up to 3,800 gpm. If the overall model of lateral flow is correct, and if the total flow through the Long Valley geothermal system was only 2,380 gpm, drawdown would have occurred in the production wells as a result of production rate exceeding recharge rate. No drawdown was detected. The results of the USGS monitoring program indicate that no decrease in flow rate from the Long Valley hot springs has been detected in the three years since geothermal production began in 1985.

Because there has been no drawdown in the wellfield or at the hot springs, it is concluded that the flow through the system must be greater than 8,000 gpm, based on the measured flow rate from wells and the estimated flow rate from springs. It is probable that the flow is significantly greater than 8,000 gpm because of the following considerations:

a. The lack of drawdown in the production wells, even at the start of plant operations, indicates that the available recharge to the production area is probably significantly greater than the present production flow rate.

b. If the lateral flow model is correct, a map of subsurface temperature distribution indicates that the main discharge of the system is not to the surface in Hot Creek gorge, but to the subsurface in the area beneath Little Hot Creek. This is based on the fact that shallow, subsurface temperatures are hotter in the Union Clay Pit well (236°F) compared to shallow subsurface temperatures near Hot Creek (well Chance 10, 218°F; well

GeothermEx, Inc.
SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804-5829

(415) 527-9876
CABLE ADDRESS: GEOTHERMEX
TELEX: 709152 STEAM UD
FAX: (415) 527-8164

Chance 7, 200°F). This means that most of the natural discharge from the systems is not being measured.

c. The possibility of significant inter-basin flow which was not accounted for by Sorey *et al.* (1978).

2. Heat in Storage

The Papadopulos model for Casa Diablo production simulates two cases reflecting two differing reservoir thicknesses:

a) all four blocks have thicknesses of 1,000 feet,

b) block 1 has a thickness of 1,000 feet, whereas blocks 2, 3 and 4 have thicknesses of only 100 feet.

The sensitivity of the model to block thickness is shown by the results of the two cases on temperature predictions for block 4 (the Fish Hatchery springs block). For case a) temperature in block four dropped only 7° C after 20 years of production plus 130 years of shut-in, whereas a drop of 34°C was obtained for case b) after 20 years of production and 55 years of shut-in.

The thickness of the thermal fluid reservoir providing production to the Casa Diablo wells ranges from about 300 to 400 feet, as defined by temperature profiles. Production is from depths of about 350 to 750 feet; this corresponds to elevations of +6,950 to +6,550 feet msl. Because flow rates from this thickness of reservoir are adequate for power production, deeper production wells have not been drilled. However, an early exploration well (Union Mammoth #1) identified a deeper reservoir beneath the presently producing reservoir. This deeper reservoir extends from an elevation of about +5,300 feet to +4,700 feet, adding another 600 feet to the known reservoir thickness beneath Casa Diablo, and giving a total thickness of about 900 to 1,000 feet. This thickness corresponds to case a) above, in which the temperature drop in block 4 was minor.

Based on what is known of the stratigraphy in the area, there is no reason to believe that this 1,000 ft. thickness decreases to 100 ft. over a distance of 3 miles. Indeed, temperature profiles from well Magma Chance No. 1 indicate a minimum reservoir thickness of 500 feet in block 4. This is a minimum thickness because the well did not reach the bottom of the reservoir.

GeothermEx, Inc.
SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804-5829
(415) 527-9876
ABLE ADDRESS: GEOTHERMEX
ELEX: 709152 STEAM UD
AX: (415) 527-8164

3. Effect of Reservoir Cooling on Fish Hatchery Springs

The Fish Hatchery springs originate from a shallow, cool water aquifer contained in young basalt flows ranging in elevation from about +7,050 feet to +7,200 feet msl. A small amount of thermal fluid leaks upward and mixes with the water in the basalt aquifer. GeothermEx's geochemical studies indicate that only about 2% of the flow of the Fish Hatchery springs consists of fluid originating in the thermal reservoir. Consequently, only 2% of the 7°C temperature drop predicted by the model, that is, 0.14°C, would actually affect the Fish Hatchery springs. Even for case b), which is unrealistic, the temperature decline would be only 0.7°C.

