WITTER SPRINGS AREA

ENVIRONMENTAL ANALYSIS RECORD

PROPOSED GEOTHERMAL LEASING

DRAFT

U.S. Department of the Interior
Bureau of Land Management
Ukiah District Office

1791 (Witter Springs)
CA-050-230

DRAFT

Environmental Analysis Record

for

Proposed Geothermal Leasing

in the

Witter Springs Geothermal Activity Area

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Tables and Other Drawings

The maps and figures presented in this document are for information only. They are not intended to be engineering or construction documents. Maps at scales large enough to be used for engineering design are beyond the scope of this report. Such maps will be on file at the BLM Ukiah District Office, 555 Leslie Street, Ukiah, California 95482.

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ENVIRONMENTAL ANALYSIS REPORT
WITTER SPRINGS GEOTHERMAL ACTIVITY AREA

I. INTRODUCTION

The Secretary of the Interior is charged with the implementation of the Geothermal Steam Act of 1970, which provides for the development of federally owned geothermal resources. The Bureau of Land Management (BLM), the agency responsible for Federal lands with known geothermal resources, has been delegated the authority to process and supervise leases.

There are five Known Geothermal Resource Areas (KGRA) with adjacent non-competitive lease application areas in the BLM Ukiah District. By law, BLM is required to take action, either positive or negative, on these known interests in geothermal resource development. A long-term schedule for meeting this requirement has been prepared by BLM. The next scheduled action involves an area encompassing the Witter Springs KGRA. An important step in this action is preparation of an environmental analysis record (EAR). The primary objective of this task is to describe the existing environment in the study area, the impacts of proposed action and alternatives and recommended methods to mitigate impacts.

The area proposed for geothermal leasing is the Witter Springs Known Geothermal Resource Area (KRGA) and nearby noncompetitive application areas. A KGRA is an area in which the geology, nearby discoveries, competitive interests, existence of hot springs, or other indicia would, in the opinion of the Secretary of the Interior, engender a belief that the prospects for extraction of geothermal resources may be economically feasible. A non-competitive application for geothermal resources may be filed on lands not within a KGRA and open to leasing under the mineral leasing laws of the United States.

The lands considered for leasing in this analysis consist of two types; national resource lands and U. S. mineral reserved lands. National resource lands (NRL), are lands which have never passed into private ownership and the federal government owns both the surface and mineral estate, U. S. mineral reserved lands are lands which through patenting under various homestead laws ownership of the surface and mineral estate has been split, the surface being privately owned, but the mineral estate remaining the property of the Federal government. The question of whether or not geothermal resources were reserved to the Federal government under the homestead laws is a matter now being decided in the courts. No. U. S. mineral reserved lands will be leased for geothermal development until the courts rule on this matter.

The study area for this EAR is centered approximately 12 miles north-northwest of Lakeport, California, and 11 miles northeast of Ukiah, California. The Geysers KGRA is located 20 miles to the south. It is the most productive field in the world, generating over 500 million watts of electrical power from dry steam.

A programmatic environmental statement (EIS) on geothermal development was prepared by the U. S. Department of Interior and published in October 1973. The EIS describes, without going into site-specific detail, the impacts of geothermal development. Volume II of the EIS included an analysis of three areas in California, one of which was The Geysers KGRA. Following public review and Interior Department approval, lease sales were held and leases were issued on NRL within the KGRA.

While leasing in itself should not greatly affect the environment, the ensuing activities, particularly if the field is fully developed, will have impacts of varying intensities. This EAR considers not only the initial leasing by BLM but also those probable actions deriving from such leasing. This EAR examines in detail areas adjacent to and within the Witter Springs KGRA. The analysis was initiated based upon interest in these areas, evidenced by the number of lease applications filed.

This EAR incorporates the findings contained in the programmatic environmental statement, the supplement (Volume II) on the original Geysers KGRA, the EAR on The Geysers Expansion Area, and various other environmental studies. However, it is site-specific to the Witter Springs area and contains significantly greater detail on the extent of environmental impacts in this new area. It should be recognized, in reading this EAR, that appropriate data from the EIS was utilized in developing each section of the EAR, but that a number of impacts and their specific local effects are examined to a greater degree than in the programmatic EIS.

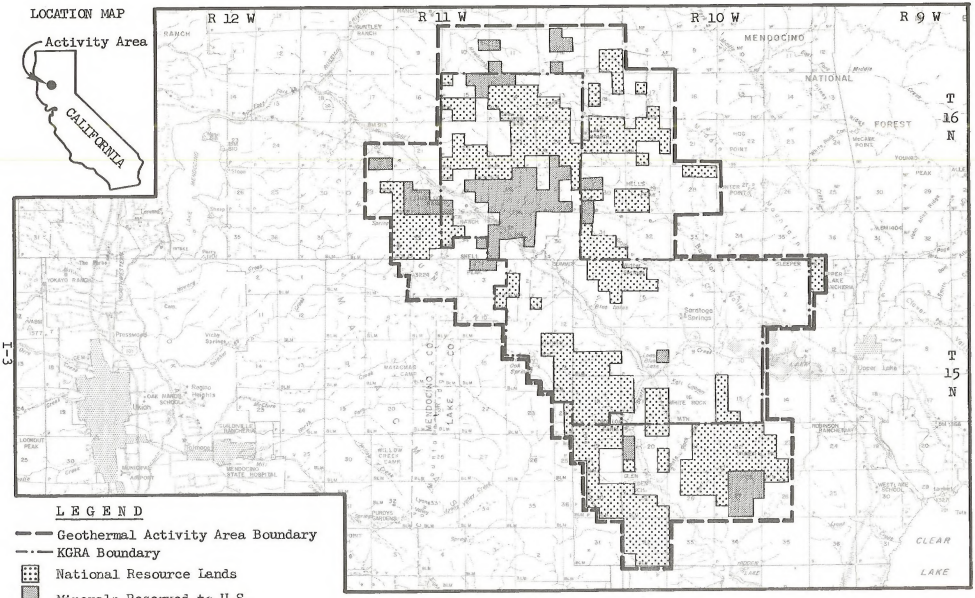
The Witter Springs area was selected for study because it appears to be a continuation of the geologic trend of The Geysers field and also because of competitive and noncompetitive interests. Since January 1974, interest in NRL outside The Geysers KGRA was indicated by receipt of numerous noncompetitive lease applications. One reason for the intensity of interest in the Witter Springs area is the hope that the steam is dry or supersaturated. Most geothermal steam fields in the world produce electricity by flashing hot water to steam with resultant large quantities of unusable saline water. Disposal of this water increases environmental impacts and costs to a level where the venture may be uneconomical.

ALTERNATIVES

1. Lease only portions of the total area. The area as shown on Map 1 has been selected for systematic environmental evaluation purposes. An individual decision could be made whether or not to lease all or part of Federal lands within each area, resulting in a number of possible combinations.

2. Decline to lease. Chapter IV (Volume I) of the programmatic environmental statement and Energy Alternatives: A Comparative Anslysis (1975) present extensive discussions of alternative sources of electrical energy, conservation of energy, and alternative types of geothermal leasing programs.

The mitigating measures listed in the mitigation sections of this study have been developed by the Ukiah BLM staff. Unless comments received during the public review period require modifications, these measures constitute a commitment on the part of the Bureau of Land Management. The proposed action or alternatives will not be implemented without inclusion of the specified measures.


LOCATION MAP
Activity Area
CALIFORNIA
R 12 W
R 11 W
R 10 W
R 9 W
T 16 N
T 15 N
MENDOCINO NATIONAL FOREST
LAKE
CLEAR LAKE
LEGEND
Geothermal Activity Area Boundary
KGRA Boundary
National Resource Lands
Minerals Reserved to U.S.
STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management
SCALE: 1/2" = 1 MILE
MT.DIABLO MERIDIAN
WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Land Status
MAP 1

II. PROPOSED ACTION

The proposed action is to lease 8162.61 acres of federally owned mineral resources for development of potential geothermal resources in areas within and adjacent to the Witter Springs KGRA. Map No. 1 shows the location of these areas. Legal descriptions of the areas being considered for leasing are given in Appendix A.

The programmatic environmental impact statement discussed, in Volume I, Chapter I, the national potential for development of geothermal resources, the Department of the Interior's mineral management policies, the administrative roles of the Geological Survey and the Bureau of Land Management and on National Forest lands, the U.S. Forest Service . Chapter I-C (pages I-8 and I-9) establishes the procedures for preparation of environmental analysis records and, where issuance of geothermal leases constitutes a major Federal action significantly affecting the quality of the human environment, environmental impact statements.

The history of The Geysers field is discussed in Volume II (pages V-8 - V-10) of the programmatic EIS. It also describes the proposed leasing program, which culminated in the January 1974 lease sale within the original Geysers KGRA.

NEED FOR PROPOSED ACTION

The national energy situation (as of October 1973), and the potential of geothermal resources is discussed in Chapter II of the programmatic EIS. The energy shortages experienced during the winter of 1973-74, caused in part by the embargo by Arab petroleum exporting nations have helped to crystallize the image of the national energy crisis. The per capita energy consumption continues to escalate at an alarming rate. Fossil fuels continue to be burned to produce heat for conversion to electricity. The following Graph 1 shows a projection of present consumption and production trends to 1980. Graph 2 projects U. S. energy consumption by source to the year 2000.

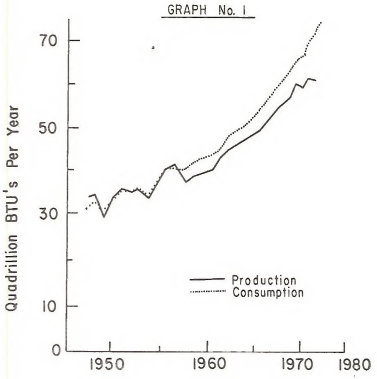
Although development of geothermal resources for production of electricity will probably not "provide a significant portion of total energy consumption in the Nation by 1985 . . . it could have significant local area importance" (Final EIS, Geothermal Leasing Program, 1973, vol. I, p. II-9).

SCOPE OF DEVELOPMENT

Because there is no actual proposed plan of operation at this time, much of what is presented in this section, as well as in the analysis of the impacts of proposed development on the existing environment, is based on information and data gathered from activities at Pacific Gas and Electric Company's

facility at The Geysers. This is presently the most productive field in the world and is located approximately 26 miles south-south east of the Witter Springs study area.

It is assumed that the geothermal system within the Witter Springs study area is the same as, or similar to, that at The Geysers, a vapor-dominated system. "Saturated steam and water are thought to coexist within the reservoir. The steam phase controls the pressure. With a decrease in pressure due to production through a well bore, the heat contained in the rocks dries and superheats the steam" (Final EIS, Geothermal Leasing Program, vol. I, p. II-10).

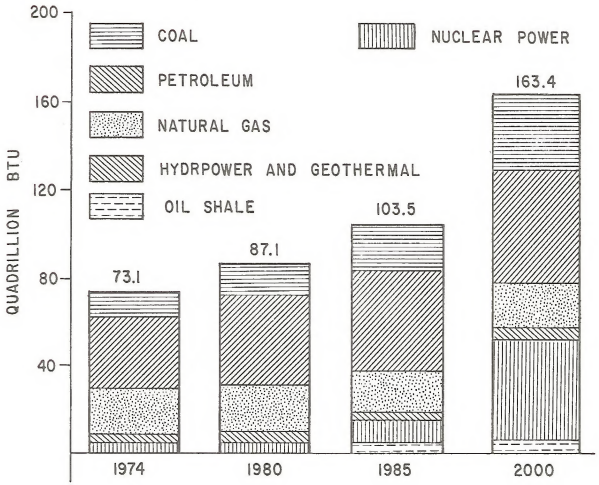


Total U.S. Energy Production and Consuption, 1947 - 1973

Source: Adapted from the Ford Foundation, 1974:
2 (based on Interior, 1972: 11).

GRAPH No. 2

UNITED STATES ENERGY CONSUMPTION BY SOURCE, 1974-2000



BUREAU OF MINES
DEPARTMENT OF THE INTERIOR
1975

Estimates of geothermal reserves vary considerably (see Table 1). Several factors explain the variance in reserve and resource estimates. The limited exploration for geothermal resources to date has resulted in a lack of agreement on unexplored reservoir characteristics, on the time required for the needed new technologies to become commercially available, and on future changes in cost factors within the energy sector of the economy, some of which would stimulate geothermal production.

The estimates range from 3,500 to 132,000 Mwe (megawatts of electricity) in 1985. In Table 2, the economic dimension is added to the resource estimate, indicating price rises required to stimulate additional production.

Most estimates indicate that geothermal energy may make substantial contributions in the western U.S. by the end of the century. By 1985, contributions are postulated to be on the order of 1 percent of U.S. electric capacity.

Although implementation of the specific action of leasing involves only technical administrative actions, the result of leasing will be a chain of further actions. Developing the lease will have a direct impact on the environment. Therefore, this analysis deals primarily with the effects of actual development.

A more detailed description of the general process of development of geothermal resources is found in Chapter II of Volume I of the programmatic EIS (pages II-24 to II-36) and in Energy Alternatives 1975 (pages 8-1 to 8-29).

Table 1

Potential Installed Geothermal Capacity by 1985

Organization Cited (with scenarios used from each)	Projected Capacity in Mwe* 1985
National Petroleum Council[a]	
Most optimistic scenario (maximum technological progress with no impediments)	19,000
Large areas of land available with no environmental delays	9,000
Realistic estimate based on current costs and technologies	7,000
Least optimistic	3,500
Hickel Panel[b]	
Moderate R&D Program	19,000
Accelerated R&D Program	132,000
Bureau of Mines[c]	
Based on projects currently under consideration	4,000
Atomic Energy Commission[d]	
Active R&D program to stimulate production	20,000
Bureau of Land Management[e]	
All western sources (assumes technology for hot water systems available)	7,000 to 20,000
Rex and Howell[f]	
Assumes hot dry rock systems are now technically exploitable. Estimate is for development in western U.S. only	400,000[g]

Sources: [a]Kilkenny, 1972: 27-35.
[b]Hickel, 1972: 15.
[c]Interior, 1973: Vol I, p. II-19.
[d]AEC, 1973: 119.
[e]BLM, 1973: 347.
[f]Rex and Howell, 1973: 63.

[g]By 1993.

* Mwe = Megawatts of Electricity

Table 2

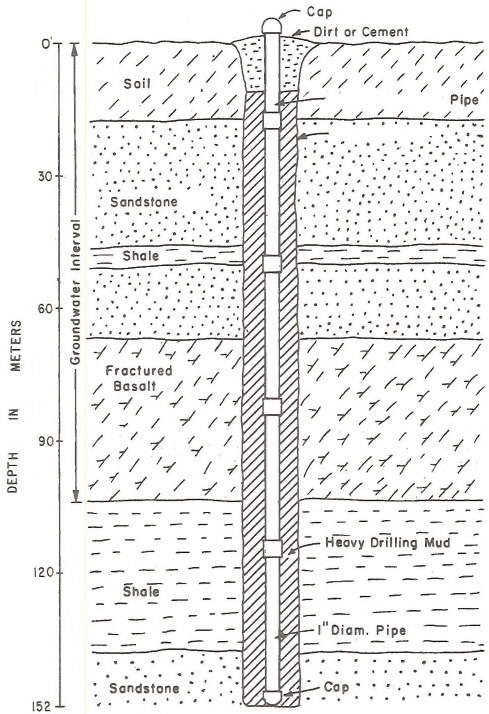
EFFECT OF PRICE ON POTENTIAL INSTALLED GEOTHERMAL CAPACITY BY 1985

National Petroleum Council[a]		Rex and Howell[b]			
Power Cost (mills per kwh)	Installed Capacity 1985 (Mwe) *	Fuel Price[c] (mills per kwh)	Known Reserves	Probable Reserves	Undiscovered
			Units Mwe for 50 Years		
5.25	7,000	2.9-3.0	2,000	10,000	20,000
5.75	14,000	3.0-4.0	60,000	800,000	4,000,000
6.25	19,000	4.0-5.0	0	1,200,000	24,000,000

Sources: [a]Kilkenny, 1972: 27-35, 1972 dollars.
[b]Rex and Howell, 1973: 63, 1972 dollars.

[c]A price of 2.9 mills per kwh (cost of the produced steam) is roughly equivalent to a power cost of 5.25 mills per kwh.

* Mwe = Megawatts of Electricity



1 meter = 3.28 feet

TYPICAL TEMPERATURE OBSERVATION HOLE
IN THE GEYSERS AREA

FIGURE 2

used are much the same as those for drilling oil or gas wells. Heavy duty roads, usually 4.3 m (13.8 feet) wide and surfaced with gravel, are necessary to allow access for large trucks.

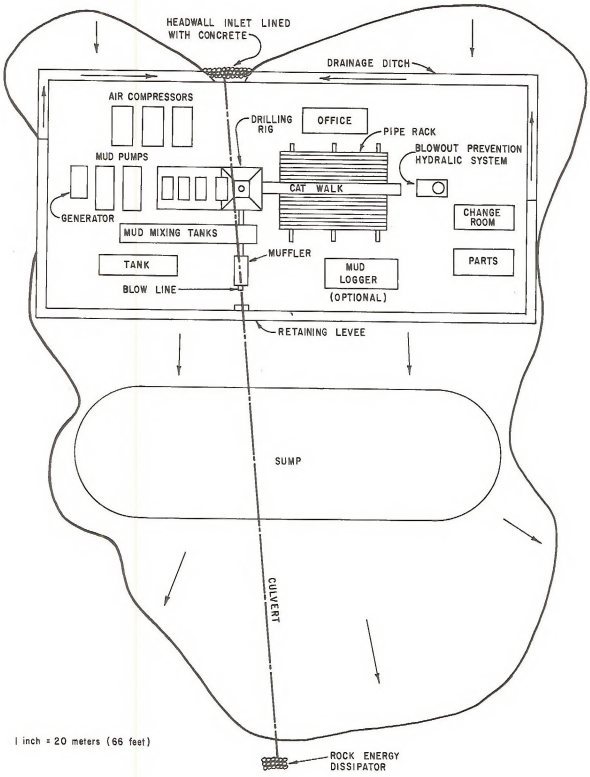
A drilling site at least 45 m by 75 m (144 by 241 feet) must be constructed to accommodate the necessary equipment. The size and strength of the drilling rig must be adequate to support the weight of 3000 m (9624 feet) of drill pipe (approximately 77,000 kg (169,400 lbs.)) and to lift the pipe from the hole (at least 750 KW of mechanical power needed). The tallest drilling rig now in The Geysers area is 49 m (157 feet) high and is visible for some distance.

In 1965, the California Division of Oil and Gas began the regulation of geothermal drilling operations, and subsequently, other state and county agencies began to control air and water discharge and land use on private lands. Operational constraints are now imposed on private lands by the county in the land use permit, by the Division of Oil and Gas in the drilling permit, and by the Regional Water Quality Control Board in the waste discharge permit. On public lands, the BLM and the USGS regulate operations. Roads and drilling sites must be constructed to prevent excess erosion or unstable slope conditions on the steep hillsides. One method of erosion control is to push brush to the area below the drilling site and flatten it with a bulldozer. The typical site construction and disposition of equipment are shown in Figures 3 and 4.

U. S. Geological Survey and D.O.G. require that blowout prevention equipment be used during the drilling of all geothermal wells. This equipment must control the well if any adverse pressure conditions are encountered. Figure 5 shows the required wellhead equipment for drilling with mud and then air in a low pressure (less than hydrostatic) geothermal area. Only one well has blown out during the drilling phase of operations at The Geysers. Well "Thermal" 4 blew out in September 1957 and is presently discharging about 80,000 kg/hr (176,000 lb/hr.) of steam to the atmosphere.

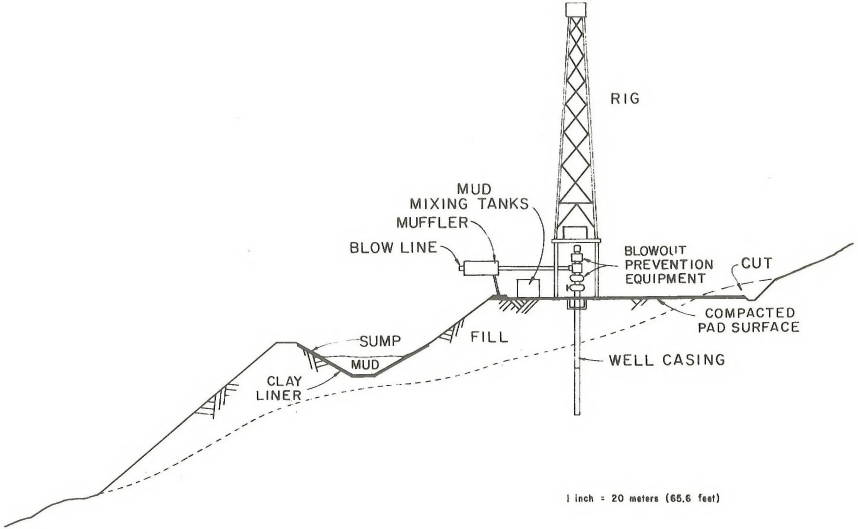
The shallow portion of a well is drilled with mud as the circulating fluid. Drilling with mud usually continues to a depth of 1,370 m (4395 feet), where the increases in temperature and decreases in permeability indicate the need to switch to compressed air. Large pumps circulate the mud and a shaker screen at the surface diverts the rock cuttings to a waste sump while allowing the mud to pass through to the mixing tanks and be recirculated. A sump with an impervious lining or a steel tank is used to store cuttings and waste fluid during drilling. Approximately 240 m^3 (314 yd^3) of drilling fluid are used in an average well and must be removed before air drilling can begin. The cuttings and solid components of the drilling mud are nontoxic and are disposed of in a site protected from erosion. The toxic fluid is transported to an approved Class I disposal site. Many additives are used to control the physical and chemical properties of the mud, and decisions on the disposal requirements are made by the North Coast Regional Water Quality Control Board. The composition of a typical mud is given in Table 3.

At several stages during the drilling operation, steel casing pipe is cemented into the hole to provide the necessary support to keep the well open. The surface casing also prevents shallow groundwater from entering the well. Cement is squeezed from the bottom of the hole and fills the space between the casing and the hole wall. The hard sandstone in the producing zone has sufficient strength to be left as an open hole.



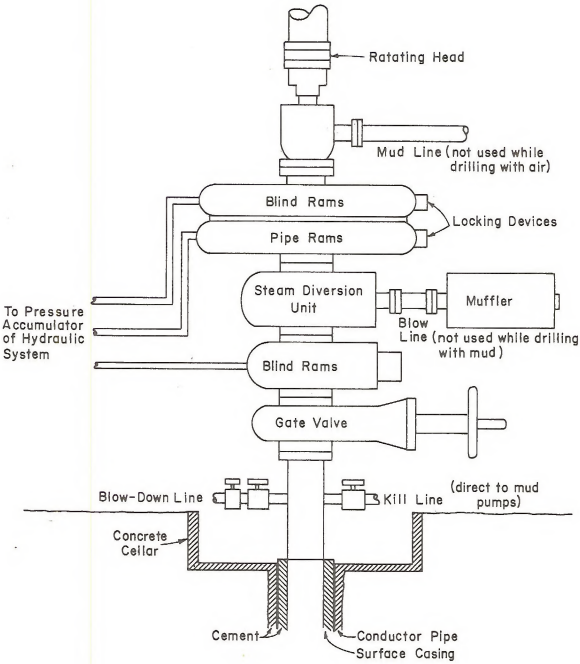
TOP VIEW OF A TYPICAL DRILLING SITE
AT THE GEYSERS GEOTHERMAL FIELD

FIGURE 3



CROSS SECTION THROUGH TYPICAL DRILLING SITE
AT THE GEYSERS GEOTHERMAL FIELD

FIGURE 4



REQUIRED BLOWOUT PREVENTION EQUIPMENT
FOR DRILLING WITH MUD AND THEN AIR
AT THE GEYSERS GEOTHERMAL FIELD

FIGURE-5

Table 3

Typical Drilling Mud Composition Used

At The Geysers Geothermal Field

Component	Composition	Volume %
Water	H_2O	93.09
Bentonite	$NA_{.33}Al_{2.67}Si_{3.67}O_{20}(OH)_2$	5.93
Quebracho (Wood extract)	Organic	0.45
Caustic Soda	NaOH	0.32
Sodium Bicarbonate	$NaHCO_3$	0.09
Lignin (Tannathin)	$C_{212}H_{171}O_{41}N_3S$	0.12

Additional Material Used

to Control Lost Circulation

Cottonseed Hulls	Organic
Walnut Shells	Organic
Mica	$KAl_3Si_3O_{10}(OH)_2$

The typical casing program of a completed well is depicted in Figure 6.

Compressed air, at flow rates up to 70 m^3/min (2474 ft^3/min) is used as the drilling fluid when penetrating the probable steam zone. Air drilling does not clog or damage the steam producing fractures as does mud drilling. Drilling continues through the probable steam zone until an economic quantity of steam is encountered or until the economic limiting depth is reached (approximately 3,000 m (9842 ft)). If steam is found, the steam aids in carrying the rock cuttings to the surface and less compressed air is needed (see Figure 7.)

During the air drilling of a well 2,290 m (7513 ft) deep (such as that shown in Figure 7) approximately 22 m^3 (29 yd^3) of rock cuttings and dust are blown into the sump. The cuttings settle into the sump, downslope of the drilling operation. Air drilling emits significant noise, and mufflers of several designs have been used to reduce the noise. The sound level measurements in Table 4 are typical for air drilling in a steam reservoir. Associated equipment such as air compressors, diesel motors, electrical generators, and pumps all contribute to the total noise emitted by the drilling rig.

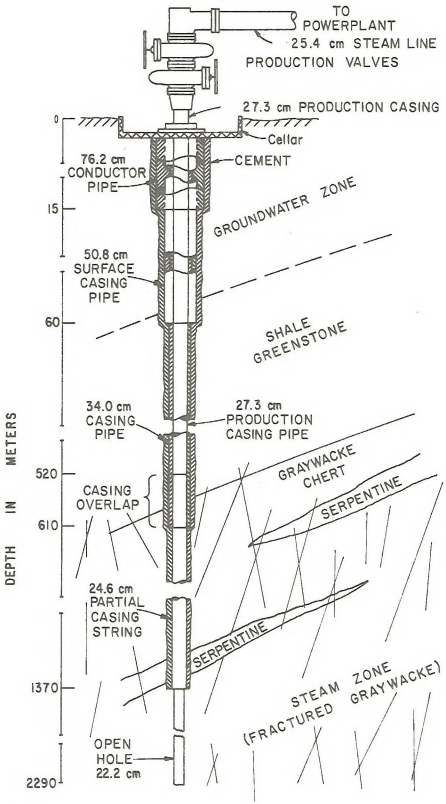
Table 4

Sound Measurement for 90,000 kg/hr (198,414 lb/hr) steam flow at 7.6 m (25 ft) perpendicular to blow direction

Equipment	Sound level
Blow line	120 dB (A)
Blow line with air sampler	95 dB(A)
Blow line with air sampler and water injection	85 dB (A)

The average initial steam flow is 68,000 kg/hr (149,600 lb/hr), but the initial steam production may be as much as 172,000 kg/hr (378,400 lb/hr). Wells producing less than 32,000 kg/hr (70,400 lb/hr) are considered uneconomical and are abandoned. The abandonment of a well is also regulated by the USGS and the Division of Oil and Gas. A successful exploratory well will be cleaned and tested for approximately 20 days. In cleaning, the loose rock fragments from drilling are blown from the well. Testing involves flowing the well to the atmosphere and measuring the production rates at several different pressures to evaluate the steam reservoir. Noise is emitted during testing, and several types of mufflers have been used in an attempt to control the noise.

The geothermal steam at The Geysers contains minor amounts of other gases which are released to the atmosphere. The composition of the steam varies widely from well to well and during the life of a single well. The more shallow wells contain less steam and more of the other gases. Representative gas analyses are given in Table 5. Hydrogen sulfide has a strong odor and is considered an air pollutant. An average well producing 68,000 kg/hr (149,600 lb/hr) of steam would also produce 15 kg/hr (33 lb/hr) of hydrogen sulfide.

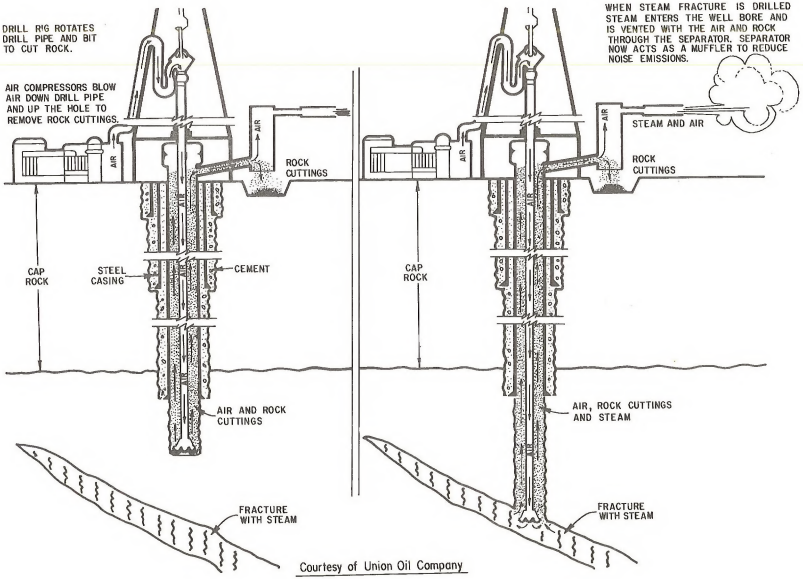


1 meter = 3.28 feet
1 cm = 0.4 inch

TYPICAL CASING PROGRAM FOR A WELL IN
THE GEYSERS GEOTHERMAL FIELD

FIGURE-6

GEOTHERMAL DRILLING



Courtesy of Union Oil Company

FIGURE 7

Table 5

Constituents Carried
in the Steam from Wells at The Geysers Field[1]

Constituent		Concentration (mg/kg) (PPM) low	average	high	Average[2] Flow into 110 MW unit kg/hr	(lb/hr)
Carbon dioxide	(CO_2)	290	3260	30600	2700	5940
Hydrogen sulfide	(H_2S)	5	222	1600	180	396
Methane	(CH_4)	13	194	1447	160	352
Ammonia	(NH_3)	9.4	194	1060	160	352
Boric acid	(H_3BO_3)	12	91	223	75	165
Nitrogen	(N_2)	6	52	638	43	95
Hydrogen	(H_2)	11	56	218	46	101
Ethane	(C_2H_6)	3	8	19	6.6	14.5
Arsenic	(As)	0.002	0.019	0.05	.016	.035
Mercury	(Hg)	0.00031	0.005	0.018	.004	.0088

[1]From measurements of 61 steam wells from 1972 through 1974.

[2]Based on steam input of 821,000 kg/hr (1,806,000 lb/hr).

During testing, the drilling rig and associated equipment are removed, the sump is dried, toxic materials removed, then filled with dirt, and the graded area is cleared of debris and planted to control erosion.

To prevent condensation of steam in the well and possible damage to the producing zone, the well flows continuously through a small diameter pipe which vents to the atmosphere. This pipe, called the bleed line, is usually 6 mm (.24 in) in diameter, but for wells with greater than normal heat loss, a larger diameter pipe is necessary to prevent well damage. The average flow through the bleed line is 450 kg/hr (990 lb/hr) of steam, and accompanying noise and hydrogen sulfide emissions. Using the average composition of steam given in Table 5, the output from a normal bleed line is 0.1 kg/hr of hydrogen sulfide. A rock filled ditch provides adequate noise suppression for most bleed lines (Table 6).

Table 6

Noise Levels for Bleed Lines

(in dB(A) at 1.5 m (4.92 ft) from outlet)

Equipment	Sound Level
Open hole	86 dB(A)
Rock filled ditch	65 dB(A)

After an initial discovery well is drilled, another two or three wells are generally needed to confirm the amount of geothermal energy available in the new area. If enough of the resource exists to supply a power plant, the exploration company will then seek a steam purchaser. After a purchase agreement is made, applications are filed with the California Public Utilities Commission for construction of the power plant and with the U. S. Geological Survey for drilling the necessary development wells.

3. Field Development - This is continued drilling to prove enough reserves to supply a generating plant - 15 to 25 wells per section. The discrete operations are the same as exploration drilling but much more intensive. In addition, there are the following:

a. power plant construction

b. pipeline construction

c. electric transmission line construction

1) Drilling

The drilling of development wells is generally postponed until the beginning of power plant construction in order to minimize the time the wells must remain idle. The optimum timing is to complete drilling and testing of the

wells at the same time construction of the power plant is completed and system testing can begin.

Development wells are drilled in the same manner and with the same equipment as the exploration wells. The average well cost drops because of lower individual expenses for transportation and for support facilities. Approximately 90 percent of the development wells in The Geysers are successful. The unsuccessful wells may have lower temperature or lower permeability than is necessary for economic production, but these wells may be usable as injection wells for disposal of excess steam condensate.

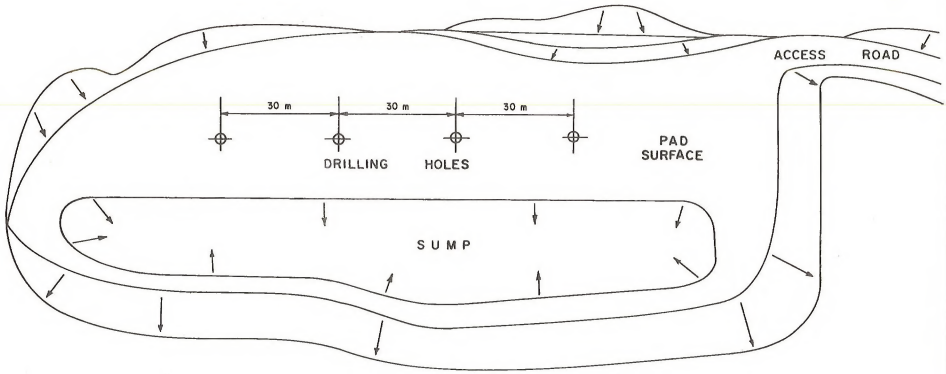
Development wells are spaced in such a way that the steam pipeline distance to the power plant is less than 1.6 km (1 mile). Longer pipelines result in greater energy loss from the steam and are uneconomical. In order to reduce the surface disruption from the construction of drilling sites, two or more wells are directionally drilled from a single site where conditions permit. Control can be imposed during drilling so that the general direction of the well is maintained. A typical drilling site for multiple wells is shown in Figure 8. The bottom hole locations of the wells will be a minimum of 20 acres from each other to prevent interference.

Each well is cleaned out and tested in the same manner as described for exploration wells, and it is then discharged through a bleed line until connection with the power plant is complete. Plate 1 shows the well head of a producing geothermal well at The Geysers.

2) Power Plant Construction

The California Public Utilities Commission has the regulatory authority for approving or denying the construction of proposed power plants. Future geothermal plant construction on private lands will fall under the jurisdiction of the State Energy Resources Conservation and Development Commission. At the present time, it takes approximately three years for the Public Utilities Commission to hold the necessary hearings and review the environmental impact report before a Certificate of Public Convenience is issued. Similar procedures will be required for power plant siting on federal lands. For Unit 12, a permit was requested July 19, 1972 and The California Public Utilities Commission approved construction in March, 1976. Construction of the power plant requires an additional two years. Thus, there may be up to five years from the initial permit request until operation of the plant can begin.

For the construction of a plant, approximately 40,000 m^2 (10 ac.) of land is cut or filled to provide an area of 20,000 m^2 (5 ac.) which is leveled, paved, and fenced. Structures which are built on the site include the turbine building, cooling tower, hydrogen sulfide treatment plant, and the power transformer and switching system. Supporting installations consist of storage tanks, a septic tank, and sewage leach field. Figure 10 gives a block diagram view of a typical power plant site, and Plate 2 shows Units 7 and 8 in operation. A maximum of 100 employees is required during the plant construction.



1 inch = 24 meters (79 feet)

FIGURE 8

TYPICAL DRILLING SITE FOR MULTIPLE WELLS
IN THE GEYSERS AREA

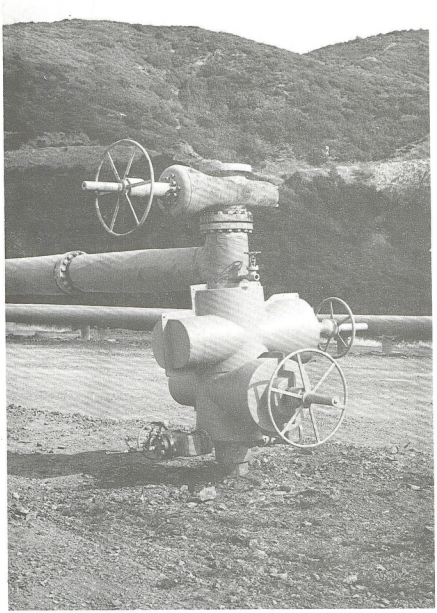


Figure 9

PRODUCING WELL HEAD, CONTROL VALVE,
AND ATTACHED STEAM LINE

Table 7. Electrical Generating Units at

The Geysers Geothermal Field, Pacific Gas and Electric Company

Unit[1]	Total Capacity (MW)	Net Capacity (MW)	Steam Flow (kg/hr)	Steam Supplier
1	12.5	11	110,000	Union[3]
2	13.8	13	120,000	Union
3	27.5	27	230,000	Union
4	27.5	27	230,000	Union
5	55	53	410,000	Union
6	55	53	410,000	Union
7	55	53	410,000	Union
8	55	53	410,000	Union
9	55	53	410,000	Union
10	55	53	410,000	Union
11	110	106	820,000	Union
12[2]	110	106	820,000	Union
13[2]	140	135	1,240,000	Burmah[4]
14[4]	114	110	900,000	Union
15[2]	57	55	520,000	Pacific Energy[5]

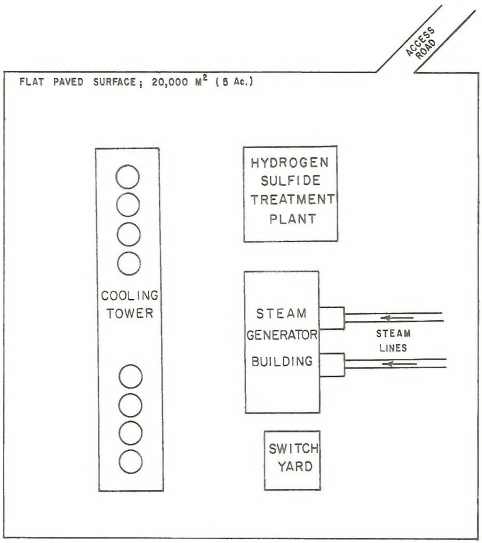
[1]Each pair of the units 1 through 10 is housed in a single building.

[2]Proposed.

[3]Union indicates Union Oil Company, Magma Power Co. and Thermal Power Company, unit operation.

[4]Burmah Oil and Gas.

[5]Pacific Energy Corporation.



1 inch = 30 meter (98.4 feet)

TYPICAL POWER PLANT SITE
THE GEYSERS GEOTHERMAL FIELD

FIGURE·10

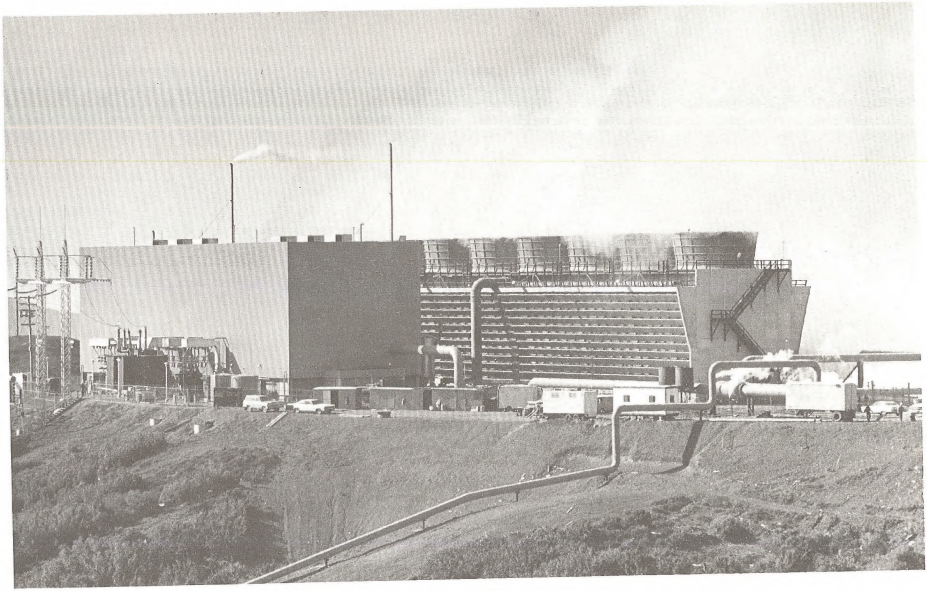


Figure 11

PLANTS 7 & 8 IN OPERATION

Steam is transported from the well head to the turbine through insulated pipes. These collection lines are mounted above ground level at heights ranging from 0.15 m (6 inches) to more than 3.05 m (10 feet). The diameter of the collection lines range from .30 m (12 inches) to 1.22 m (48 inches). Vegetation is removed along the pipeline route and shrubs and trees are not allowed to grow back.

At present there are three transmission lines distributing the electricity from The Geysers. A 60 kilovolt line with a 24 m (79 ft) wide right-of-way runs south from The Geysers to Healdsburg, a 115 kilovolt line with a 24 m (79 ft) wide right-of-way runs west from The Geysers to Cloverdale, and a second 115 kilovolt line on towers rated for 230 kilovolts and with a 37 m (121 ft) wide right-of-way also goes to Cloverdale. There are plans to increase the third transmission line to 230 kilovolts in the near future and to install an additional 230 kilovolt line at a later time. With the increase to 230 kilovolt transmission, a substation will be required in The Geysers to house the necessary transformers for conversion to the higher voltage. The higher voltage lines have a greater capacity to carry electricity, and fewer lines would be needed for the transmission of energy.

4. Production of Steam and Electricity - This is full-scale operation and maintenance of facilities. The discrete operations are the same as in Stage 3 plus maintenance of existing facilities.

One of the greatest advantages of The Geysers geothermal system is the low maintenance requirement. With the aid of remote monitoring and control equipment, a small staff can operate and maintain the power plants from a central location. With the exception of drilling replacement wells, only a few people are needed to control and service the producing geothermal wells.

For power plant operation during a 35 year period, 35 wells will be drilled to tap a reservoir area of 2.9 km^2 (720 ac.). The land surface will be cleared and graded for roads, well locations, the power plant site, and pipe lines. Of the 2.9 km^2 (720 ac.) area of land surface above the steam reservoir, approximately 20 percent will be used in development and 80 percent will not be physically disturbed. Plate 3 shows the development along the northeast slope of Big Sulphur Creek canyon.

All of the generating facilities installed at The Geysers use evaporative cooling towers. The steam is condensed at the outlet of the turbine through the use of cooling water; and the steam condensate, with the cooling water, is circulated through the cooling tower (Figure 11). Approximately 80 percent of the geothermal steam produced is evaporated to the atmosphere, and the remaining 20 percent is excess and must be removed from the cooling tower. Prior to 1971, this excess water was released to Big Sulfur Creek. Since 1971, the excess water has been injected back into the steam reservoir rocks. The excess cooling water is pumped to the injection well and drops under its own weight into the low pressure steam zone. In the hot reservoir environment, the water boils and becomes part of the steam system. In effect, this is an artificial recharge of the reservoir, and it makes available more of the heat energy stored in the deep rocks.

Figure 12

DEVELOPMENT ON NORTHEAST SLOPE OF BIG SULPHUR CREEK

The noncondensible gases are vented to the atmosphere from the gas ejector and the cooling tower (Tables 8 and 9). For operations at The Geysers, The State Air Resources Board and the Northern Sonoma County Air Pollution Control District have been issuing temporary variances for the hydrogen sulfide emissions from the power plants. Beginning with Unit 11, all of the new power plants will have a hydrogen sulfide abatement system built in, and the units now operating will be fitted with similar abatement facilities. The hydrogen sulfide released to the atmosphere after processing should be less than 10 percent of the unabated emissions.

Radon is a radioactive decay product of uranium contained in the sedimentary rocks, and because it is a gas, it mixes with the steam and flows to the surface. Measurements of radioactivity are much more sensitive than chemical analysis and can detect minute quantities (Table 10).

Table 8. Composition of Flow from the Turbine Gas - Ejectors at The Geysers Field[1]

Constituent	Average Concentration (weight percent)	Average Flow From 110 MW unit (kg/hr)	lb/hr
Carbon dioxide	59.9	2500	5500
Nitrogen[2]	25.8	1100	2420
Oxygen[2]	8.4	350	770
Methane	3.8	160	352
Hydrogen sulfide	1.2	50	110
Hydrogen	0.9	38	84

[1]From measurements of 9 generating units from 1967 through 1974.

[2]Nitrogen and oxygen are from air entering at the turbine.