Futhermore, the temperature declines forecast by Papadopulos are based on a highly unrealistic decline of 150°C in the production area, whereas it is unlikely that the plant could maintain production, for economic reasons, after a temperature drop of about 30°C, that is, only 20% of the temperature drop modeled by Papadopulos. Based on the Papadopulos model, this means that the reservoir temperature in block 4 would not decline more than about 7°C (20% of 34°C) after 150 years because of economic restrictions on plant operation.

In summary, it is our opinion that the Papadopulos report is based on a number of erroneous assumptions concerning the geology, hydrogeology and heat content of the Casa Diablo system, as well as erroneous assumptions concerning the economic restraints to developing the reservoir. These erroneous assumptions have resulted in a report which is misleading and which can not be used as a guide to predicting future temperature trends related to geothermal development.

Yours truly,

James R. McNitt
Vice President, Exploration

JRM:mjm

santa fe geothermal, inc. A Subsidiary of Santa Fe International Corporation

JUN 17 '88

June 15, 1988

Mark S. Ziegenbein
787 N. Main Street
Suite P
Bishop, California 93514

RE: Papadopolous and Associates Report

Dear Mark:

We wish to comment on the report by S.S. Papadopolous and Associates entitled "Evaluation of Impacts of Geothermal Development within Long Valley". The report, in our opinion, is erroneous. The model utilized is far too simplistic and the boundary conditions used do not conform to known and clearly documented facts concerning the hydrologic environment in the Long Valley Caldera. Their failing may stem from their inexperience with geothermal systems which led them to several erroneous assumptions and conclusions to wit:

1. The thermal discharge via springs does not equal the thermal input into a geothermal system as the majority of the heat is convected downwards.

2. The measured thermal discharge used in the calculations is in error by a factor of approximately 2.5 based on references cited in the report but apparently ignored by the authors.

3. No evidence exists to support a thermal reservoir of 200°C in any of the blocks utilized in the study. Evidence from nearby drilling to depths of 5300′ indicate significantly lower reservoir temperatures.

4. Using the actual reservoir temperatures and the model temperature declines the proposd Casa Diablo plants would drop below their lower operational limit in 4 years. The plants would have to be retrofitted to handle the lower temperatures. Even so the proposed plants wouldn't last beyond 10 years based on the models calculated temperature drop and equipment limitations. The models prediction of a 15°C temperature decline in a short time would adequately indicate the need for mitigation far in advance of any "irreversible effects".

5. Since the Fish Hatchery springs are a mixture of cold meteoric water and geothermal water, the temperature impact will not be equal to the "reservoir" temperature change but rather proportional to the amount of thermal water in the Fish Hatchery springs. Hence the temperature changes of the springs will be between 0.07°C and 0.67°C depending on which scenario you choose. It is arguable that there is no thermal component to the Fish Hatchery springs, but rather they are warmed as the result of conductive heating during their subsurface movement.

13455 Noel Rd. • Suite 1100 • Two Galleria Tower • Dallas, Texas 75240-6620 • Telephone (214) 701-7530

Mark S. Ziegenbein
June 15, 1988
Page Two

We suggest that the interaction of warm fluids with their surrounding reservoir rocks leaches the constituents interpreted to represent the mixing of geothermal fluids with the groundwater.

Previous model studies (incorporated in the E.A. for the PLES-1 development) on the impact of development by groups with experience in geothermal clearly show that the temperature effects predicted by Papadopolous & Associates will not occur. In comparison to Pappadopolous & Associates simplistic heat budget model, these previous studies employed more rigorous and comprehensive modeling techniques which match the existing production data from the MBP-1 plant. The Papadopolous & Associates heat budget model will not match the observed production data and in fact is in error with respect to the initial reservoir temperatures by as much as 60°F at Casa Diablo and 110°F at Chance Ranch.