Table 9. Estimated Output from
Plant Cooling Towers at The Geysers Field

Constituent	Average Concentration (mg/kg) (PPM)	Average Flow From 110 MW unit[1] (kg/hr)	lb/hr
Ammonia	240	160	352
Carbon dioxide	210	140	308
Hydrogen sulfide	200	130	286
Hydrogen	12	8	17.6

[1]Based on water vapor output of 658,000 kg/hr (1,448,000 lb.).

Table 10

Maximum Measurements of Radon
at The Geysers

Steam from well	8.3 picocuries per liter
Ejector gas from plant	5.3 microcuries per liter
Cooling tower water	0.21 picocuries per liter
Ambient air outside plant	0.026 picocuries per liter

The California Department of Health requires that the radon concentration in uncontrolled access areas is less than 3 picocuries per liter. Measurements at The Geysers show that the standards are not exceeded in areas of normal human access. One picocurie of radon is approximately 6.8×10^{-21} kg (2.4×10^{-19} oz.).

If a power plant must be shut-down, steam from the wells is diverted. During an unplanned shut-down of short duration (less than 3 days), the steam wells are vented to the atmosphere. For planned maintenance or a serious unplanned shut-down of longer duration, the steam wells are closed in to the bleed-line flow; and when normal operations resume, the wells are vented to the atmosphere for 3 to 5 days to clean out the accumulation of rock particles.

Two producing wells have blown out at The Geysers. Well "Thermal" 5 blew out in January 1970 and was controlled and abandoned a few days later. Well "Happy Jack" 7 blew out in January 1973 and vented about 90,000 kg/hr until it was controlled and abandoned in November 1974.

5. Total Close Out of Operation - This takes place after geothermal resources can no longer be economically extracted from the reservoir. Geothermal dry steam reservoir knowledge has not yet advanced to a stage where a reasonable economic limit can be predicted. For planning purposes we have used 30-50 years which is the steam plant amortization period.

The discrete operations are:

a. abandonment of wells

b. removal of surface equipment

c. surface reclamation and restoration

When steam production from the wells drops below an economic level, or when power plant operation is no longer economic, the system will be shut down. The wells would be abandoned in accordance with U. S. Geological Survey regulations. There are no regulations governing the abandonment of power plants and transmission lines on private land, so disposition of structures will depend upon negotiations between the utility and the land-owner. All material and equipment that has salvage or scrap value will probably be removed. All structures could be removed, and the surface leveled or regraded to a more natural appearing contour, and the surface replanted to mitigate erosion. U.S.G.S. and BLM regulate abandonment on Federal sites.

ACKNOWLEDGMENT

Marshal Reed, Env. Impact in Geysers
California Division of O&G
Union Oil Co.
California Department of Conservation
PG&E

III. DESCRIPTION OF THE EXISTING ENVIRONMENT, IMPACTS & MITIGATION

The programmatic EIS describes in a general way the existing environment on the approximately 638 million acres of public lands potentially available for geothermal leasing in the western states. The description on a biome basis includes generalized information on geology, water, vegetation, wildlife, land use, aesthetics, ethnographic history, and human settlement.

Volume II of the programmatic EIS (pages V-11 to V-50 describes the existing environment of the original Geysers KCRA. Two potential leasing areas to the north and south of The Geysers are described in The Geysers Expansion EAR (BLM 1976). These documents should be referred to in conjunction with reviewing this environmental analysis record to get a more complete picture of the regional environment.

Better techniques for analyzing some resourse values have been implemented since the programmatic environmental statement and Geysers Expansion EAR were published. Examples include the identification of land slide areas through air-photo interpretation techniques, application of a visual resource management system and completion of archaeological reconnaisance on 20 percent of the study area.

The mitigating measures are those exceeding standard Federal construction procedures and engineering practices, which are outlined in Federal construction manuals.

A. Topography and Geology

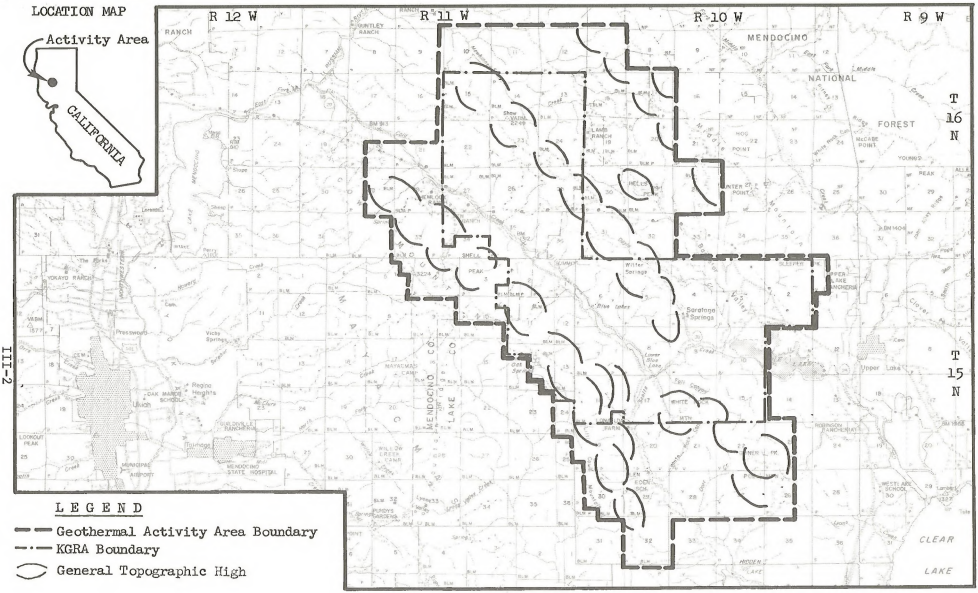
1. Existing Environment

The Witter Springs study area is characterized by rugged northwest trending ridges bisected by steep walled canyon-like drainages and small intermountain valleys. Elevations range from approximately 983 meters (3224 feet) at the crest of Little Cow Mountain to a low of 412 meters (1352 feet) near Tule Lake.

The major drainage feature is the Scott's Creek - Blue Lakes system which flows into Clear Lake. National Resource Lands (NRL) are located on ridge crests and upper slopes. Several small areas of flat rolling terrain at ridge crests and on side-hill benches are found on NRL. Ridges are narrow and drop off quickly into steep V-shaped valleys. Map 2 depicts the general topographic relationships in the Witter Springs study area.

The northwest-trending topography which characterizes the California Coast Ranges is a product of bedrock geologic structure. The rock units trend northwest and dip toward the northeast. These trends are disrupted only where large intrusive igneous masses, such as the Clear Lake Volcanic Series, have been intruded.

The Franciscan Formation comprises the bedrock under the study area. As typically developed, this assemblage is composed of thick sequences of graywacke containing minor interbeds of dark shale. These beds are



III-2

STATUS LEGEND

P - Patented Lands
V - National Resource Lands

Withdrawals

NF - National Forest
BLM - Bureau of Land Management

SCALE: $\frac{1}{2}$" = 1 MILE
MT. DIABLO MERIDIAN

WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Topographic Features

MAP-2

interlayered with dark volcanic rocks of submarine extrusive origin, chert closely related to the extrusives, chemically precipitated limestone, and metamorphic rocks with exotic metamorphic minerals.

The Franciscan has other unusual aspects in addition to the character of its rocks. Its base has not been observed, and what lies below it is at present unknown. Likewise, the upper limit has not been precisely defined. Locally, Franciscan rocks appear to be overlain by non-Franciscan rocks of Late Jurassic age, but in other areas Franciscan rocks are clearly Late Cretaceous age. Within the Franciscan, correlation of isolated outcrops cannot be made. Distinctive sequences of key beds, with the probable exception of rare foraminiferal limestones, have not been recognized.

Structures are generally so complex and fossils so rare that the stratigraphic succession of the whole assemblage has not been established. Better understanding of the Franciscan is also prevented by the lack of adequate geologic mapping, as perhaps only one-tenth of the thousands of square miles of outcrop area has been mapped adequately at scales of 1:62,500 or larger.

The assemblage of Franciscan rocks is characterized by great diversity, and because of this, as well as its great expanse, no single geologist has been able to gain intimate knowledge of its many aspects in most areas.

Mapping in the Franciscan Formation in adjacent areas has shown it to consist of two units. An upper unit, about 3049 meters (10,000 feet) thick, consists of shale and graywacke sandstone; sandstone comprises at least 80 percent of the total assemblage. A lower unit, about 4573 meters (15,000 feet) thick, is composed of graywacke sandstone, altered basalt (greenstone), chert, and shale (McNitt, 1968). Masses of serpentinized peridotite and gabbro have been intruded into the Franciscan Formation. Regional metamorphism of Franciscan rocks has resulted in formation of zeolite minerals and, locally, higher grade metamorphism has produced schist.

Graywacke consists of angular grains of quartz, feldspar, and rock fragments in a finer-grained matrix of the same materials, plus chlorite and carbonate cement. Minerals of the zeolite family may be present. Shale usually consists of the same constituents as graywacke sandstone, but in very fine-grain size. Basalt is a lava rock, composed primarily of plagioclase feldspar and pyroxene with varying amounts of olivine. Where altered, carbonate minerals, chlorite, and even quartz may develop; the altered basalt is called greenstone. Chert is a chemical precipitate of silica, usually formed under water in the vicinity of basaltic volcanic activity. Peridotite is a rock composed of pyroxene and olivine that formed at great depths within the earth, perhaps as part of the mantle or subcrust. Alteration to serpentine destroys these minerals and replaces them with iron oxides, carbonates, and minerals similar to chlorite.

The entire Franciscan assemblage is believed to have been formed in an ancient oceanic trench some 100 to 130 million years in the past, and emplaced on the continent through recurring violent upheavals over several millions of years. This emplacement caused pervasive shearing and fracturing of the rocks, as well as giving rise to the northwest-trending faults. Where

shearing has been intensive and accompanied by structural crumbling of rocks, a texture is produced known as melange, in which sound, coherent blocks of rocks are set in a matrix of clayey, incoherent debris. Sizes of coherent blocks may vary from inches to miles in size; the matrix may comprise only a few percent to more than half of the total mass. Typically, in melange terrain, numerous small landslides occur around the margins of major coherent blocks. Structurally sound sites can usually be found within melange terrain by careful investigation and selection of coherent blocks. During the early part of the Cenozoic Era (from about 60,000,000 to perhaps 20,000,000 years ago) this section of the northern Coast Ranges is believed to have been emergent above sea level, as a portion of a wide area of low elevation.

Uplifts are geologically recent, and mass wasting in the form of landslides and soil creep has been accelerated; the area is characterized by steep slopes on which surface earthflow features and landslides abound. This is especially true in areas of melange structure in the Franciscan Formation.

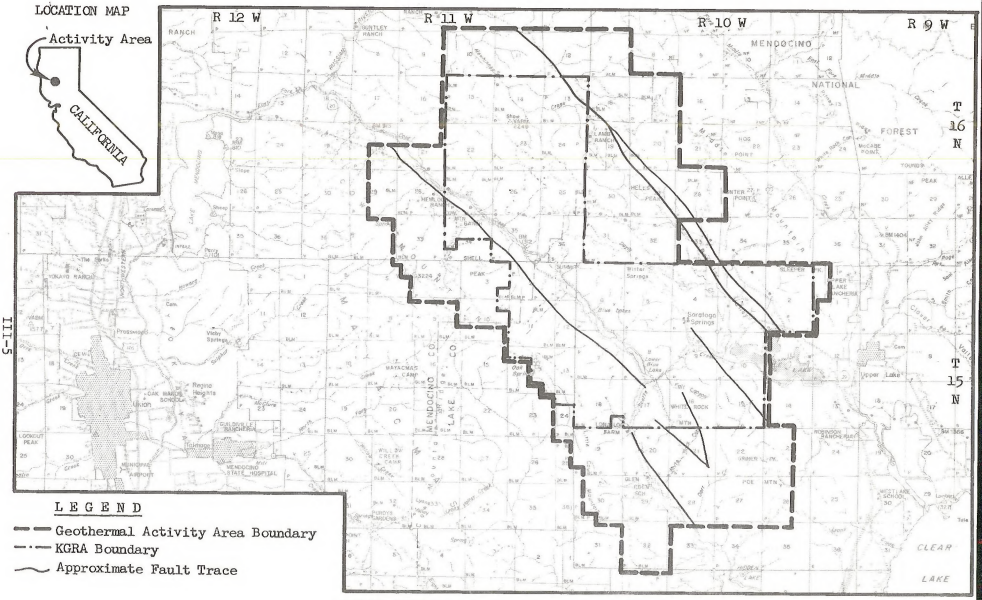
Faulting and Seismology

The Franciscan rocks dip generally northeast in a broadly homoclinal structure which has been complexly faulted and locally folded. Faults, certain of which have curved traces, trend to the northwest, following generally the regional strike of the rock units. Faults generally are steep in this area, with downdrop occurring on their southwest side. The faults may possibly flatten at depth. Map 3 shows the approximate location of faults in the study area.

Most of the Coast Ranges of California are seismically active, including the Witter Springs study area. Earthquakes have been recorded and felt within the study area. Appendix B shows some of the events recorded in the vicinity of the study area, for the twenty-five year period 1947 to 1972, occurring within ten miles of the study area.

Map 4 shows the zones in the study area which have been delineated as to the maximum intensity earthquakes that can be expected to occur. The data show that no major earthquakes have been recorded in the study area, numerous non-destructive events have occurred, and there is a likelihood of further medium intensity events in the future.

An exact correlation between Richter Scale magnitude and Mercalli Scale intensity is not possible. An event of a given magnitude will have varying intensity at the two equidistant points from an epicenter. The intensity observed depends on type of bedrock, soil moisure content, compaction, and depth as well as distance from an epicenter. The following table gives an approximation of expected intensities associated with events of a given magnitude. Appendix C gives the events associated with Mercalli scale intensities.

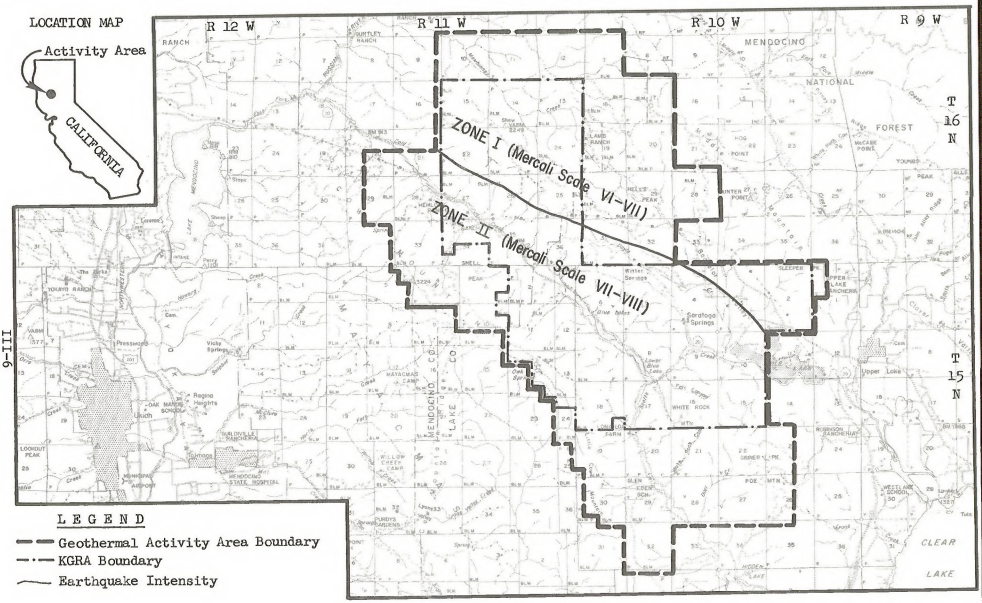


STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management

SCALE: ½" = 1 MILE
MT. DIABLO MERIDIAN

MAP 3

WITTER SPRINGS GEOTHERMAL ACTIVITY AREA
Fault Locations


LOCATION MAP
Activity Area
CALIFORNIA
R 12 W
R 11 W
R 10 W
R 9 W
T 16 N
T 15 N
ZONE I (Mercoli Scale VI-VII)
ZONE II (Mercoli Scale VII-VIII)
MENDOCINO NATIONAL FOREST
LAKE CO.
MENDOCINO CO.
Witter Springs
Saratoga Springs
Upper Lake
CLEAR LAKE
LEGEND
Geothermal Activity Area Boundary
KGRA Boundary
Earthquake Intensity
STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management
SCALE: ½" = 1 MILE
MT. DIABLO MERIDIAN
WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Earthquake Intensities

III-6

MAP-4

Table 11

Magnitude-Intensity Correlation

Richter Magnitude	Mercalli Intensity*
1	Not felt
2	I - II
3	III
4	IV - V
5	VI
6	VII - VIII
7	IX
8	X - XI
9	XII

*See Appendix D for abridged Mercalli Scale.

Volcanism

Volcanism was centered to the south and southeast of the study area in Quaternary time (the past two million years). Such mountains as Mt. Konocti, Boggs Mountain, Cobb Mountain, and Mt. Hannah are the sites of volcanic intrusive and extrusive activities. Near Clear Lake, volcanic flows and cinder cones may have formed as recently as 20,000 to 50,000 years ago. Volcanic rocks at the surface may reflect a body of near-molten rock (magma) beneath an area of perhaps several hundred square miles.

2. Impacts

Preliminary Exploration: Broad scale topographic features will not be modified by the proposed action. General geologic data will be increased by additional field mapping, geophysical exploration, and drilling of temperature gradient probe holes.

Exploration Drilling: The construction of heavy duty access roads and drill pads will not modify the broad scale topographic features but will increase the store of general geologic data by exposing more bedrock for mapping and examination. This construction will also increase the risk of landslides, especially in dormant slide areas.

Field Development: The impacts of field development are as in exploration drilling but more intensive. Well spacing will be reduced to approximately one per 40 acres. Even with multi-well pads, the field development stage will require additional road and pad construction, with increasing landslide potential.

Production: During the production phase additional construction of generating facilities, transmission lines, and steam collection lines will not modify general topographic features but will increase geological knowledge of the area by exposing bedrock for mapping and study. Landslide potential continues to increase at onset of production, caused by removal of vegetative cover for construction of facilities. At the advanced stage of production, landslide probability decreases as revegetation is implemented.

At The Geysers a detailed survey has not been able to detect any subsidence as a result of production from the steam reservoir. No subsidence is anticipated from any steam reservoir in the study area.

Northern California is earthquake country. Numerous small scale and several medium scale events have been recorded in the vicinity of the Study Area. From studies at The Geysers, there is no record of geothermal development or production of electricity inducing seismicity.

Areas which have geothermal potential often have hot springs. As shown in Figure 6, typical geothermal wells are cased often in excess of 1300 meters (4265 feet), well below zones which produce surface water. It is clear that geothermal development and production will not curtail the flow of water from these springs.

Closeout: The general topographic features and geologic structure remain unchanged.

3. Mitigating Measures

By avoiding active slide areas during construction stages of development the risk of landslides is reduced. A detailed on-the-ground mapping program coupled with air photo interpretation techniques can delineate these sensitive areas. Proven construction standards will be enforced to reduce the probability when crossing dormant or potential slide areas. Construction will not be allowed on areas outlined as active slide areas as shown on the map on file at the Ukiah District Office.

4. Residual Impacts

Any construction or surface disruption will increase landslide potential. Proper siting and construction of development facilities will minimize this potential.

B. Soils

1. Existing Environment

The soils of the Witter Springs study area include several different soils associations, each having separate capabilities and limitations. The boundaries of these soils associations along with their detailed physical descriptions can be found in the Unit Resource Analysis, Cow Mountain Planning Unit (Ukiah BLM District Office). Map 5 is typical slope data.

Soils of the Witter Springs study area, for the purposes of this document, have been classified at the series level. Representative soils from each of these groups are included for discussion. Most of the information contained herein was derived from Gardner, Wieslander, Storie, and Bradshaw, 1964. Laboratory data for most of these soils can be found in the Unit Resource Analysis for the Cow Mountain Planning Unit.

Hugo Series

The Hugo soils occur on moderately steep to very steep slopes under natural cover; they are relatively stable and show little or no evidence of erosion. Erosion hazard is high, however, if vegetative cover is removed.

Where these soils are undisturbed, litter and a porous surface favor rapid infiltration and the soil profile is moderately permeable. Water moves readily into cracks of the underlying fractured parent rock. Water-holding capacity is moderate to high, depending mainly on depth.

The Hugo soil material is well-suited for road building purposes. It has a high bearing capacity and other properties are reasonably favorable for road construction.

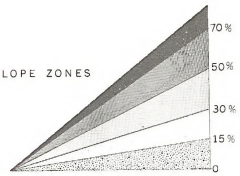
Josephine Series

Although some Josephine occurs intermingled with the Hugo throughout Mendocino and Lake Counties, it appears most extensively in the warmer southern and eastern parts. The general topography is mountainous, but slopes are somewhat less steep than those associated with Hugo. The Josephine series is moderately permeable, well-drained, and ranges in depth from 2½ to 5 feet. The subsoils are somewhat thicker, have a higher clay content and lower gravel content than the Hugo.

Accordingly, the water-holding capacity is slightly higher than the Hugo, while bearing capacity and suitability for road construction are somewhat less.

Sites Series

The Sites soils resemble the Josephine soils and occur on similar sedimentary rocks, but they differ rather strikingly in color, being distinctly redder.



V - National Resource Lands

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WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Slope

III-9a

MAP·5

The surface soils are typically reddish-brown and the clayey subsoils red to yellowish-red. In areas mapped as predominantly Sites, inclusion of small Josephine areas is fairly common. In a few places, inclusions of small areas of the Hugo also occur. In addition, areas where the parent rock is more basic and the soil is more similar to the Aiken series (a soil not found in Mendocino County) may be included in mapping.

Laughlin Series

The Laughlin soils are the common pale-brown or grayish brown soils on sedimentary rocks found in the upland areas of woodland-grass. The surface soils are medium-textured (usually loam) and are firm when moist and rather hard when dry. Subsoils do not differ greatly from surface soils, but usually contain slightly more clay and coarse rock fragments. Depth to parent rock ranges from about 15 inches to about 30 inches, but in a few places depth may extend more than 3 feet. Parent rock of hard sandstone, occasionally mixed with shale, belongs to the Franciscan Formation and is shattered or cracked to a depth of many feet. Calcite seams (calcium carbonate or lime) or evidence of old seams develop more often under the Laughlin than under the Hugo, although both are found under the same general kind of rock. Widely scattered rock outcrops are characteristic.

The Laughlin soils are associated in one place or another with most of the soil series mapped in the eastern part of the study area.

Many areas of the Laughlin on private lands show evidence of slight erosion because they have been heavily grazed over a long period. On NRL, Laughlin is not common, occurring on very shallow and on slopes ranging from 20 to 40 percent. The hazard of additional erosion is high. Small severely eroded areas occur as inclusions in the Laughlin.

The Laughlin soils are well-drained and moderately permeable. Under herbaceous vegetation water moves readily into the soils. However, compaction reduces the infiltration rate. Water-holding capacity ranges from low to medium, depending on depth of the soil.

The soil material has a moderate to moderately high bearing capacity. No particular problems in road construction or maintenance will occur. In most places the parent rock is well-fractured to a depth of 10 to 15 feet and can be excavated fairly easily. Deeper rock and occasional rock outcrops are massive and hard.

Los Gatos Series

The Los Gatos soils are underlain by shattered or well-fractured, fine-grained sandstone somewhat metamorphosed in places. Both surface soils and subsoils are medium to moderately fine textured, although the subsoils contain slightly more clay and are somewhat more reddish than the surface soils. Small rock fragments increase in number with depth, and in many places the soils are distinctly gravelly. Parent rock develops at about 14 to 26 inches, but may be less than a foot or nearly 3 feet. Rock outcrops occasionally occur.

This series is associated with paler and shallower Maymen Soils. Los Gatos usually occurs on cooler, northerly slopes; Maymen, on warmer southerly slopes. However, minor inclusions of the Maymen may be expected in areas mapped as the Los Gatos. Los Gatos soils are also associated with the somewhat similar but deeper Josephine soils, and less commonly with the Hugo soils.

The soil is moderately permeable and well drained to somewhat excessively drained. Its water-holding capacity is low, mainly because of shallowness, but in part because of coarse fragments. If exposed, its erosion hazard is high in steep areas. Some erosion, severe in places, has occurred.

A rather low bearing capacity for road construction purposes is indicated by tests on samples of the Los Gatos from outside the county. This capacity is apparently affected by the clay content. However, the soils do not slip easily and the hard, well-fractured underlying rock is rather easily excavated to a depth of several feet.

Maymen Series

The Maymen soils occur on well-fractured sandstone and other sedimentary rocks of the Franciscan or similar geologic formation. These soils are medium-textured and gravelly or shaley, with rock fragments increasing in number with depth. Other than in content of rock fragments, the soils undergo little change from the surface to underlying parent rock, which usually lies at a depth of less than 12 inches, but may occur at depths up to about 18 inches. In some places, a few rock outcrops occur.

Maymen soils are moderately permeable and often susceptible to erosion. Under chaparral vegetation, very little surface protection is offered against erosion. After some fires these soils are particularly erosive due to the production of a hydrophobic zone in the surface 3 inches. The hydrophobic condition restricts percolation and accelerates runoff. Erosion can be severe if heavy fuels have been burned in a hot fire.

Maymens are relatively low in clay and high in angular rock fragments giving it a high bearing capacity. Road construction on these soils is very suitable with the only problem in the relative stability of the underlying bedrock on cut banks. Most sandstones encountered are considered stable.

2. Impacts

a. Preliminary Exploration

The degree of impact will depend upon topography, soil type, season of use, the amount of use, and the amount of soil and vegetative disturbance on existing roads and trails. Minor to extensive road and trail use during the wet season could cause minor to extensive damages to the soil surface, as a result of deep ruts, soil puddling, and structure damage. Combined with heavy rains, road and trail use will result in soil loss even on the most stable soils. The dust will develop in soil areas that will be easily eroded during heavy rains.

b. Exploration Drilling

Impacts from road use would be similar but of a much higher intensity as those during preliminary exploration. Similar adverse impacts will result from the construction activities on drilling pads. The degree of impact, therefore, will depend upon the soil type, topography, the project and its design and construction, and revegetation success. Soil will erode when the vegetation and soil surface are disturbed, increasing soil surface area exposure. Road and drill pad construction could encounter unstable soils conditions, increasing the risk of soil slumps and slides. Construction on steep slopes will expose excessive unprotected soil surface area both up and down slope to erosion. Exposed surface areas generally consist of subsurface soils low in nutritive value, coarse textured and poorly structured, thus extensively limiting rehabilitation success.

Accidental spills from sumps, blow outs, or pipe breaks could contaminate soils with toxic compounds.

c. Field Development

The intensity of all impacts listed under preliminary exploration and exploration will be increased under field development. The surface area could be heavily dissected by roads and drilling pads. Probably more critical areas which have unstable and highly erodable soils will be penetrated to get the additional well or wells needed to supply a plant.

Power plant construction will have about the same effect that a well drilling pad will have except the area involved would be considerably increased.

Pipeline construction and installation will increase surface area disturbance. Pipeline sections will run parallel to hill slope. Pipeline pathways will be denuded of vegetative cover until revegetated. Increased erosion and gully development can be expected from such construction.

Electric transmission line construction at some point usually crosses over very rough topography, steep slopes and soil hazard areas. Access roads and trails are constructed to permit tower and line installation and maintenance. These usually are designed for limited one-time use, without elaborate drainage facilities, and with few erosion precautionary measures. Such roads contribute extensively to new erosion sources. In addition, these roads also open up new areas for off-road vehicle use, increasing the erosion hazards.

d. Production of Steam and Electricity

Impacts on soil during this stage will be minimal.

Gaseous emission impacts on soil from steam plants is unknown, but there is no apparent adverse impact on soils near the existing Geysers steam plants.

Some impacts would occur under new construction, road maintenance or maintenance of well pads or power plant sites with surface disturbance by grading or drainage facilities failure.

Brush control for fire protection along pipelines by the use of herbicide sprays may cause impacts. This practice is very controversial and needs further investigation with specific parameters to fit the conditions of brush control in general.

e. Closeout of Operation

Closeout should cause less soil disturbance than installation. Surface disturbance can be expected from dismantling operations, i.e., removing steam lines, power lines, and buildings and restoring roads, plant sites, and well pads to as near natural conditions as possible. Access roads would represent a source of continued erosion if they would continue to be used by members of the general public.

3. Mitigating Measures

a. All preliminary exploration will be done on existing roads and trails.

b. Use of unsurfaced roads and trails shall not be allowed during very wet periods.

The following mitigating measures and precautions shall be followed in exploration drilling operations:

Road and Drill Pad Construction

a. Soil conditions shall be investigated so that road locations can be planned to avoid steep slopes and areas of unstable soil and rock.

b. Roads and drill pads shall not be constructed during very wet periods.

c. Construction of Roadway Backslopes and Embankments

1) The tops of all cut slopes will be rounded as per standard construction practice for highways.

2) Cuts shall be brought down as nearly to the angle of repose as is practicable, considering the soil type, depth of cut and steepness of the natural slopes.

3) Backslopes shall be terraced at intervals related to the ratio of backslope. If depth of cut exceeds 20 feet, benches will be constructed to relieve excessive surcharge and reduce the probability of slope failure.

4) All terraces and benches shall be constructed to a level grade line.

5) All secondary benches will be drained with suitable structures to prevent erosion by carrying any water from the bench to suitable spillway areas.

6) All embankments shall be constructed to slopes no steeper than a 1½:1 ratio.

d. All cut and fill slopes except solid rock shall be protected from erosion by seeding grasses, planting shrubs or trees, and applying mulch and fertilizer properly tested for the site.

e. Excess material shall be end-hauled to safe disposal sites to decrease surface area erosion.

f. All embankments shall be compacted to AASHO (American Association of State Highway Officials) requirements during construction, and decomposable material shall be eliminated from fill slopes.

g. Road and pad construction shall not take place in unstable soil and landslide areas.

h. All roads and drill pads used during the wet months shall be paved or rock surfaced. Unpaved roads and pads shall be closed during the wet season.

Road and pad paving or rocking consists of all types, such as asphalt, chip seal, and gravel, and includes the necessary drainage facilities. Drainage improvement is required for unpaved roads and drilling pads and includes insloping of road surfaces and installing of paved gutters, culverts, energy dissipaters, cross drains, concrete fords, and bridges.

On existing roads, road relocation is recommended in unstable areas such as natural water seeps where maintenance problems occur. Road closure costs include installation of barriers to stop traffic, removal of temporary bridges and culverts, installation of barriers to stop traffic, installation of water barriers on road surfaces, outsloping (sloped toward downhill edge), and seeding. Outsloping consists of grading unpaved roads so that they slope toward the downhill side and removing berms along the outside edges.

i. Soil sampling test and field test plots shall be established to determine soil nutrient deficiencies and required soil amendment to insure revegetation success of all disturbed sites. This will include soil sampling and test plots on each soil series and each proposed subsurface soil site before soil surface damage occurs.

j. Soil surface mulching tests shall be conducted by using trial method on each slope and soils conditions to insure soil surface protection. These tests shall be conducted before soil surface disturbance occurs on construction projects where data is not already on file for similar slope and soil conditions.

Field Development

a. Refer to soil mitigating measures under preliminary exploration and exploration drilling.

b. Powerline installation in rough terrain shall be done by acceptable methods which may include the use of helicopter transportation.

c. Roads shall be constructed to the same standards as required by other development programs listed under Mitigating Measures - Exploration and Drilling.

Production of Steam and Electricity

Maintenance of facilities in many respects would be similar to standards established under field development. Refer to prior sections.

Total Closeout of Operation

Limit surface disturbance to existing roads, building and well pad sites.

4. Residual Impacts

a. Soil surface disturbance on roads and trails will expose loose surface soil particles to erosion. Some slight amount of erosion will occur under the best of rehabilitation methods.

b. A positive impact could be from improvement of poor vegetative sites by fertilization and seeding after some disturbance has taken place.

c. Steep road and drilling pad cuts and fills will limit revegetative success. Some areas may be impossible to revegetate because of continual soil raveling, surface movement, and exposed infertile unproductive subsurface soil. Erosion will continue from these areas on a diminishing basis until the sites are deflated of fine soil particles.

d. Soil contamination from the immediate sump area or accidental spills will have some residual effect. Some chemicals emitted from venting and well testing, or by some mishap, i.e., well blow out, pipe break, etc., could contaminate the soil for an extended period.

e. A residual effect of the increased off-road vehicle (ORV) traffic on powerline roads will increase erosion hazards and expose new off-trail virgin areas to ORV use.

f. Drilling pad sumps may contaminate soils of the immediate sump area, if the sump were to break or overflow. Soils of the flow area would be polluted with chemical materials. Chance of additional polluted soils area could result from leached chemicals from sump or overflow sites.

g. Some areas will be disturbed exposing infertile non-productive soil. These areas will show and be a source of erosion until the soil mantle is developed and revegetated. This is a long, slow process.

h. Some soil sites contaminated by chemicals will remain until gradual chemical decomposition will permit soil development and vegetative growth. These areas are expected to be quite limited.

C. Water

1. Existing Environment

1) Water Quantity

a. The climate section details precipitation patterns in the study area.

b. The fisheries section includes a more detailed discussion of each drainage and its characteristics.

c. Equal mean seasonal run-off in the vicinity of the study area varies considerably (5-25 inches) dependent upon many factors i.e., total precipitation, soils type, slope, vegetative types, etc.

d. Water has many uses including agriculture irrigation, culinary, municipal, fisheries, and recreation at the Blue Lakes.

2) Water Quality

a. Sediment load and chemical analysis data are quite limited for the Witter Springs area. However, the USGS has gauging stations located at various sites along the Russian River. This information is in the Cow Mountain URA. Generally, complete information at each station for any length of time is lacking except for water discharge. These data are not adequate to locate point sources of pollution as discussed later under baseline data.

Water quality varies by season. During the dry season, stream flows are generally clear and free of pollutants, although mineral content is generally higher than in winter because a greater percentage of the water has surfaced from deep percolation and has been exposed to water-soluble minerals in geologic formations. Mineral content, however, in all seasons is quite low, except that boron in some streams and other ground water sources will reach concentrations at times that are toxic to plants and animals. Winter storms increase sediments and pollutant materials, especially during peak flows. Water flow over the soil surface from the first heavy storms of the season accounts for most of those materials by flushing soil particles that have been broken down naturally during the hot, dry, summer or that are the annual accumulation of man's disturbance. Because of the natural release of nitrates or phosphorous from plant decay and soil breakdown, these compounds are also more abundant in the first runoffs from heavy storms.

Chemical analyses of the main Russian River system indicate that waters are well within chemical tolerances for agriculture and culinary uses, except boron in some streams at low water stages. Scotts Creek water chemical "data shows a direct correlation between total phosphorous and amount of flow, and between turbidity and amount of flow, indicating that phosphorous is probably related to suspended sediment, which increases during storms due to erosion and scouring. Nitrate nitrogen, however, is found to

have an inverse relationship with amount of flow, indicating that it enters the stream in a dissolved state and is diluted by increased flows." (Final E.I.S. Lakeport Lake project Scotts Creek, Calif., Dec. 1972, by U.S. Army Corps of Engineers.)

Stream class and stream channel stability conditions are as listed below for the major creeks of the area. 1/

Creek	Location	Class	Stability Condition
1. Cold Creek	Upper reach to East Fork Russian River	II	High-Poor
2.a. Scotts Creek	Glen Eden School to Highway 20	II	Low-Fair
2.b. Scotts Creek	Along Highway 20	II	Low-Good
3. Dayle Creek	Sec. 31, T. 16 N., R. 10 W.	II	Medium-Good
4. Mewhinney	Upper reach	II	High-Fair
5. Black Oak Spr. Creek	Upper reach	II	Low-Good

1. Cold Creek is an intermittent stream flowing into the East Fork of the Russian River. It is classified as Class II. Stream channel stability conditions are rated as High-Poor because of considerable mass wasting and heavy streambed load. Turbidity samples (Table 12) also indicate very high suspended sediment content during peak flows. These conditions have considerable influence on downstream water quality and sediment in Lake Mendocino.

2. Scotts Creek flows directly to Clear Lake and is classified as Class II.

a. The stream channel reach between Glen Eden school and Highway 20 has a Low-Fair stability rating. During peak flows, flood waters are not contained within the oblique stream channel. Mass wasting and vegetative undercutting, exposing plant roots and erupting trees and other vegetation, is a common occurrence. The removal of fine-textured soil materials caused by water cutting stream banks of this area contributes fines to Clear Lake.

b. Scotts Creek along Highway 20 is rated Low-Good. The area is sodded in with coarse grass species resulting in little channel erosion.

1/ BLM Stream Channel Stability Study, BLM Block of the Cow Mountain Geothermal Study, Feb. 1976.

3. Dayle Creek flows to Clear Lake via Cooper Creek and Scotts Creek. It is a Class II stream and has a Medium-Good stream channel stability rating. The Good rating is due mostly to the exposed bedrock and generally rocky condition of stream channel and generally good watershed conditions. The stream banks are V-shaped and occasionally contain small slide areas or stream bank cutting. Sediments are stored in two reservoirs constructed across the lower reaches of the stream channel.

4. Mewhinney Creek flows to the northwest converging with the North Fork of the Russian River in south Potter Valley. This creek is a Class II stream and has a High-Fair stream channel stability rating. Some mass wasting is occurring from a few areas of stream bank cutting and small slide areas.

5. Black Oak Springs Creek flows to Scotts Creek thence to Clear Lake. It is a Class II stream and has a Low-Good stream channel stability rating. The stream banks have a good vegetative cover and some exposed bedrock assisting in stabilization. Some bank sluffing and head cutting is occurring in places. Some of this condition is attributed to livestock grazing and off-road vehicle use.

Suspended sediment varies considerably by storm, by year, and by drainage. Streams also revert rapidly to normal conditions after each event. (Refer to turbidity data collected by BLM in February 1975, Table 12.)

Table 12

Witter Springs Area Turbidity Data

Stream Name	Number	JTU's*	Time	Date
Scotts	2	160	12:45 p.m.	2/12/75
Scotts	2	162	4:05 p.m.	2/13/75
Scotts	2	51	1:00 p.m.	2/14/75
Cold	6	500+	3:30 p.m.	2/12/75
Cold	6	137	1:45 p.m.	2/13/75
Cold	6	37	11:30 a.m.	2/14/75

Rainfall Data from Coyote Dam Project Engineer, Ukiah, California

2/12/75 - 12:00 p.m. thru 4:30 p.m. 2/12/75 - 1.43"
2/12/75 - 4:30 p.m. thru 2/13/75 4:30 p.m. - .52"
2/13/75 - 4:30 p.m. thru 2/14/75 4:30 p.m. - .00"

Rainfall Data from George Turnball, independent gauge, Lakeport, Ca.

2/11/75 - 5:00 p.m. thru 2/12/75 5:00 p.m. - 1.94"
2/12/75 - 5:00 p.m. thru 2/13/75 5:00 p.m. - .43"
2/13/75 - 5:00 p.m. thru 2/14/75 5:00 p.m. - .00"

* Jackson Turbidity Units

There are also yearly variances in stream flow and total suspended sediments measured at the Cloverdale USGS station (see Table 13).

Table 13

Year	Total Discharge For Year (CFS Days)	Total Load for Year (Tons)	Tons Per Acre Per Year
1964-1965	479,156	2,111,126	6.6
1965-1966	317,621	622,946	1.9
1967-1968	247,929	344,976	1.1

USGS sediment yield data for Highland Creek cannot be related to the study area because samples were taken from below the Highland Springs Reservoir. Most sediments would be deposited in the reservoir. More complete sediment data are found in the Cow Mountain Unit Resource Analysis.

a. Source of sediment

The Witter Springs area is naturally susceptible to erosion, as is most of the North Coast area. This condition is attributed to the interplay of a number of factors: a relatively young geologic history, i.e., broken topography and canyons with steep gradients and slopes; soils development and conditions that are conducive to erosion; a large percentage of the area is chaparral vegetation which is lacking in a dense vegetative understory (some of this condition is the product of man and fire); and high precipitation which results in high runoff at times.

Man-caused erosion on national resource lands appears relatively minor to the casual observer. However, the extent that man-caused disturbances contribute to today's erosive conditions could be extensive even in areas that appear to be in a natural state. Some chaparral areas in this unit were probably subjected to frequent burning by man, a practice which can be detrimental to a watershed.

b. Flood and Sediment Damages

Runoff in the watersheds of the Witter Springs area follows definite seasonal distribution with approximately 75 percent occurring in the four-month period from December to March. From April to November most minor streams have little or no flow.

Water runoff from the area contributes slightly to flood damage of downstream property.

The Russian River is the recipient of about one-third of the runoff from the Witter Springs area. The Russian River has a history of flood damage in one out of every two years and some years damage is considerable. A detailed report was published by the U.S. Army Engineer Districts, San Francisco. About 3 percent of the total Russian River drainage at the USGS

Cloverdale gauging station originates on national resource land within the Witter Spring area. Lake Mendocino receives all the sediment from the Russian River drainage portion of the study area.

Drainages from the other two-thirds of the Witter Springs area empty into Clear Lake and contribute to flood conditions around the lake. See Map 6 for drainage basin patterns.

Scotts Creek, as reported in the Lakeport Lake EIS, "For most of its length ... is an intermittent stream, with no flow during the summer and fall months except in extremely wet years. There is usually some flow from December through May...with the largest flows occurring in January and February." Floods on Scotts Creek occur during the winter months as a result of heavy storm precipitation, and are characterized by high peaks receding rapidly to normal flows in a few hours. The Scotts Creek downstream channel has a present capacity of about 2,600 cubic feet per second through Scotts Valley, about 1,000 cubic feet per second through the canyon between Scotts Valley and Bachelor Valley, and about 100 cubic feet per second through the Tule Lake marsh area. The portion of Scotts Creek in the study area is considered to be the source for approximately 4 percent of the sediments in Clear Lake.

Other streams in the area do not have stream gauging stations.

Erosion is detrimental to aquatic life in streams and lakes. The Witter Springs area is a source of sediments, creating problems of water quality in the Russian River and Clear Lake which are noted for fisheries values (see Wildlife section of this report).

Presently these deposition areas of silt, sand and gravel are located on the plains near the coast or adjacent to Clear Lake and along old terraces adjacent to the main rivers and tributaries.

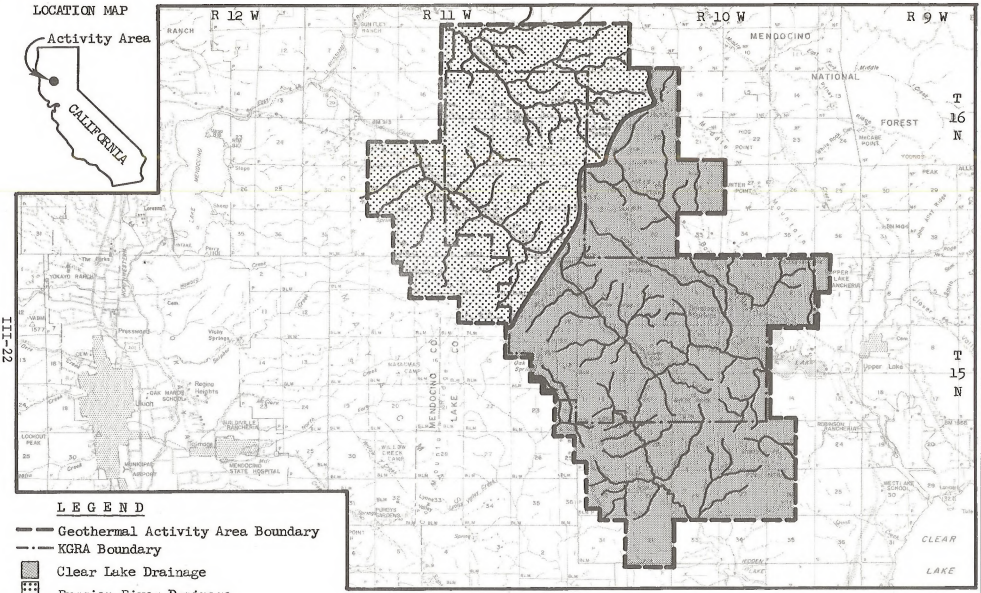
Channel deposition is another source of damage. Stream channel aggradation and degradation action over a long period will appear to reach an equilibrium until a major storm and then the process cycles again. With each storm, as channel aggradation takes place, the flooding problems in adjacent areas become greater.

c. Dissolved solids data are very limited. Sampling by USGS on the Russian River at Hopland showed a low reading of 125 parts per million. This is typical of most sampling of this general area.

d. Chemicals, heavy metals, and toxic substances at concentrations harmful to humans and crops are probably not present. Boron, however, as discussed above, may present some problems. Detailed data are lacking.

e. Nutrients

Nitrogen is the nutrient most susceptible to transport by water. Sources of nitrogen in water are rainfall, crop fertilization, and erosion of surface organic and inorganic forms, either in sediments or by solution in surface water.