If Papadopolous and Associates wish to invalidate the previous findings, they need to demonstrate why the previously used models are inaccurate by utilizing rigorous calculations that can fit the observed data base.

Yours truly,

Timothy K. Linscott
Exploration Manager

TKL/te

JUN 8 1988

4.8

STATE OF CALIFORNIA—THE RESOURCES AGENCY

GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF CONSERVATION

DIVISION OF OIL AND GAS

1416 9th STREET, ROOM 1310

SACRAMENTO, CALIFORNIA 95814

(916) 445-9686

June 2, 1988

Sean Hagerty
Department of the Interior
Bureau of Land Management
2800 Cottage Way
Sacramento, California 95825

Dear Mr. Hagerty:

The Division of Oil and Gas is pleased to review the EVALUATION OF IMPACTS OF GEOTHERMAL DEVELOPMENT WITHIN LONG VALLEY, prepared by S.S. Papadopulos & Associates, Inc. for the Bureau of Land Management (BLM). We appreciate BLM's willingness to share this information.

The Division is mandated by the State of California to ensure that wells for the discovery and production of geothermal resources be drilled, operated, maintained, and abandoned in such a manner as to safeguard life, health, property, and natural resources, and to prevent damage to, and waste from, the underground geothermal deposits, and to prevent damage to underground and surface waters suitable for irrigation or domestic purposes.

The Division has also received and reviewed Mesquite Group, Inc.'s draft comments and summary analysis, dated May 26, 1988, on the S.S. Papadopulos and Associates, Inc. Report. For the most part, we agree with Mesquite's findings, and will therefore, not reiterate their comments. Our comments address some areas not covered by Mesquite Group, Inc. and are as follows:

1. Clarification is needed as to the method of designation of area blocks (i.e. block 1, 2, 3, and 4). They acknowledge that the lateral extent of the resources may be controlled by fault zones, which we agree is a distinct possibility. If this is so, the Hilton Creek (Mammoth-Airport) fault zone and the unnamed fault zone to the west trending through the schoolhouse, should mark the boundaries of their chosen blocks. According to the consultants' logic, the hatchery springs, which occur on the unnamed fault zone, would not be effected by production in the Chance Project since most of the Chance wells are on the Hilton Creek Fault Zone, and thus, on a fault block down-gradient from the springs.

2. The report refers to block 4 as the fish hatchery block, yet, the fish hatchery springs are located in block 3.

3. After all the effort the consultants put into their model, why didn't they predict the change in the hatchery springs temperatures as the end product? Since the thermal component of these springs is only 2%-5%, we feel that the changes in spring temperatures would be minor even under the worst predictions for decrease in reservoir temperatures.

4. In equations 3,4, and 6, Tr and Tiw are described as follows: Tr is the temperature of the reservoir, in degrees Celsius; Tiw is the temperature of the inflowing water, in degrees Celsius. How could you multiply the remainder of the terms by temperature in degrees Celsius? Surely the modelers must mean degrees Kelvin. If the modelers actually did use degrees Celsius, the apparent-heat flow into the system would be erroneously low.

5. In equation 6, conductive heat-flow into the system was omitted. The conductive heat-flow as measured at the surface may appear low if the overlying cold groundwater is drawing off the heat. However, the conductive heat-flow into the system may be significant, and would increase in significance if the reservoir temperature actually starts declining as predicted. The increase in thermal gradient would actually cause conductive heat-flow into the system from below and from the sides, to increase, and cause conductive heat-flow out of the system through the top, to decrease.

The Division legislative mandate is to assure that geothermal projects are conducted in an environmentally sound matter. All concerned individuals, local, state, and federal agencies, and geothermal producers are encouraged to work with us in setting up environmentally sound procedures for operating geothermal fields. If we can be of any further assistance, please don't hesitate to call me or Rob Habel at 323-1787.

Sincerely,

Robert S. Habel

for Richard Thomas
Geothermal Officer

cc: M.G. Mefferd
Robert Habel