LOCATION MAP
Activity Area
CALIFORNIA
R 12 W
R 11 W
R 10 W
R 9 W
T 16 N
T 15 N
MENDOCINO
NATIONAL
FOREST
MENDOCINO CO.
LAKE CO.
CLEAR
LAKE
III-22
LEGEND
Geothermal Activity Area Boundary
KGRA Boundary
Clear Lake Drainage
Russian River Drainage
SCALE: ½" = 1 MILE
MT. DIABLO MERIDIAN
STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management
WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Watersheds
MAP 6

Phosphorus movement in water is usually less than nitrogen because the phosphorus compounds formed in soil are less soluble. Soil erosion is one of the major sources of phosphorus in water.

Generally, modifying natural conditions increases the concentration of nutrients in surface and subsurface flows.

When soil erosion takes place the potential for transport of nutrients is enhanced.

f. Solid Debris

Solid floating objects such as trees, logs, and construction waste are not a problem in the upper watersheds where the national resource lands are located. Very little heavy material is produced from chaparral vegetation.

g. Coliform contamination has not been investigated in the Witter Springs study area. However, the Russian River in most of its reach has a coliform count above the standards established by the California Department of Public Health as being suitable for water contact sports.

h. Acid Balance (pH)

Water pH ranges in the Russian River at Hopland from 7.0-8.4 and at Highland Springs from 6.6-7.5. Data from other areas are lacking.

i. Dissolved Oxygen - No data are available as yet.

j. Water temperature taken by the USGS at the following stations are:

Streams	Minimum	Maximum
Russian River East Fork	47°F	69°F
Russian River Calpella	39°F	74°F
Russian River Ukiah	44°F	81°F
Russian River Cloverdale	44°F	76°F
Highland Springs	32°F	77°F

k. Radiological contaminants have not been investigated, however, significant quantities are not likely to be present. Baseline data are inadequate to measure water quality of each stream in relation to subsequent disturbance that may result from geothermal exploration and development. Water quality will vary depending upon the time the sample is taken within each storm event and by the magnitude of each storm. Therefore, reliable quality baseline data is critical if point source pollution problems are to be identified.

Numerous hydrologists recognize that existing baseline data are inadequate to measure incremental increases in pollution.

2. Impacts

Introduction

The degree of total impacts that geothermal development and electrical plant operation will have on water quality will depend on many varying conditions, including: surface slope, vegetation type, present ground cover, soil type, distance from streams, surface disturbance extent and type.

At this time, point locations for roads, well drill pad sites, power plants, steam lines, power lines, have not been chosen. The impacts, therefore, cannot be quantified until more detailed information is received, but more information will not be available until steam reserves are located and a place for development can be designed.

At this time, the impacts could range from severe to slight depending upon the site where steam is located and subsequent development and operation. Impacts will be discussed in general and will not get into specific problems.

a. Preliminary Exploration

The degree of impacts during this stage would depend greatly upon the extent of use of roads discussed under Soils Impact. Normally this use is very light.

b. Exploration Drilling

1) Water quality will decline through increased sediment loads to a greater degree than the previous stage. Increased surface disturbance and soil erosion from construction activities increases sedimentation.

Toxic materials may enter the water through mishaps (sump failures, pipe breaks, well blowouts, etc.). There may be impacts of unknown magnitude on water quality from toxic elements in vented steam.

2) Drilling operations could decrease water supplies to small streams, riparian habitat, fisheries, and other down-stream users. Although great water quantities are not used, enough water is used in road and pad construction, road sprinkling to reduce dust, and in drilling operations to decrease water supply for other uses or users.

c. Field Development

Field development will increase construction activities and concentrate efforts on specific sites. Water quality will also be directly affected from more specific site sources. Stream channels and water quality immediately below construction sites will suffer the worst degradation. Degradation will decline as water is defused into larger stream channels. Coarse materials will be deposited into stream beds with lower water

velocities and the fine material will be carried on to be deposited into lake or reservoir sites, such as Clear Lake and Lake Mendocino.

Nutrients will enrich and increase both aquatic plant and bank vegetation in streams and lakes.

Chemicals, toxic and non-toxic, will be carried down stream affecting water quality.

d. Production of Steam and Electricity

Adverse impacts on water may decline as the geothermal field comes to full production. The construction phase will taper off causing less surface disturbance and heavy traffic. Stream channels and water quality will begin to reach equilibrium and stabilize. Vegetation will begin to cover disturbed sites reducing erosion and stream sediments. However, new construction of wells and related facilities to maintain production will continue the problem.

Some chemical contamination may develop from the well and power plant venting operation. Little is known as yet as to the cumulative effects of hydrogen sulfide or radon in the watershed and in the water. Herbicide spray used to control brush for fire protection may also be a water pollutant source.

e. Total Closeout of Operations

The impacts discussed under the Soils section will directly affect water quality during closeout operations. The increased surface disturbance mentioned will increase sediments for a short period. Residual nutrients or chemicals displaced in the soils could also be exposed to water runoff through surface disturbance.

3. Mitigating Measures

Many impacts to water are a direct result of impact to soils; hence, mitigation directed toward soil impacts will also mitigate many of the impacts to the water resource.

a. Preliminary Exploration

No mitigation measures needed.

b. Exploration Drilling

Implementation of measures designed to mitigate surface disturbance will reduce the sediment loads in streams and creeks caused by construction work.

1) Buffer zones along water courses will be established. The actual width of the buffer strip will vary depending on a site specific analysis.

2) Roads and drill pads shall be located so that fills will not encroach upon streams during peak flows. Riprap rock and retaining walls shall be provided to protect fills when it is necessary to locate them within high-water elevations at culvert or bridge crossings.

3) Fording of live streams with construction equipment shall not be allowed, except as necessary to construct authorized crossings.

4) All drainage ditches, dips, and culverts shall be inspected each year and repaired and cleaned out prior to the rainy season. Maintenance operations shall not remove the toe of cutbanks, and the excess material shall not be sidecast or deposited on streambanks. Excess material from road, drilling pads, and maintenance shall be end-hauled to safe disposal sites where it will not erode into streams.

5) Drill pads, drainage ditches, and berm shall be installed to collect water to collection areas. Culvert down spouts with the same type specifications as listed under Roads shall be installed for water drainage and release.

6) Water used for drilling and related operations shall be secured from plentiful sources that will secure downstream needs. This could mean reservoir construction or providing other storage facilities to collect water during high water yield periods.

c. Field Development

1) Mitigating measures are the same as those listed under field development in the Soils discussion.

d. Production of Steam and Electricity

1) Continue mitigating measure discussed under the Soils section.

2) These practices shall include monitoring ground water sources, e.g., wells and springs for toxic substances and other adverse contamination.

e. Total Closeout of Operations

The practices discussed under the Soils discussion shall be used to mitigate water quality problems.

4. Residual Impacts

a. Preliminary Exploration

A slight sediment increase can be expected in stream channels, Clear Lake, and Lake Mendocino.

b. Exploration and Drilling

Residual impacts will be directly related to the success of mitigating measures listed under the Soils section. Some sedimentation and other water pollution can be expected in stream beds and lakes.

c. Field Development

Residual impacts will depend upon the variable conditions discussed under General Impacts and the effectiveness of the mitigating measures discussed under Water and Soils. There will be residual impacts from sediment, nutrient, and chemical deposition in streams and lakes.

d. Production of Steam and Electricity

Some residual effects could develop from any one or all of the topics discussed under Impacts.

e. Total Closeout of Operations

Long-term residual impacts could persist from the total overall geothermal operation that could degrade water quality. What these problems could be are not fully known at this time. These problems may include: The continual leaching of a sump pit or an abandoned well because of casing disintegration could develop leaks emitting chemicals to the atmosphere, or to surface and ground water.

Closeout operations have never taken place. However, lessees shall be held responsible for residual impacts in leasing stipulations and bonding procedures.

D. Climate

1. Existing Environment

The climate of the Witter Springs study area is characterized by warm summers and mild winters. Extremes of temperature range from lows of 20°F to highs of 115°F. The summers are influenced by a high pressure system which lies off the coast of California. This high pressure system forces polar air masses to the north causing the warm, dry summers, and during the winter months, shifts to the south and allows the frontal systems to pass through.

The mountains cause some variation in climate with elevation. Precipitation tends to increase with elevation, and temperatures are affected by cold air drainage as well as by the normal temperature decrease with elevation. All this results in a very complex climatic pattern in mountain areas. Most of the study area falls into this category.

Climatic data is lacking for the study area. Records are kept at Ukiah and Lakeport, but these stations are much lower in elevation than the study area. The Hopland Field Station of the University of California has for 10 years collected precipitation and temperature data at three locations about 10 miles south of the study area. Elevation at the Station ranges from 800 feet to 2900 feet compared to 1300 feet and 2800 feet in the study area. Analysis of data from the nearby locations makes it possible to estimate the annual precipitation and temperatures in the study area.

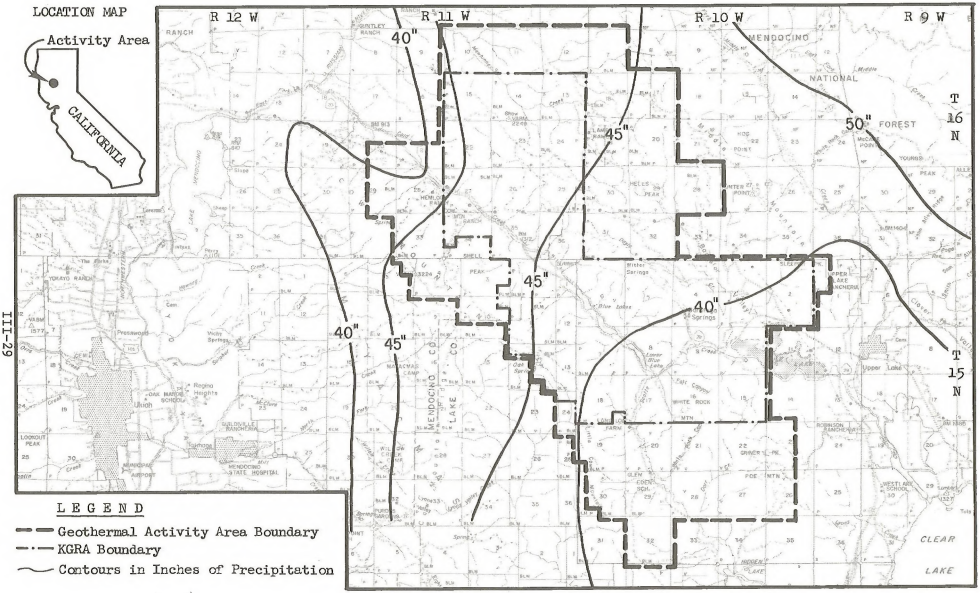
Precipitation

Precipitation is concentrated in the winter with about 85 to 90 percent of the rainfall occurring between October and May. Annual totals average around 35-40 inches. The maximum and minimum annual rainfall in the vicinity of Witter Springs, interpolated from rainfall records at Ukiah and Lakeport, are 65 inches and 25 inches, respectively. Occasionally some precipitation may be received during the summer months from local thunderstorms. Most of the rainfall in the area is associated with frontal weather systems (see Map 7).

Snow is common along the crest of the Mayacmas Mountain Range, but the fall is usually scant and rarely persists more than a few days. Snow is more persistent at the higher elevations of the Middle Mountain area.

Temperature

The average annual temperature in the study area is approximately 60°F. The highest temperature during the summer averages approximately 109°F. Afternoon temperatures in July usually average in the lower and middle 90's over most of the mountainous area, with slightly higher temperatures in the valleys.


LOCATION MAP
Activity Area
CALIFORNIA
R 12 W
R 11 W
R 10 W
R 9 W
T 16 N
T 15 N
40"
45"
50"
MENDOCINO NATIONAL FOREST
LAKE CO.
MENDOCINO CO.
CLEAR LAKE
III-29
LEGEND
Geothermal Activity Area Boundary
KGRA Boundary
Contours in Inches of Precipitation
STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management
SCALE: ½" = 1 MILE
MT. DIABLO MERIDIAN
MAP-7
WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Isohyetal

Winter temperatures are moderate throughout the Coast Range. Afternoon readings in January average from 50° to 56°F with minimums at night dropping to 30° to 40°F in the valleys and to the low 20's in the mountain areas.

Evaporation and Humidity

There are no summarized relative humidity data for the Witter Springs area but according to the Mendocino County Soil and Water Plan, night readings will average 90 percent during the winter and will drop to around 60 percent in the fall. Daytime readings range from 80 percent in winter to 30 percent in the fall. Summer daytime lows of 10 percent occur in low valley areas, causing high fire danger in dense fuel areas. On the Lake County side of the Cow Mountain area, humidity readings probably average slightly lower. There are no evaporation measurements within Mendocino or Lake Counties. On the basis of readings in the northern part of the state, it is estimated that the loss from a lake or reservoir is approximately 38 to 44 inches per year.

Wind

The orientation of the ridges, the proximity of the study area to the West Coast, and the prevailing pressure patterns create an air flow that is usually from the northwest or the southeast in Mendocino and Lake counties.

Wind directions and intensities are highly variable and strongly influenced by mountain topography. Generally there are down-valley winds during the evening and up-valley winds during the day, the result of diurnal heating of ground and air masses. During the dry season these local mountain-valley wind regimes dominate over a generally weak northerly regional scale wind flow, while during the wet season large scale features dominate, producing winds with an easterly to southerly component.

During the summer, the wind speeds near ground level are normally less than five miles per hour in the early morning hours and frequently reach 20 miles per hour in the afternoon. During the winter season, wind speeds in excess of 20 miles per hour may occur from a southerly direction and are normally associated with precipitation.

No data on wind speeds and directions are available at the weather stations within or near the study area. Wind in interior parts of Mendocino County can be expected to reach speeds of 40 mph as often as once every two years, and 80 mph once in 50 years. Wind speeds on exposed ridges probably exceed these estimates.

A more detailed discussion of wide-scale regional interior winds can be found in the climate section of the Cow Mountain Unit Recource Analysis (Bureau of Land Management, Ukiah, CA) and the Environmental

Impact Analysis on Geothermal Development of the Leaseholds of Geothermal Kinetics Corporation and Pacific Energy Incorporation at The Geysers, Sonoma County, 1974, pages 20-25.

Air Inversions

Air inversions are infrequent within the study area. The surrounding valleys are often affected by inversions. The Ukiah Valley has been studied by Alan J. Anderson of North American Weather Consultants in connection with Air Quality Impact Evaluation of the Proposed Georgia-Pacific Formaldehyde Plant at Ukiah, California. In general the evaluation showed that surface inversions occur about 86 percent of the time, with all these inversions eroding to a height of at least 100 meters by solar heating during the day.

In the fall data, only one case of persistence was found in which two successive days of mixing depths of less than 600 meters (1963 feet) occurred. In the winter data, three cases of persistence of mixing depths less than 600 meters (1968 feet) were found. Two of the cases were for three-day intervals and one for a five-day interval. No successive days of mixing depth less than 300 meters (984 feet) were found. Most mixing heights during the two-year study were 600 meters (1968 feet) or greater with inversion breakup occurring in the early morning.

A stagnation period of 10 days was indicated in the report as being the maximum the valley could experience. An inversion persistence longer than 10 days would be rare.

The Clear Lake Basin is influenced by, or is part of, the summer inversion layer that lies over the Sacramento Valley and would probably experience longer stagnation periods than the Ukiah Valley and other smaller valleys adjacent to the study area.

Fog

Fog potential is greatest during the rainy season, occurring about 40 percent of the days. During subfreezing temperatures the potential for fog drops to 5 percent or less. From May through October there is very little fog.

2. Impacts

Preliminary Exploration

General climatic conditions will not be altered by the proposed action.

Exploration Drilling

Particulate nuclei from air drilling (drilling well holes with compressed air) would increase during this stage, possibly affecting condensation patterns.

Steam release from well testing and cleanout, and venting of capped wells will increase but due to the small number of wells involved climatic conditions will not be altered to any perceptible extent.

Field Development

During the course of geothermal field development and operations, steam will be released to the atmosphere in considerable quantities, as much as 68,000 Kg (150,000 lbs.) of steam/hour/well during well cleanout periods. Although the specific impacts of increased atmospheric water vapor have not been researched within The Geysers KGRA, several climatic variables could be affected by persistent steam emissions. These variables include: 1) humidity and temperature, 2) heat exchange capacities of moisture-laden air, icing characteristics and fog and haze potential, and 3) atmospheric world temperature relationship.

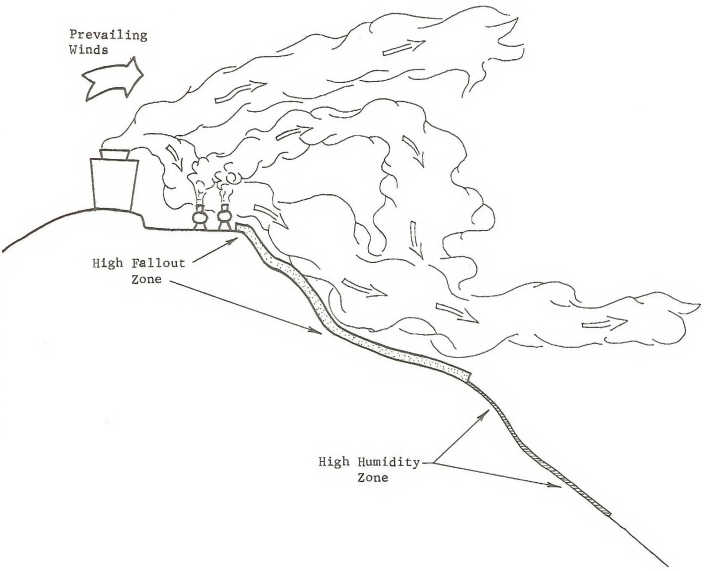
These potential effects are based on the current techniques of field production.

There is reason to believe that, eventually, climatic modifications may occur, especially by increasing humidity. Steam or water vapor is released from well heads, pipelines, and power houses (including cooling towers) in considerable quantities. Its effect appears to be important in limited areas of the established field at The Geysers. While the impact is as yet not clearly established, at full field development the general level of humidity may be increased sufficiently to have impacts on vegetation and, possibly, on fog and visibility levels in topographic lows within the general area. There is a strong possibility of increased disease incidence in native vegetation, particularly near power plants and in the path of air stream flows where steam is concentrated (see Figure 13). A more detailed discussion of the relationship of California's native vegetation with a possible change in the heat-moisture regime (microclimate) can be found in the EIR's of Neilsen et. al. Cobb Mountain Leasehold, 1974, pp. 43-45 and Neilsen et. al., Upper Part of Squaw Creek Leasehold, 1974, pp. 82-85.

Heat exchange capacities of moisture-laden air, icing characteristics, and haze and fog potentials could also be modified on a regional scale by large increases in atmospheric water vapors and the chemical and particulate nuclei that accompany steam emissions.

The impacts arising from these phenomena are: 1) premature condensation of moisture in the air that causes local premature precipitation and may prevent natural thunderstorms from occurring in areas as remote as the east side of the Sierra Nevada, and 2) modification of local climates causing a higher-than-normal rainfall. However, according to a Stanford Research Center (1976) paper, the heat releases from a field of several geothermal generating plants is relatively small on a regional scale. The significance of this heat output on distant thunderstorm activity is considered negligible. Also, the effects of water vapor and steam effluxes (which increase atmospheric moisture) are similarly not considered to be realistic factors in preventing thunderstorms in the Sierra Nevada.

FIGURE 13



Diagrammatic representation of air turbulence at generator Unit 7 and 8. Prevailing winds during the day blow directly across this northwest-trending ridge, then seem to turn and flow up valley across the county line ridge. Turbulence seems to force the steam downward on the hillside below the plant before up-valley winds affect it. A high disease incidence in all evergreen shrubs and trees occurred in the fallout zone below the plant.

The total effect and large scale implications of these impacts are not presently known but with full field development very significant effects, both positive and negative, could occur at large distances from the field.

Production of Steam and Electricity

The impacts mentioned above apply here also. The steam released from cooling towers which amounts to approximately 80 percent of steam entering the generating plant will increase in this stage and will be the main source of steam from the developed geothermal field.

Steam production from various activities in The Geysers can be summarized in general terms as follows:

Activity	Production Capacity Kg/hr
Power Units	4,360,000 (9,600,000 lbs/hr)*
Producing Wells	182,000 (400,000 lbs/hr)
Idle Wells	91,000 (200,000 lbs/hr)
Well Drilling	54,500 (120,000 lbs/hr)

* A typical new well will produce steam at a rate of 91,000 Kg/hr (200,000 lb/hr). The output from about 10 wells is required to operate 1 power plant of 100 MW capacity. Eighty percent of steam entering plant exits through the cooling towers. Twenty percent of the steam (condensed surplus water) is returned to the steam field through reinjection wells).

Closeout

The abandonment of wells, removal of surface equipment and surface reclamation and restoration of roads and drill pads would all have favorable impacts. The overall steam emissions would be reduced to that of an undeveloped naturally occurring steam field. The impacts of climate modification would be low if not altogether eliminated.

3. Mitigating Measures

Preliminary exploration

No mitigation needed.

Exploratory Drilling

Mitigation is not feasible at this stage due to the small number of wells being drilled and/or employed (1 to 2 per 640 acres) and the high cost of corrective equipment.

Field Development

Due to incomplete data on local and regional climate modification as related to increased field development, specific and practical mitigation measures

E. Air, Odors, and Noise

Air

1. Existing Environment

Air quality has not been monitored in the study area. Current air quality in the mountainous parts of Mendocino and Lake Counties is considered very good due to the lack of heavy industrialization in the area. Valley areas (Ukiah and Covelo, etc.) have high particulate matter contents due to influence from local mills and wood processing plants.

The southern portions of the Lake and Mendocino counties are influenced by H_2S emissions from The Geysers especially during the dry season as the result of high night time intensity drift (Swanson and Mooney 1973). During part of April and May of 1975, the Air Resources Board operated mobile air-monitoring units at three locations in Lake County (at Kelseyville, Upper Lake, and Middletown). The data gathered at these units show that the concentration of all sulfur-containing gases was below .02 ppm during all observations. (The state standard for H_2S is .03 ppm, hourly average.) The study area is further from The Geysers than any of these three locations.

2. Impacts

The potential for air pollution arises from the noncondensible gases that accompany natural steam.

The term "noncondensible gases" is used to describe those compounds contained in steam that are not condensed when steam is cooled to ambient air temperature. The composition and quantity of remaining gases are variable depending on the well and field. Generally, the total of noncondensible gases adds up to just over 2 percent of the total steam weight at the high end of the range, down to 0.15 percent at the minimum (see Table 14).

Listed in approximate order of decreasing importance these gases are released to the atmosphere from: 1) cooling-tower discharges, 2) well clean-out and testing, 3) bleeding shut-in wells, 4) air drilling, 5) generator by-pass, 6) pipeline bleeding, 7) failure of transmission or generating systems necessitating plant shut-down, 8) blowout wells, and 9) natural emissions from fumaroles and hot springs.

a. Preliminary Exploration

General air quality will not be altered by the proposed action.

b. Exploratory Drilling

Drilling, road and pad construction operations, traffic, and well blowouts all contribute to increased particulate matter in the atmosphere. Drilling and, in very rare instances, blowouts have in the past

TABLE 14

Composition of Steam From Wells at The Geysers

Constituent		Concentration[1] (mg/kg) PPM			Percent by Weight[3]			Average Flow[2] into M.W. Unit (kg/hr)	lb/hr
		Low	Average	High	Low	High	Design		
Carbon dioxide	(CO_2)	290	3260	30600	0.0884	1.90	0.079	2700	5940
Hydrogen sulfide	(H_2S)	5	222	1600	0.0005	0.160	0.05	180	396
Methane	(CH_4)	13	194	1447	0.0056	0.032	0.05	160	352
Ammonia	(NH_3)	9	194	1060	0.0056	0.106	0.07	160	352
Boric Acid	(H_3BO_3)	12	91	223	--	--	--	75	165
Nitrogen	(N_2)	6	52	638	0.0016	0.064	0.03	43	95
Hydrogen	(H_2)	11	56	218	0.0018	0.019	0.01	46	101
Ethane	(C_2H_6)	3	8	19	0.0003	0.002	--	6.6	14.5
Arsenic	(As)	.002	.019	.05	--	--	--	.016	.035
Mercury	(Hg)	.00031	.005	.018	--	--	--	.004	.0088
				Total	0.120%	2.19%	1.00%		

1. From Measurements of 61 steam wells from 1972 through 1974.
2. Based on steam input of 821,000 kg/hr (1,806,000 lb/hr.)
3. From "Sources and Sampling of Pollutants for Geothermal Steam Areas" Stanford Research Institute (1975).

ejected dust more or less unabated. Up to 45 tons of rock dust and fragments can be discharged into the sump from one well in the course of the compressed air phase (Neilsen, et al, Ecoview Francisco Leasehold, 1975.) During the air drilling process, rock dust may be ejected over the landscape through the blow line. There will be incremental emissions from automotive and diesel exhaust. The latter operate 24 hours a day, over a two to three month period for each well drilled (Nielsen, et. al., Cobb Mtn. Leasehold, pp. 75-76).

Aerosols are also released during air drilling--especially when the steam zone is entered, during well-testing, cleanout, and during standby. Hydrogen sulfide (H_2S) (2.96% of total noncondensible gases by weight) is the principal air pollutant associated with geothermal operations. This gas has an extremely powerful odor and has toxic properties. Although estimates for odor threshold of H_2S (the threshold concentration for human detection) indicate great individual variation, the 0.03 ppm/hour level has been adopted as the California ambient air quality standard. Any level above this is considered a nuisance, and at concentrations in the 0.07 ppm range, adverse physiological responses in humans have been detected (ARB 1970). Ten ppm is the toxicity threshold of health impairment in human beings. Air drilling operations during exploratory well drilling may produce modest amounts of steam with associated concentrations of H_2S. Average concentration of H_2S at the blow line range between 1000-2000 ppm.

At present, exploratory well practices are to vent all steam and gases directly to the atmosphere. Union Oil representatives estimate that during well cleanout, as much as 260± lbs of H_2S can be discharged per well per day, and about 7± lbs of H_2S can be expected per well per day during standby steam venting.

c. Field Development

Dust and particulate matter will increase with increased vehicle traffic, well drilling, and road and pad construction (see exploratory drilling above).

Also, with the increase in wells drilled in this stage, the daily amount of H_2S and aerosals released will increase in multiples of the figures mentioned above.

d. Production of Steam and Electricity

More significant quantities of H_2S emissions will be encountered when the power plant complex comes on line, approximately five years from initial exploratory well drilling. Estimates for the more recent units in The Geysers field project an average H_2S concentration in steam of 220 ppm by weight (see Table 4). At this concentration, approximately 2.0 metric tons (1 metric ton = 2200 lbs) of the sulfur will be emitted per day per 53 MW unit, assuming no control of emissions. This figure is based on the amount of steam that actually goes through the plant turbine-generators. Steam sometimes bypasses the generators because of excessive steam pressures, plant malfunction, or curtailed power generation. This figure, then, can be taken

as a conservative estimate of total, unmitigated steam field H_2S emissions. The oxidation of H_2S into sulfur dioxide (SO_2) would amount to a production of 27,000 metric tons per year (1 metric ton = 2200 lbs), approximately 25 percent of what is produced by Los Angeles County per year (105,500 metric tons). The production of secondary sulfur compounds from geothermal development may not be trivial.

In connection with H_2S emissions and production of sulfur compounds, several local and regional climatic factors should be kept in mind:

(1) Ground monitoring of these emissions may be misleading. Even on still days local turbulence and air transport near the ground may disperse gases aloft rapidly when the air is warm and keep them concentrated at low levels when the air is cold. The importance of gas dispersion aloft in convected air may be very significant when coupled with inland movement to Central Valley air masses and associated smog and smoke load.

(2) The elevation of the proposed lease tracts above the valleys will usually result in dissipation of emissions in upper air levels; however, strong down-valley and down-slope winds evident in mountain terrain may transport emissions into the valleys during stagnation periods of long duration or large coastal inversions.

(3) Hydrogen sulfide and other oxides of sulphur from various sources form aerosols by combining with water molecules from the atmosphere, and are the primary base for summer hazes common over the Central Valley during summer. The topmost layer lies just under the temperature inversion layer which also extends over the lower interior Coast Ranges between 1500-2000 feet. This becomes particularly important to The Geysers-Calistoga KCRA and possibly to the Witter Springs area. If the majority of the emissions are directed up over the inversion, the dispersion layer is 1524 to 3048 meters (5 to 10,000 feet) thick. Since ozone concentrations increase with altitude then the SO_2 production would be sufficient (from the reaction of H_2S and ozone) and figure in the total sulfur cycle. If the majority of the emissions are directed below the inversion layer, it mixes with the high levels already accumulated there from other sources--mainly as a result of industry and vehicular exhausts. This layer also contains accumulations of ozone which rapidly reacts with hydrogen sulfide to form sulphur dioxide (Neilsen et. al., Upper Squaw Creek Leasehold, 1974, pp. 71-73). A more accurate prediction of expected H_2S emissions levels and resulting impacts cannot be formulated because the behavior of H_2S in the atmosphere and its potential environmental effects have not been well researched.

The probability of a substantial change in area air quality as a direct result of the proposed action is low. With acceptable emissions control at the source, (cooling towers and power plants) any concern could all but be eliminated. However, inasmuch as Geysers H_2S emissions continue more or less unabated, a potential regional hazard exists, increasing with each incremental expansion in field production at The Geysers and in the study area.

As background atmospheric H_2S levels increase throughout the KGRA's it will become more and more difficult to accommodate new geothermal operations and, at the same time, maintain air quality standards throughout the North Coast Region. The impact of widespread dispersal of H_2S and its oxidation products on plants, soil, and water is another potential hazard virtually unresearched in Northern and Central California.

The Lake County Air Pollution Control District has had a unit at several locations in the Anderson Springs and Geysers Rock areas measuring gaseous sulfur concentrations, and data gathered show that concentrations occasionally exceed the State ambient air quality standard. There is no year-round information yet for any study areas near The Geysers.

The transformation of H_2S emissions is a critical factor. The Air Resources Board (1970) describes in detail the potential human hazard from H_2S. An additional hazard occurs when H_2S oxidizes. H_2S in the atmosphere could produce, by oxidation, SO_2 and SO_3, which are both injurious to plants by direct gaseous contact or by accumulation. If SO_3 is produced, it could in turn, by absorption of water, form sulfuric acid.[3] The mechanisms governing these processes in the atmosphere are basically unknown and untested. Insofar as H_2S is oxidized in the atmosphere to sulfuric acid and sulfate ion, it may contribute to two additional problems--aerosol haze and acid rain.

H_2S production from various operations at The Geysers:

Activity	Production (kilogram/hr.)
Power Units	2182 (4800 lb/hr)
Producing Wells	91 (200 lb/hr)
Idle Wells (venting)	45 (100 lb/hr)
Well Drilling	27 (60 lb/hr)

Important sources of aerosols during production are cooling tower drift, steam venting of wells and lines, power plant bypass, and venting of excess steam.

As mentioned before, hydrogen sulfide and other oxides of sulphur form aerosols by attracting water molecules from the atmosphere. The aerosol problem is especially acute in temperature inversions during stagnant air weather patterns.

Limited studies at The Geysers has shown it to be a substantial source of sulfur aerosols. Dr. Thomas Cahill of the Air Quality group of the Crocker Nuclear Lab, University of California, Davis, reports that the major effect of atmospheric aerosols in low humidity areas of the West is visibility reduction. The hazes have been traced to fine sulfur aerosols in the 0.65 to 1.5 micrometer size (1 micrometer - 0.00004 inches) (Neilson, et. al., Union Oil, Feb. 1975).

Particles on the order of 5 to 15 microns (.0001 centimeter) fall out within 1 to 5 miles of the emission source; particles on the order of .5 to 5 microns are suspended for longer periods of time, permitting chemical reactions to occur, hence changing the nature of the particle (sulfur aerosols). These two classes of particle size are large enough to be eliminated from the human respiratory tract when breathed; therefore, the potential for absorption of heavy metal ions and potentially toxic substances is minimized. Particles in the size range of .1 to 5 microns or smaller are maintained in suspension indefinitely. Clouds of these materials may circle the globe many times and still be identifiable as to their source. When inhaled, particles in this size range are carried deep into the respiratory tract and readily absorbed into the blood stream through lung tissue. Accumulation and residual time varies for each element; e.g., mercury tends to accumulate without being eliminated, lead resides in the body for up to several days (Neilson, et. al., Cobb Mtn. Leasehold, Oct. 1974).

The problem of acid rain is an impact that has been studied little and which has complex ramifications. While initial quantitative observations of H_2S in populated areas to the east of The Geysers indicate present concentrations in ambient air levels to be below the accepted tolerance limit for human safety (Swanson and Mooney, 1973), the additional contributions of H_2S and NH_3 (ammonia) at full field production in the study area may increase the incidence of acid rain. Acid rain gained attention when it was noted in central California during the winter 1972-73.

Acid rain results from the hydrolysis of sulfur and nitrous oxides. Sulphur dioxide and H_2S are oxidized to sulphuric acid and ammonia is converted to nitric acid. If these acids do not neutralize in the air, they fall to the ground in precipitation, either rain or snow.

The ecological effects of this change are as yet unknown, but potentially they are numerous and very complex. Effects may range from changes in decomposition of nutrients from plant foliage, changes in leaching rates of soil nutrients, acidification of lakes and rivers, effects on metabolism of organisms, and corrosion of metal structures.

A detailed discussion of air chemistry of H_2S and NH_3 and the production of haze and acid rain can be found in ECOVIEW EIR reports (Neilson, et. al., Jan. 1974, pp. 114-116; May, 1974, pp. 73-82; and February 1975, pp. 166-174).

Radon (222 RN) measurements taken at various Geyser plants have shown that noncondensible gases collected from steam and ejector off-gas samples had concentrations above the State standard of 3.0 pico curies/liter (pC./l.).* The ambient air sampled contained 222_{RN} concentrations ranging from less than 0.01 to 0.20 pC./l. These measurements indicate a sufficient natural dilution and dispersion to reduce 222_{RN} concentrations at the ejector off-gas stacks to acceptable concentration at ground level. Lead (310 Pb) concentration, (a natural occurring isotope in addition to being a decomposition product of radon) in Big Sulfur Creek water samples were less than 0.40 pC./l, which is well below the State regulation of 100 pC./l in uncontrolled waters.

* A pico curie equals 6.8×10^{-21} kg (2.4×10^{-19} ounces)

No evidence of health hazards as a result of radioactivity in the air and water has been observed at The Geysers. The only impact in the study area seems to be from possible cumulative effects from expanded field production in which the present natural dilution and dispersion of 222_{RN} would not be adequate.

Mercury vapor is often present in geothermal releases but at very low levels and does not generally pose a hazard or impact.

e. Closeout of Operations

General air quality conditions will not be altered by the proposed action.

3. Air Mitigation

a. Preliminary Exploration

No mitigation required.

b. Exploratory Drilling

For dust abatement, oil or water will be spread on roads and pad areas. Water injection on the blow line during air drilling will largely eliminate dust pollution.

The H_2S emissions from exploratory drilling will be low. These releases would be diluted by the natural dispersion effect of the surrounding air basin and would need no mitigation to bring the H_2S concentration below the California ambient air quality standards.

c. Field Development

During air drilling, the concentration of H_2S from the blow line can range between 1000-2000 ppm. By injection with ammonia this can be reduced to 200-500 ppm (monthly Geothermal Report, 1975). This procedure would result in a chemical reaction with H_2S to produce ammonium sulfate ($(NH_4)_2SO_4$), a common fertilizer. This product would be non-volatile and would condense to form a precipitate. As it becomes technically feasible, abatement equipment shall be required on all wells on standby. At present there are two methods of H_2S abatement that might be applied to wells on standby. In the first, the iron catalyst system, a prototype test has achieved a 90-percent reduction in H_2S to about 0.5 ton/day per unit. However, corrosion of equipment and disposal of residual wastes are major problems. The second system, the H_2S-SO_2 system, consists of an additional unit which first converts the H_2S to sulfur dioxide, then scrubs the SO_2. About 50 percent of the H_2S is removed, but no solid wastes are produced.

With employment of these systems in this stage, the H_2S problem can thus be avoided, with only temporary and slight releases to the atmosphere. However, these systems would not work for wells being tested because of other unsolved technical problems.

d. Production of Steam and Electricity

The two abatement systems mentioned above would apply to the emissions being released from cooling towers associated with generating plants. However, at present, abatement equipment is operational only on Geysers Unit 11, with emissions continuing unabated from the other units. That is, corrosion problems (iron catalyst system), waste disposal problems and economic considerations of installation and maintenance have caused the developers to abandon the program of a fullscale abatement system at The Geysers. Also, emissions control applies only to the steam that enters the generating plant. At any time the plant is shut down or production is curtailed, raw steam is automatically vented to the atmosphere for varying periods of time. So far no H_2S abatement devices have been provided by the steam supply companies to control these emissions. The solution shall be to shut down wells if the generator down time is prolonged beyond five days, or to shift a portion of the steam to other generators through interconnecting pipelines. If it appears that a power plant in a particular location cannot operate without causing H_2S levels in excess of the State standard, the option of prohibiting plant operation will then be taken.

It should be noted that if the California ARB standard for ambient air concentrations of H_2S (0.03 ppm) is not exceeded, then the resultant concentration of H_2S and transformation products (aerosols, acid rain) would be insufficient under normal meteorological conditions to adversely affect local climate (fog or haze) or air quality.

e. Closeout of Operations

No mitigation needed.

4. Residual Impacts

a. Preliminary Exploration

No residual impacts.

b. Exploration Drilling

A temporary reduction in air quality can be expected to recur from steam releases caused by well testing and, rarely, during well blowout (See the Climate, Residual Impact section).

c. Field Development

Generally, the impacts associated with geothermal development in full field development cannot be completely mitigated.

The release of H_2S and other gases into the atmosphere from venting and testing of numerous wells is a residual adverse impact on air quality.

d. Production of Steam and Electricity

Power plants and cooling towers release steam and contaminants. With the present progress of abatement equipment use and research, the cumulative impact of numerous power plants releasing steam and non-condensible gases will continue throughout the life of a developed geothermal field (see the Climate, Residual Impacts section).

The effect of radon released in geothermal steam on the total environment is still not known and is a residual impact.

Odors and Noise

1. Existing Environment

Sounds and smells within the Witter Springs Study Area are for the most part natural. Natural sounds include wind movement through brush and trees, animal and bird calls, the occasional sounds of insects, and the sound of running water near springs and streams. Odors include vegetation, and natural fermentation odors. State Highway 20 with its associated traffic sounds and odors passes through the center of the study area but affects little of the study area. The decibel background noise in the natural setting mentioned above would range between 30 to 40 dB(A) (see Table 14).

No noisy large-scale gravel or mining operations exist. There are no pulp mills or refineries or other odor creating industries. Over most of the Federal land the noise from highways, farms, and towns along the valley bottoms cannot be heard. In the Cow Mountain area, where there is good public access, motorcycles, jeeps, trucks, etc., create a substantial amount of noise. These vehicular sounds occur mainly on weekends in the spring, summer, and fall. Logging operations in the Middle Mountain area create noise mainly in the summer months.

2. Impacts

a. Preliminary Exploration

Noise level will increase with light vehicular traffic and probe hole drilling. General odor conditions will not be altered by the proposed action.

b. Exploration Drilling

Unnatural odors will increase with vehicular traffic and drill site construction. Vehicular exhaust and H_2S gas from well drilling, testing, and venting will be produced. Most odors will dissipate quickly, except H_2S gas. It will be constantly emitted through well venting or bleeding.

Noise levels will increase with vehicular traffic and drilling. The impacts at this stage will be low.

c. Field Development

With increased well drilling, H_2S levels will increase and ambient air concentrations may rise above 0.03 ppm (State Air Quality Standard). Hydrogen sulfide (H_2S) occurs at 300-500 ppm in the steam and concentrations in the air at The Geysers can range from 5 to 10 ppm (near wells and power plants).

During the period of 1970-1975 the State Air Resources Board has received numerous complaints concerning strong H_2S odors from Cobb Valley residents in Lake County (Cobb Valley is east of The Geysers area just over the Sonoma-Lake County ridge boundary line).

Unnatural sounds will increase during developmental drilling. Escaping steam from muffled testing well is quite loud near the source but does not carry great distances.

Due to the frequency distribution, noise from muffled testing wells does not attenuate as rapidly with distance as air drilling noise. Air drilling noise comes from the air compressors and discharge vents. At The Geysers, well testing may last only a few days; however, a time lag of several years between testing and utilization of the steam may occur. The wells are bled continuously during this interim (Energy Alternatives, 1975, p. 8-10), and noise levels are approximately the same as for a muffled testing well.

Under present practices at The Geysers the following impacts can be expected in this stage:

(1) Air drilling and well clean-out will seriously increase noise levels. Air drilling noise levels range from 50 to 110 dB(A) at 30.5 m (100 ft.), depending on the operation in progress. Air drilling lasts 2 to 4 weeks, depending on drilling progress; and well clean-out can last from 2 hours up to 5 days (see Table 13).

(2) Air compressors will give out a low throbbing, vibrant noise.

(3) Sharp sounds arising from pipe and drill stem handling will occur. The above noise sources are more disturbing at night due to increased air density, reduced wind, and an overall lower background sound level.

(4) Noise levels of 90 dB(A) can cause permanent damage to humans or animals subjected to long-term exposure. Above 90 dB(A) permanent damage will result from short-term exposure (Philip Leitner, Geothermal Environmental Seminar, Clear Lake, Calif.). Such noise levels are common within 6 meters (20 feet) of bypass vents and blow lines.

(5) A noise impact that has a cumulative effect is that of traffic. As field exploration and subsequent development increase traffic of light cars and pickups, truckloads of heavy equipment and earth-moving equipment will increase along existing access routes that lead into the study areas. The noise level will be increased substantially from this source in the residential areas and dwellings surrounding the entire study area.

d. Production of Steam and Electricity

With the steam releases from power units the amount of H_2S will increase greatly. Eventually, if unmitigated, H_2S generated over the field may exceed ambient air standards even under favorable wind conditions.

Noise levels once drilling is completed will drop. The main source of noise in the production stage would be:

(1) Steam venting from delivery lines. Noise level average 100 dB(A) at 15 meters (50 feet) to 90 dB(A) at 76 meters (250 feet).

(2) Noise levels in and around generators varies from 40 to 90 dB(A) at 15.4 meters (50 feet). Where excess steam is being vented measurements as high as 92 dB(A) at 123 meters (400 feet) were found at Units #9 and #10 at The Geysers (Neilson, et. al., Francisco Leasehold, July 1975).

e. Closeout of Operations

Impacts will be similar to those discussed under preliminary exploration. These noise impacts are summarized and compared with other noise sources in the following table:

Table 15

Predicted Project Related Noise at 15.25 Meters (50 feet)

Activity	Noise Level (dB(A))[1] at 15.25 Meters
Road Building Equipment	80-90
Drilling Rig (air)	102
Steam Exiting a Blow line during clean-out and testing	125
Steam Exiting a Blow line with Muffler	89-100
Steam Well Venting - Standby	60 (at source)
Steam Generating Plant	85-90
Truck Traffic bringing Equipment and Supplies	100
Other Activities	
Jet aircraft takeoff	125 (at 200 feet)
Threshold of pain	120
Unmuffled diesel truck	100
Street corner in a large city (Average)	75 (at source)
Residential area at night (Average)	40 (at source)
Motorcycle (2 stroke-muffler)	80 (at source)

(See Notes on following page).

1/ Final EIR, Vol. 3, Davies Estate in Lake County by EVIRONS, Los Altos, Ca.
2/ ED&T 2428 Noise Reduction of Forest Service equipment, USDA, Forest Service, San Dimas, CA. 91773.

Table 14 Notes:

1. Decibel A Scale: A decibel is the universally adopted unit for measuring sound intensity. One decibel change in sound is approximately the smallest difference in sound intensity that the human ear can detect.

2. Decibels are scaled on a logarithmic scale. The actual sound pressure on the ear increases 10 times with each 10 decibel increase.

3. Mitigating Measures - Odors and Noise

a. Preliminary Exploration

No mitigation required.

b. Exploration Drilling

Since the impacts at this stage will be low, no mitigation of H_2S odors or drilling and vehicle noise will be required.

c. Field Development

Mitigation measures can be divided into two categories to reduce the noise impacts:

(1) Use of muffler installations:

(a) Air drilling exhausts, well clean-out, and testing will be made through a cyclonic muffler on the blow line. Noise reduction with a muffler system depends on the type of operation involved. With air drilling before the steam zone is entered, noise reduction of air exhaust is 100 percent. With well clean-out and testing the percent reduction is smaller, around 30-50 percent. Shell Oil, on some of their government leaseholds in The Geysers KGRA, have obtained 120 dB(A) (decibels) readings 50 feet from the blow line. With a muffler and water injection the noise level drops to around 86 dB(A) at 50 feet. This mitigation would apply to impact Number 1.

(b) All subsequent venting will be directed into mufflers or other devices capable of reducing noise to less than 55 dB(A) at 30.8 m (100 ft.) in any direction (including vertically) from the point source. Mitigation for impact Number 4.

(c) All motor exhausts of drill rig engines, compressors and construction equipment could be directed into mufflers. Mitigation for impacts 2 and 5.

(2) Timing of Operations:

Around any residential or commercial areas, operations like air drilling and pipe and drill stem handling shall be limited to daytime activities as opposed to nighttime operations. This could mitigate impacts 1 and 3.

d. Production of Steam and Electricity

Odor mitigation would be the same as in field development (Air section). Mitigation of the noise impacts is as follows:

(1) Steam venting from delivery lines leading to power plants will be directed into mufflers capable of reducing noise to less than 55 dB(A) at 30.8 m (100 ft.). Use of screening devices (natural or artificial barriers) could also be used as well as siting the power plants in areas where steam releases and noise production would have the least impact.

(2) All noise from exhausts of generator steam will be abated to levels of between 45 to 55 dB(A) at no greater than 92.3 m (300 ft.) in any direction including vertically, from the noise source. Two methods are: (a) tandem mufflers for generator bypass discharges to the atmosphere, or (b) direct venting of raw steam during generator bypass into a condenser, either the one operated within the generator, or an auxiliary built for the purpose (Neilson, et. al., Francisco Leasehold, July 1975). Mitigation for impact 2.

The technology to do these things is available, although during development of a well or power unit operation it is not customary to use these techniques except in very sensitive areas. If noise from operations on national resource lands occurs where it would cause adverse impacts, then noise control measures will be required.

d. Closeout of Operations

No mitigation needed.

4. Residual Impacts - Odors and Noise

Generally, the noise and odor impacts associated with all phases of geothermal development cannot be completely mitigated, because blowing steam will recur throughout the entire process, by the changing of control valves, cleaning of wells, and, possibly, during well blow-outs, controlled or otherwise. However, implementation of the proposed mitigating measures will serve to keep cumulative noise and odor effects at a minimum, especially in sensitive areas. In addition, new wells will be drilled periodically to maintain production of existing power plants.

Continuing operations will also require a low level of road traffic.

F. Vegetation and Wildlife

1. Existing Environment

Primary vegetative species in the Witter Springs area and their use by wildlife are outlined in Appendix D. Wildlife species found in the area are summarized in Appendix E. No rare or endangered species have been identified in the Study Area.

Riparian Habitat

The riparian habitat encompasses all areas adjacent to water, including ponds, streams, and springs. Vegetation in this habitat includes willows and other water-loving shrubs, succulent grasses, forbs, sedges, wild berry, cottonwood and pine trees, and oak shrubs and trees.

The major drainage in the Witter Springs Area is Scotts Creek. Animal use here includes deer summering and fawning areas, especially from May-October; summer concentration areas for reptiles, amphibians, feral pigs, quail, waterfowl, and water birds, small mammals including raccoon, opossum, marten and fisher.

Use by predators, including raptors, coyote, and bear occurs year-round; it is also a winter-use area for migratory birds including wax-wings, snipes, and white and golden crowned sparrows.

The riparian environment supports the dietary needs of a greater variety of wildlife than any other habitat type because of the presence of water and the accompanying diversity of plant life.

Woodland-Grass Habitat

Vegetation in this habitat is made up of black oak, leather oak, tan oak, valley white oak, canyon live oak, madrone, white leaf manzanita and Douglas-fir, in association with various grasses and forbs.

The woodland grass habitat is very important to the yearly dietary requirements of large and small mammal populations and upland game birds. Here succulent forbs and grasses help to provide the necessary minerals, vitamins, and plant proteins needed to support an animal through the winter months when the chaparral vegetative areas are dormant, and plant food is lacking. In addition, the woodland grass ecosystem produces a mast crop of oak-acorns each fall that provides a source of fats and carbohydrates to supplement the otherwise inadequate nutritional state of shrubs at this time of year. A significant amount of browse and lichen falls from mature oaks as a result of normal breakage and wind action, providing additional nutrients.

Animal use in this habitat includes:

Spring and fall: Black tail deer acorn forage areas (fall) and fawning habitat (spring) seed foraging and nesting habitat for upland game, such as

gray squirrel, quail, rabbits, birds such as woodpeckers, thrushes, and many small song birds.

Year-round: Turkey, rodents, small mammals, feral pigs nesting, foraging, and resting habitat; hunting habitat for predators such as red-tailed hawk, golden eagle, grey fox, raccoon, opossum, bobcat and coyote.

Chaparral/Pine-Fir-Chaparral Habitat

There is a variety of vegetation within the chaparral/pine-fir-chaparral type, including chamise, manzanita spp., ceanothus spp., scrub oak, interior live oak, madrone, Douglas-fir, knobcone pine, nutmeg fir, chaparral pea, mahogany, buckeye and silk tassel.

During the spring greenup period from March to May, active stem growth takes place in the shrub species, and protein content in many shrub stems and leaves is at a maximum. After flowering and seed production in late summer the protein content decreases. When the plants dry out they become dormant, stems and shoots become increasingly woody and tough, and protein content reaches a low point.

Animal use includes:

Spring through fall: Valuable spring forage for black tail deer on new shrub sprouts during April, May, and June; brush rabbit and feral pig foraging habitat.

Spring and summer: Nesting and feeding habitat for small song birds including Oregon junco, towhee, wrens, and other birds such as California thrasher, raven, and scrub jays.

Year-round: Predators such as coyote, bobcat, red fox, raccoon; cover and foraging use by deer; habitat for reptiles such as the western fence lizard and western skink; fall use on manzanita and madrone berries by upland game birds, non-game birds, small mammals, bear, and coyote.

Wet Meadow Habitat

Vegetation in the wet meadow includes cattails, sedges, willows, rushes, and grasses. Succulent herbs are common and make up a large part of the diet of many mammals and birds. Meadows are summering areas for mammals, year-long use areas for waterfowl and other birds and amphibians. Furbearers make frequent use of meadows as do avian predators.

Animal use includes:

Spring and fall: Black tail deer, upland game and small mammals.

Fall seed use: Upland game birds, non-game birds.

Winter: Foraging by black tail deer.

Year-round: Quail, upland game, burrowing rodents.

Conifer Forest Habitat

North-slope pockets of Douglas-fir, nutmeg, knobcone pine and associated broad leaf trees such as madrone, interior live oak, cypress, and shrubs including manzanita, ceanothus, and oak shrubs.

Animal use includes:

Year-round: Stellar jay, western skink, black tail deer (below 4500 feet), black bear range (yearlong and seasonal), mountain lion hunting range.

Spring through fall: Band-tailed pigeon roosting and nesting spring habitat; small non-game bird nesting, food-gathering habitat; raptor spring and summer nesting, roosting and hunting habitat; small mammal (raccoon, opossum, martin, fisher, squirrel, skunk, gray fox, ring-tailed cat, bats and rodents) spring and summer nesting, foraging habitat, and winter denning habitat.

Agriculture Habitat

Orchards, vineyards, pasture and cultivated lands are included.

Animal use includes:

Summer and fall: Concentration areas for deer, upland game and small mammals.

Year-round: Feeding and burrowing habitat for small rodents, reptiles and burrowing predators such as the badger; habitat for muskrat, waterfowl, and raptors.

Preferred Use Areas for Specific Species

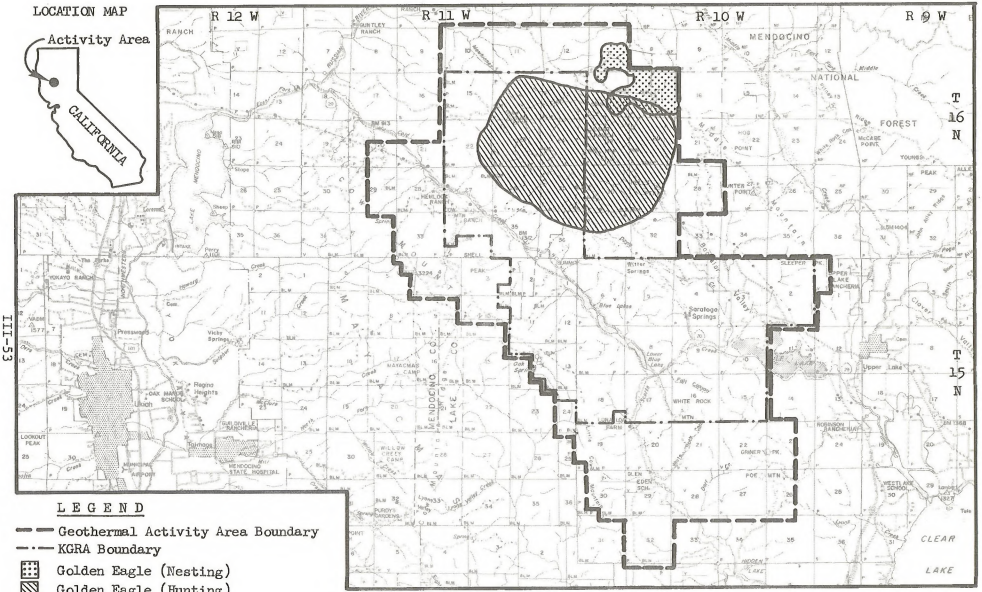
Golden eagles were observed hunting over the Witter Springs area. Eagles utilize all habitat types during their search for prey, however, some vegetative communities produce more prey species than others. Open grass meadows support ground squirrels and other small mammals. Prey capture is facilitated here due to the lack of cover and the distance and prey item must move before it can reach its den or protective shrub cover.

Eagles and many other raptors also utilize ridge tops and open areas adjacent to riparian streams and ponds to obtain prey.

Nesting sites are available for eagles in the conifer trees on the east side of the unit.

Preferred use area(s) for golden eagles is(are) shown on Map 8.

Witter Springs contains habitat conditions that are beneficial to black tail deer. There is a surplus of open-meadow areas containing forbs, grasses, and water that supply needed fall and winter nutrients to suppliment their use of the chaparral brush. These meadows are intermixed with chaparral that has undergone controlled burning in the past, and different stages of comparatively young shrub growth are available.



STATUS LEGEND

P - Patented Lands

V - National Resource Lands

Withdrawals

NF - National Forest

BLM - Bureau of Land Management

SCALE: ½" = 1 MILE

MT. DIABLO MERIDIAN

WITTER SPRINGS GEOTHERMAL ACTIVITY AREA

Preferred Use Areas

Golden Eagle

MAP 8

The overall effect of both communities in their present condition is to maintain a high body condition and population density. Deer densities in this area are estimated to be 70 deer per square mile compared to 30-40 deer per square mile in much of the Cow Mountain unit. The preferred use area for deer is shown on Map 9.

Wild pig habitat includes riparian, chaparral, and woodland grass. Surface water and moist areas throughout the year are essential requirements. During the dry season (June through October) pigs will utilize creek bottoms and all damp, cool riparian areas. During winter and spring when they are not so dependent on permanent water, pigs utilize ridge tops, woodland grass slopes and meadows. Fall use is made of the oak mast crop in woodland grass and chaparral communities. Wallows are commonly found adjacent to springs, creeks, and reservoirs where sufficient cover exists. Prefered use areas for wild pigs are shown on Map 10.

Aquatic Habitat

Table 16 is a list of waters on NRL with fisheries values within the proposed Witter Springs geothermal development area.

Russian River Drainage - Mewhinney Creek has downstream barriers to steelhead, but has rainbow trout in its headwaters. Mewhinney Creek also contains non-game fish (western roach and western sucker) in its lower stretches.

Rare and Endangered Species

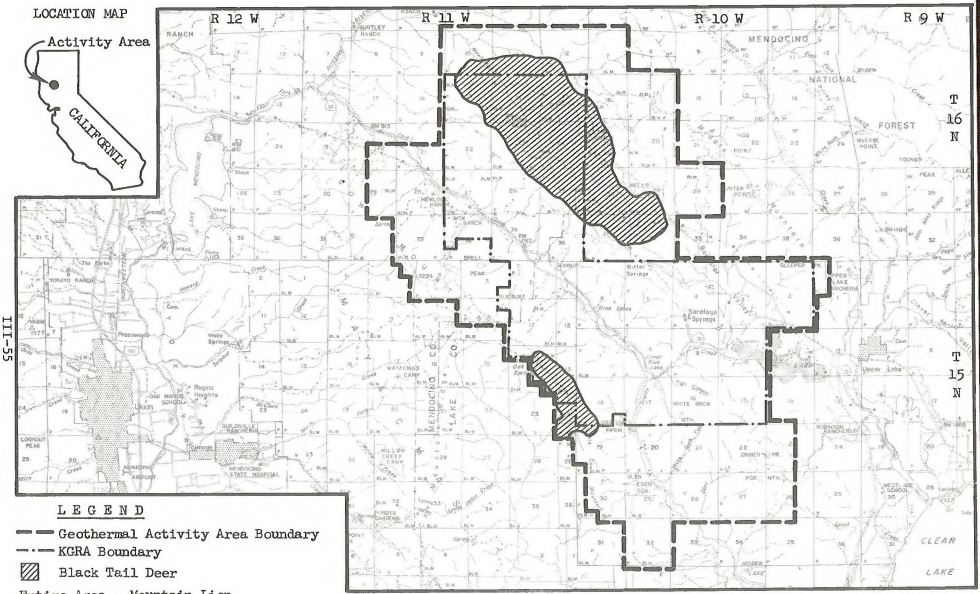
No rare or endangered species of wildlife have been identified in the Study Area.

The Inventory of California Natural Areas and the Inventory of Rare and Endangered Vascular Plants of California were consulted regarding botanical interests. There are no unique or rare and endangered plant species identified for the area. However, there has been no field survey conducted.

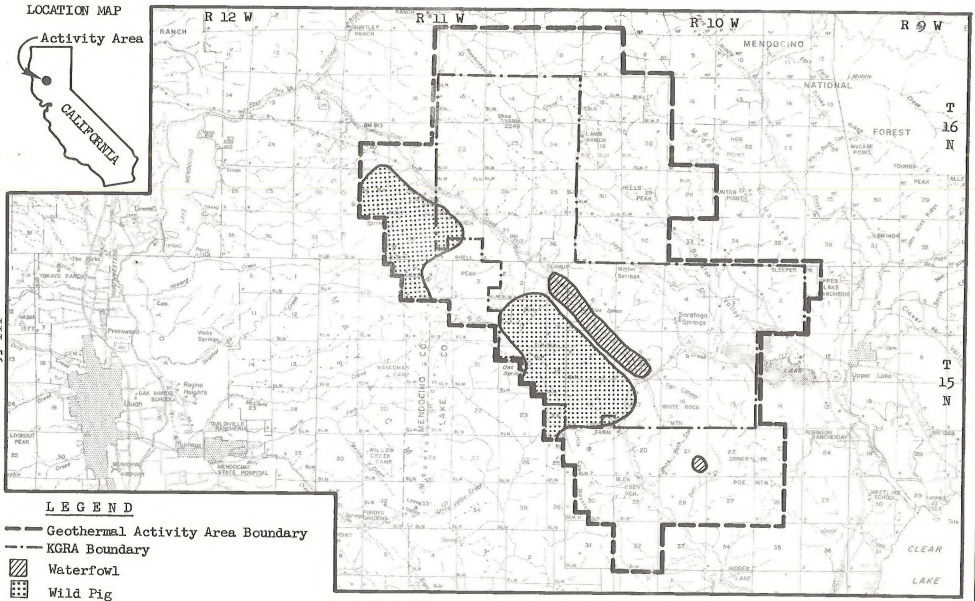
Scotts Creek Drainage - The streams in this drainage all have rainbow trout in their headwaters. Non-game fish, usually consisting of squawfish western roach, and western sucker are found in the lower stretches. Although the area's trout fisheries resources are quite limited in size, they are considered to be very valuable by virtue of the relative scarcity of this type of resource anywhere in this area.

2. Impacts

Geothermal development generally has impacts on all wildlife because of: 1) loss of habitat, 2) fragmentation of habitat, use areas, and ranges, 3) reduction in quality of existing habitat, 4) introduction of biosensitive contaminants into the atmosphere, 5) increased erosion rates into drainages and water courses.


LOCATION MAP
Activity Area
CALIFORNIA
R 12 W
R 11 W
R 10 W
R 9 W
T 16 N
T 15 N
MENDOCINO NATIONAL FOREST
LAKE
CLEAR LAKE
LEGEND
Geothermal Activity Area Boundary
KGRA Boundary
Black Tail Deer
Entire Area - Mountain Lion
STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management
SCALE: 1/2" = 1 MILE
MT. DIABLO MERIDIAN
WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Preferred Use Areas
Deer & Mountain Lion

MAP-9



III-156

STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management

SCALE: $\frac{1}{2}$" = 1 MILE
MT.DIABLO MERIDIAN

WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Preferred Use Areas
Waterfowl & Wild Pig

MAP-10

Table 16

Waters With Fisheries Values on National Resource Land (NRL)
Within the Proposed Witter Springs Activity Area

Mewhinney Creek	RT,NG
Scotts Creek, N.F.	RT,NG

Abbreviations:

RT - Rainbow Trout
NG - Non-game species, usually western roach, western sucker, squawfish and hardhead.

There is little factual evidence regarding species adaptability to geothermal activity. However, intense use of areas by humans may prevent use by many wildlife species, and one obvious aspect of development is the loss of diversity of wildlife habitat and niches.

All construction activity involving soil surface disturbance has the potential for being damaging to the aquatic environment and fisheries. The previous sections on impacts on soils and water quality are related to the impacts on aquatic life. Specifically, while silted or turbid water will not directly kill large fish, it can cause losses by covering gravel nests containing eggs or young fish. Siltation of the spawning gravel restricts water movement through the gravel and, in effect, smothers the young fish. Because of this, fish will not spawn in silted areas. Moreover, silt can greatly reduce the aquatic organisms that fish need for food, thereby also reducing or eliminating these higher life forms. Soil erosion and sediment transportation and deposition in streams occur naturally. However, excessive amounts can be very damaging.

The section on water describes other adverse impacts that could occur. The degradation of water from toxic materials that enter from either soil erosion or mishaps (sump failure or pipe leaks) will have adverse impacts on the aquatic life. An unknown is the cumulative effect on the watershed of the toxic materials in steam released to the atmosphere from the power plants. The California Department of Fish and Game (letter, 3-16-76) (See Appendix F) has documented from 4 to 9 mechanical failures or accidents each year (1973-75) which have caused stream pollution from the existing geothermal operations in The Geysers area.

Impacts on living components of the ecosystem can be directly tied to the five stages of geothermal operations as follows:

a. Preliminary Exploration

No or low negative impacts to all fish and wildlife will occur during preliminary exploration.

b. Exploration Drilling

(1) Construction of roads, pads, and sumps will bring about a habitat loss to all orders, especially rodents, insectivores, raptors and other birds, and may effect changes in predator populations of carnivores. Resident or nesting animals in project areas will be displaced and/or eliminated. High negative impacts will occur to: a) vegetative cover, b) water quality, c) territorial boundaries and preferred use areas, d) reproductive success, and e) general body maintenance of all animals in affected areas.

Along with the on-site destruction of species such as reptiles, amphibians, rodents and other small mammals, many other wildlife species are displaced because of loss of habitat. Displacement can result in death if the particular animal cannot successfully compete for food and nesting sites in a new area. This may or may not be too large a task for a migrating species if it happens to return to a new area. Its success depends on whether a nest site, feeding territory and general activity area is available, i.e., existing and vacant.

It is, however, a more serious consequence for resident wildlife to establish a new territory, and in most situations the "new" area it chooses already has a full complement of species and the territories are occupied. In either case, the result of full geothermal development is an increased demand on the remaining usable habitats of additional numbers which it may or may not support.

The effect on wildlife populations within and adjacent to the development area is a decrease in population numbers, and likely elimination of others depending on their sensitivity to development, portioning of habitat, and reduction in habitat diversity. Several species may remain and adjust to the new environment, but they will be a remnant of the original population.

In addition, increased sediment and dust movement deposited on surrounding vegetation will render it unsuitable for most wildlife activity including nesting, food gathering, and reproduction. Increased sediment loads in streams will result as pads are developed adjacent to steep slopes. This increase will adversely impact aquatic vegetation and invertebrate organisms that provide food for amphibians and fish. Negative impacts here are medium to high for all orders.

(2) Trucking and other access travel will produce a concentrated noise level along many ridge tops and access routes. Negative impacts will consist of a continuous interruption of wildlife activities including reproduction, body maintenance, and territory usage. Negative impacts are from low to medium for most orders.

(3) Drilling operation and associated noise and disturbance will have direct negative impacts on the use of on-site and adjacent habitat. The effects of noise on predator-prey relationships are presently unknown, but it is safe to assume that animals which depend on their hearing for survival will be adversely affected. It is quite possible that many species will avoid the use of areas adjacent to drill pads and equipment concentration sites because of the noise factor, and the value of the adjacent areas in providing food and reproductive and resting sites is diminished.

Successful development of steam-producing wells introduces raw steam and accompanying compounds such as methane, hydrogen sulfide, carbon dioxide, and ammonia. In large concentrations hydrogen sulfide and ammonia are poisonous to animals. If the concentrations of these compounds on the native wildlands are sufficient and are accompanied by increased humidity levels, a potential danger exists for animal and plant life. Hydrogen sulfide is a contaminant which, through oxidation to sulfur dioxide and incorporation into aerosol particles can enter animal bodies through the respiratory system. In addition, the increased humdiity levels associated with geothermal development have been implicated as a factor in the disease susceptibility of certain chaparral shrubs. (See Ecoview EIR - Nielson et al, 1974 Union Leasehold - Squaw Creek Air Quality and Vegetative Impacts , pp. 70-86.)

Little is presently known of the total effects of contaminants on plant and animal life in The Geysers and adjacent areas. A study to determine the

impacts of different noise levels on animal life is presently underway (Dr. Phil Leitner, St. Mary's College, Moraga, California).

Negative impacts are high for terrestrial carnivores as prey species will be reduced or eliminated in these sites. Nesting activity for many passerine species, birds of prey, and game birds will be eliminated and food-chain levels will be reduced for many wildlife species. Impacts are medium for the remaining orders.

(4) The impact of well testing activity on wildlife is unknown at this time.

(5) Waste disposal of drilling muds, oils, and geothermal fluids is accomplished by placing them temporarily in sumps adjacent to the drill pad. Periodically liquids are removed to a Class 1 disposal site. Subsurface leaching or failure of a sump to hold the drill fluids due to winter rains and/or sump wall failure will introduce toxic material into the native habitat. Feeder drainages may carry this material down into the main creeks and produce serious negative impacts on aquatic plant and animal life.

Accidental blowouts and dispersal of contaminants will, in effect, produce the same negative impacts on surrounding vegetation and associated drainages and streams. The impact of waste disposal on amphibians, reptiles, fish, and invertebrates will be high due to interference with photosynthetic processes of terrestrial and aquatic plant life and direct toxic effect on insect and animal organisms. Remaining orders will experience low to medium negative impacts depending on sump operation and containment of waste material.

(6) Well venting or bleeding will produce a certain amount of continuous noise which may produce effects similar to those discussed in Exploration Drilling, Number Four. Other impacts on wildlife are unknown at this time.

c. Field Development

(1) Road construction impacts are similar to those in exploration drilling with increased portioning of the land into parcels of industrialized activity. Increased earth movement and removal of vegetative cover will further decrease usable habitat for all wildlife. Increased dust from earth movement and sediment movement into drainages and streams will adversely affect aquatic plant and animal life. Those animals most affected by this level of activity include rodents, reptiles, invertebrates, fish, amphibians, raptors and other bird species. Low to medium negative impacts will occur on remaining orders.

(2) Drill-site construction impacts are similar to those in exploration drilling with more intensive development. There will be an increase in noise levels, human activity, and resultant subdivision of habitat. The overall effect will be a reduction of important use areas for many wildlife species. The remaining undisturbed habitat may not provide the essential elements necessary for survival. Negative impacts are medium to high for all orders.

(3) Trucking and other access travel will have its greatest impact on terrestrial carnivores such as bear, lion, coyote, bobcat, mink, marten, and fox whose survival depend on well-established hunting lanes, routes, and territories. Hunting ranges and prey species availability will be drastically reduced. Increased human activity and disturbance levels will effect high negative impacts on predator activity. Other wildlife orders will experience low to medium negative impacts from this disturbance.

(4) Drilling operation - as in exploration drilling with more intensive negative impacts - medium to high for most orders.

(5) Well testing - as in exploration drilling.

(6) Waste disposal will be similar to exploration drilling with overall effects on ecosystems amplified by increasing number of sumps. The number of organisms and diversity in all food chain levels is lowered. Negative impacts are similar to exploration drilling.

(7) Well venting or bleeding - refer to exploration drilling.

(8) Construction of power plants and associated buildings will produce noise and concentration of human activity sufficient to negate wildlife use of the immediate area and associated habitat. Cooling tower release of steam and associated chemical compounds will increase humidity levels and amounts of biosensitive materials in the atmosphere.

As power plants, feeding wells, and cooling towers become more numerous, overall negative impacts increase proportionately. On and off-site plant and animal organisms that are more susceptible to the adverse effects of geothermal development are consequently displaced or eliminated.

Negative impacts are medium to high for all orders of mammals, birds, reptiles, fish, and amphibians.

(9) Above-ground pipelines and steam-bleeding stations will create site modifications that will create a wide range of impacts on wildlife. Most affected will be the territorial behavior of terrestrial carnivores and their use of hunting ranges. Maintenance activities, road traffic, and noise from bleeder valves will negate use of these pipeline areas and the general site will be avoided. Common rodent prey species populations such as the pinyon mouse, deer mouse, Sonoma chipmunk, and California ground squirrel may be reduced, and effect similar changes in the predator populations.

Vegetative loss along the pipeline route will increase the sectioning off of wildland habitat and will adversely affect many bird and mammal species. Soil erosion will also increase in these disturbed areas which will affect all aquatic life. Negative impacts range from low to high.

(10) Initial construction of transmission towers and lines will create negative impacts on resident wildlife, including reptiles, amphibians, fish, small mammals and birds.

Immediate impacts will be continued subdivision of the wildlands into smaller parcels and avoidance of the area by many wildlife species.

Historic territories, trails, and preferred areas will be damaged or destroyed and future use of these areas for some species will be ended.

These negative impacts may be temporary, however, if human activity along the pipeline route is minimum after construction is completed. Brush removal or disturbance will stimulate new shrub, grass, and forb growth.

Positive benefits of opening up the brush field include increasing habitat for blacktail deer, rodents, small mammals, and increasing hunting territory for several species of raptors, predators, and small mammals. Impacts range from low to high.

(11) Surface disturbance and steam plant emissions may destroy unique plant life. However, without additional knowledge of unique plant communities, or exact siting of development facilities, the magnitude of such impacts can not be determined.

d. Production of Steam and Electricity

The level of human activity necessary to maintain operation of facilities at full field development will add a continual human disturbance factor to the areas. Mechanical failures and accidents will result in pollution of land and water resources. Those animals adversely affected include the terrestrial carnivores and many of the bird species as well as aquatic species. Impacts vary from low to high for all orders.

e. Closeout of Operations

(1) With the restoration of ground cover and reduction in trucking and other access travel due to abandonment of wells, favorable positive impacts will occur to all faunal orders. Territorial ranges may again be established and with the increase of vegetative cover foraging and reproductive activities will increase. Positive impacts are from low to medium.

(2) Removal of surface equipment including drill rigs and associated equipment and elimination of noise levels will, after a period of time, allow recovery of habitat and return of faunal species. Reduction of habitat division or separation will increase survival potential for all affected species. Positive impacts are from low to high.

(3) Surface reclamation by plantings, seedings, and restoration of sumps and pad areas will encourage the establishment of the original diversity of floral and faunal species with site-specific limitations. Accompanying this restoration and complete abandonment of the general areas of human activity, air and water quality will improve, habitat communities will improve, and positive impacts on all faunal orders will be from medium to high.

3. Mitigating Measures

Initially, restrictions will be incorporated into the lease agreement and operating plan on: 1) levels of humidity and noise, 2) biosensitive contaminants, and 3) construction activity. Without these restrictions, the results of intensive development could be environmentally unacceptable. Site-specific measures will be taken to reduce the overall negative impacts of development. (Refer to specific areas cited in impacts section.) Provisions will be included in the lease agreement to allow undisturbed buffer zones within the development sites. Areas containing identified critical habitat for wildlife species will be included in these buffer zones. (See Maps 8, 9, and 10.)

Sensitive riparian areas will be excluded from surface disturbance and protective measures, such as buffer zones, taken to preserve aquatic vegetation and animal populations including insects, fish, and amphibians.

Proper location and design of access roads, pads, and sumps is essential in reducing erosion rates and sediment loads in all watercourses. Mitigation of disturbed areas including hillsides, burns, drill pads and road edges will be accomplished by seeding to grasses and forbs to decrease erosion potential and provide food for wildlife. (See Appendix G for seeding recommendations.)

To the extent possible, placement of generator/turbine buildings, roads, cooling towers, and all associated structures will be confined to central locations to avoid any more division of the wildlands than is necessary.

All sumps that are built in unproductive areas where abandonment is necessary will be cleaned and left intact to provide future water and marsh sites. Some productive sites which become unproductive will be rehabilitated and restored to wildlife use by revegetating, planting grasses, forbs, and shrubs, and reclaiming sumps. (See Appendix H for seeding recommendations.)

Aquatic

Adverse impacts on fisheries will be mitigated by measures identified in previous parts of this section. In addition, however, any unforeseen significant impacts such as loss of a major portion of aquatic habitat or associated fish or wildlife populations will be mitigated by an approved rehabilitation plan, such plan to be prepared by the lessee.

Prior to any surface disturbance the lessee will have a qualified botanist survey the proposed area for unique botanical resources. If significant resources are found the project will be modified to avoid impact, or if avoidance is not feasible, mitigation measures will be taken. Mitigation steps will be developed by the botanist conducting the survey in consultation with the lessee and BLM.

4. Residual Impacts

Geothermal development will have residual impacts on vegetation and wildlife by reducing populations and communities due to decreasing vegetative cover, water quality, preferred use areas, reproductive success, and general body maintenance of animals in the Study Area. The creation of open areas, increasing food supply and edge effect, is a positive residual impact.

G. Ecological Interrelationships

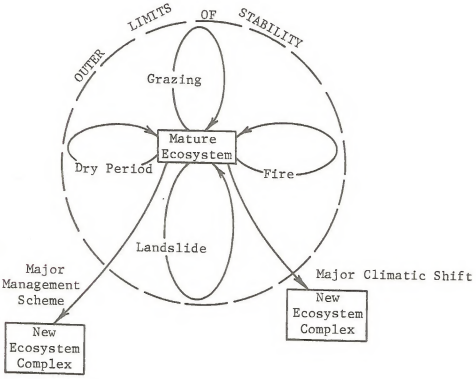
1. Existing Environment

The majority of national resource land in the study area is relatively undisturbed by human activities. Interrelationships between native plants, animals and other ecosystem components are occurring under near natural conditions. These interrelationships are described in previous sections and will not be repeated here. The basic intent of this section is to lay the groundwork for describing the impact of geothermal activities on long-term ecological interrelationships.

General Ecosystem Dynamics

The long-term effects of various disturbances on any ecosystem are illustrated in Figure 14 (Sierra Club, et al, 1974:97).

FIGURE 14



Ecosystem Dynamics (Simplified)

The illustration is very simplified and not intended to explain the intricacies of ecosystem dynamics. It does give a general perspective to ecosystem response under various natural and manmade circumstances.

The "mature ecosystem" in the illustration represents a vegetative community in equilibrium. Equilibrium does not mean an absence of change. Disruptions can and do occur. However, if the "outer limits of stability" are not exceeded, the community will return to a balanced condition. For example, fire in chaparral is a disturbance which creates conditions quite different from those in the mature community. However, there are organisms in chaparral which can exploit newly burned land and which eventually yield to plants and animals of the original community. The outer limits of stability, i.e., total destruction of fire tolerant organisms, are rarely exceeded by the occasional fires that occur in chaparral.

Grazing, dry periods, and landslides are additional examples of possible major disruptions which normally do not permanently change an entire system. Man, of course, has the ability to completely modify a system by adding or removing species. A major climatic shift will also push mature ecosystems beyond the limits of stability.

The majority of national resource land in the study area is in a state of equilibrium. A few disturbed areas are gradually returning to equilibrium. Even those areas with exotic species introduced for rehabilitation purposes will probably revert to conditions preceding the latest disturbance. Within historic times, the outer limits of stability have probably not been exceeded by any disturbance in mature communities within the study area.

2. Impacts

Any impact on the environment can, and probably will, have an impact on ecological interrelationships. There are insufficient data available to prove that a significant impact, i.e., one which exceeds the outer limit of stability of a major ecosystem, will be caused by geothermal development. However, because ecological relationships are so complex, and because so little is known about many of them, the possibility of subtle change and ultimate transformation of the ecosystem cannot be dismissed.

Since the magnitude of the impact required to bring about a particular effect is so poorly known, all the alternatives except nonleasing are roughly comparable.

The possible impacts described below are examples of things which could happen rather than a reasonably full list.

a. Preliminary Exploration

All activities within this phase will cause a short-term disruption of the near natural conditions. Assuming no activity beyond this phase, time and normal mitigation measures will bring the area back to conditions preceding exploration.

b. Exploration Drilling

(1) Vegetation and soil removal during road and drill site construction will destroy wildlife habitat. Animals will be displaced, creating imbalances in adjacent stabilized areas. Some animals may die as a result of displacement and food chains may be slightly disrupted.

(2) Noise and vehicle movement will cause additional animal displacement and slightly intensify the chain of events discussed in point 1.

(3) Water for drilling operations may be removed from surface flow areas. If water is removed at critical periods, e.g., summer low flow, aquatic habitat and organisms may be impared or destroyed.

(4) The ground-water table may be modified following earth moving. Stream flows and vegetation could be reduced or increased by this displacement.

(5) Non-native grasses, forbs, and shrubs will be introduced to control erosion. It is possible that some of these species will become naturalized and replace some native species. For various reasons over the past 100 years, exotic species have been introduced to the area, including most of those likely to be used in geothermal operations.

No significant changes in major ecosystems have occurred or are likely to occur due to revegetation work.

(6) Accidental particulate emissions may injure or kill plants in the immediate vicinity of drilling operations. This impact is being studied in The Geysers Geothermal Area (Neilson et al, 1975:62). Precise impacts are not yet completely predictable but there appears to be little danger of widespread ecosystem change due to this impact.

(7) There is also evidence that gaseous emissions can injure or kill plants near drilling and powerplant operations (Neilson et al, 1975:66). The cumulative impacts of increased heat, humidity, hydrogen sulfide, and sulphur oxides are difficult to predict without further research. A slow accumulation of biosensitive materials in soil and water, leading to subtle changes in mature ecosystems, may be occurring in highly developed areas.

(8) Waste-disposal sumps, containing drilling muds, geothermal fluids and other biosensitive materials, may fail resulting in pollution of surface and ground water sources. Death of aquatic organisms and riparian vegetation may occur but complete destruction of the ecosystem is not likely.

Assuming no discovery of steam or no major mishaps, the cumulative impacts of this development stage can also be corrected with time and normal mitigation measures.

c. and d. Field Development & Production of Steam and Electricity

All impacts associated with the previous stage will intensify with the addition of new wells, pipelines, power plants and transmission lines. Although cumulative impacts are difficult to predict, there is no doubt that ecological interrelationships will be greatly modified in the steam field.

Some plants and animals will be able to adapt to industrial development. Others undoubtedly will not be able to make the necessary adjustments for survival in the midst of human activity.

e. Closeout of Operations

Once an area is developed for industrial purposes and used for 30-50 years, the likelihood of a return to near natural or original conditions is very remote. There are several reasons for this prediction:

(1) Growing competition for space will make the lands valuable for some other purpose, e.g., recreation, livestock grazing or another industry, and require maintenance of roads and building sites.

(2) Competition for space will force wildlife into smaller niches and some species may be eliminated. Even with closeout operations some animals may not return to the area.

(3) Biosensitive materials may remain in soil and water for long periods and disrupt natural regeneration.

3. Mitigating Measures

There are no practical means to avoid some modification of ecological interrelationships. A concerted effort will be made to avoid unnecessary change, e.g., excessive vegetation removal or soil disturbance. All mitigation measures (see other sections) will be included as lease stipulations and strictly enforced. As new technology evolves, lessees will be encouraged to use the new methods to curtail disruptions of the environment. Baseline data collection and monitoring of operations, which are gaining momentum in The Geysers, will increase the knowledge of ecological impacts and mitigation required to avoid possible ecosystem change.

4. Residual Impacts

Ecological interrelationships will be modified. Whether these modifications are sufficient to alter entire ecosystems is unknown at this time.

H. Aesthetics

Visual

The visual values of the NRL were inventoried and classified using the BLM Visual Resource Management System. The VRM system establishes management zones on the basis of visual quality and "sensitivity" of the area to the viewing public. The visual quality index is based on variety, harmony, and integrity of the landscape, and categorizes areas as A, B, or C in a descending scale of quality. Visual sensitivity zones are established using criteria of the number of viewers, associated uses, community attitudes, land use on adjacent private land, and other relevant factors. Lands are classified on a high, medium, low sensitivity scale. These two elements, visual quality and visual sensitivity, are then overlayed to construct a map placing areas into visual resource management classes.

The VRM classes range from I-IV, and are defined by the degree of restriction or care that must be taken in modification of visual qualities. Class I is the most restrictive. The premise of the classification system is that the highest quality scenery that is of most concern to viewers warrants the highest degree of protection; and logically following, that the lowest quality scenery with the lowest viewer sensitivity merits the least protection. The VRM classes and general guidelines for permissible changes in visual quality are discussed further in the section on mitigation. The classes as defined in BLM Manual 6300 are:

Class I. This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

Class II. Changes in any of the basic elements (form, line, color or texture) caused by a management activity should not be evident in the characteristic landscape.

Class III. Changes in the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV. Changes may subordinate the original composition and character but must reflect what could be a natural occurrence within the characteristic landscape.

1. Existing Environment

The landscape of the area is typical of the Low Coastal Mountain province. It is characterized by steep rolling hills intersected by sharply defined drainage patterns. Lower elevation flats are generally in grass. Vegetation shifts to mixtures of hardwood and grass on lower slopes and then to brush on the hills. North and east slopes are frequently forested with hardwoods and hardwood-conifer mixtures, while ridge tops and south and west slopes are usually covered with chaparral brush. Open, grassy glades occur infrequently in the brush. The valleys of Scotts Creek, Blue Lakes, and Cold Creek are the most prominent land form features.

Line patterns in this landscape are created by the gently undulating ridge-lines, curvilinear drainage patterns, and the outlines formed by grass openings and the margins where grass and brush or grass and tree cover meet. Man has imposed a few unnatural lines. The most noticeable are firebreaks which follow many ridges and traverse steep slopes creating straight, discordant lines.

Colors range from grey-green to dark green in the brush and trees to a light golden brown or green, depending on season, in the grass. Exposed soil is generally a light yellowish brown to red.

Texture is primarily created by vegetation. It is relatively uniform in brush and grass areas and is varied where there is a mixture of plant types.

Visual Quality

Scenic qualities are highest in the valleys of Scotts Creek, Blue Lakes, and Cold Creek. These areas have a harmonious pattern of vegetation and landform with interesting variety in line, form, color, and texture. The corridor of State Highway 20 is especially attractive, with the area around Blue Lakes rated as "A" quality because of the added variety provided by the lakes. The upland areas have less variety and interest but are all of moderate or "B" quality.

Visual Sensitivity

Areas that can be seen from State Highway 20, a high tourist traffic corridor, were considered to be of high sensitivity. Highway 20 has been recommended as a scenic highway in a recent draft of the scenic highway element of the Mendocino County Plan, and several resorts are located in the Blue Lakes area in the highway corridor. The view zones from the Scotts Valley Road and roads in Bachelor Valley, all low traffic roads, were ranked as medium sensitivity. All remote areas were considered to be of low, "C" sensitivity.

Sound

Sounds are primarily of natural origin, although in areas near highways and vehicle trails some traffic noise may be heard.

Odors

Odors are primarily of natural origin.

2. Impacts

Visual

Geothermal development, that is, roads, drill pads, power plants, transmission lines, etc., will result in major changes in the visual environment. Vegetation will be removed, soil exposed, structures introduced; a natural landscape will change to one of industrial development.

The amount of visual impact is determined by the degree that any alteration contrasts with the existing landscape. The specific visual elements involved are color, line, form and texture. The following chart provides an analysis of the impact of full geothermal development on these visual elements.

Unmitigated Visual Contrast

	Form Contrast	Line Contrast	Color Contrast	Texture Contrast	Overall
Roads	O	X	X	O	◐-X
Power Plants	X	◐	◐	◐	X
Steam Pipelines	◐	X	◐	◐	◐-X
Power Lines & Towers	X	X	◐	O	◐-X
Potential Blowouts	◐	O	X	X high contrast	◐ low probability
Disposal Ponds (Sumps)	X	O	◐	O	O
Drill Pads	X	O	X	◐	◐-X
Steam Plumes	◐	◐	◐	◐	◐

X High Contrast

◐ Moderate Contrast

O Low Contrast

The above analysis is of course generalized and is intended to give indications of relative magnitude. Specific impacts depend on specific conditions of site and design.

Impacts that will be associated with specific stages of development are as follows.

a. Preliminary Exploration

No surface disturbance of consequence, therefore, no visual impacts of significance.

b. Exploration Drilling

This stage will involve visual impacts associated with road construction, drill site construction, disposal ponds, and steam plumes from well venting and bleeding.

c. Field Development

Impacts of this stage include all of those in exploration drilling plus those associated with power plant construction, pipelines, and powerlines.

d. Production of Steam and Electricity

All impacts in previous stages.

e. Closeout of Operations

No additional impacts.

Odor and Sound

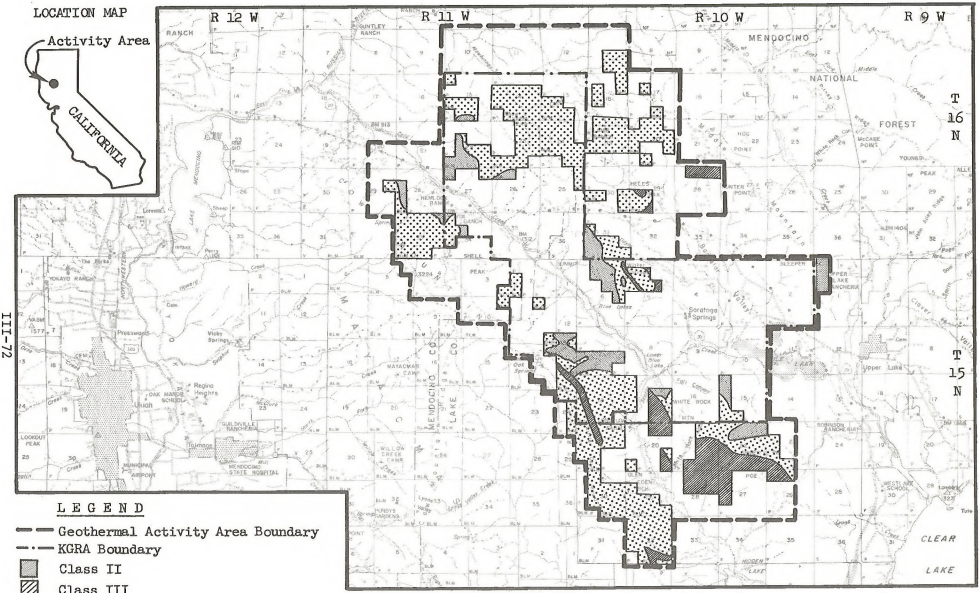
For a discussion of odor and sound impacts see Section E.

3. Mitigating Measures

All areas visible from State Highway 20, approximately 1380 acres, have been designated as Class II visual management zones. Viewing areas from Scotts Valley Road and Bachelor Valley Roads are designated Class III. About 1900 acres are in that category. All remote areas were placed in Class IV. VRM Class II guidelines require that changes caused by a management activity not be evident in the landscape. It is not likely that any surface geothermal development can meet that restriction; therefore, geothermal development cannot be accommodated if visual objectives are to be met. Where extraction of the steam is feasible by slant drilling, the area could be leased with the stipulation that there be no surface disturbance.

Requirements of Class III are that changes may be evident, but must remain subordinate to the visual strength of the existing character. Class III requirements will be very difficult to meet for most types of geothermal development. Power plants would not be feasible if visual goals are to be met, but low densities of other kinds of development will be possible if great care is taken in design and location.

Class IV guidelines are that changes may subordinate the original composition and character but must reflect some elements of the characteristic landscape. These requirements can be met by geothermal development if efforts are made to meet that goal through design and location (see Map 11).



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MAP-11

WITTER SPRINGS GEOTHERMAL ACTIVITY AREA
Visual Resource Management Classes

Landscape architectural skills and techniques should be utilized throughout planning and development. In order to minimize the impact of development on the natural character in any area, consideration must be given to:

- locations that minimize damage to vegetation and maximize natural screening.
- locations that avoid major focal points, e.g., mountain peaks, water bodies.
- designs that borrow from, compliment, or repeat lines, color, forms, and textures that occur in the natural environment.
- utilization of materials which blend with the environment.

The objective of the Visual Resource Management System is to minimize the adverse impacts of land use activity while at the same time maintaining the effectiveness of the activity. The VRM class designations are intended as guides that will help achieve that objective. Because visual impact is highly dependent upon specifics of site and design, proposals must be evaluated on a case-by-case basis. A stipulation will be included in each lease requiring that landscape architectural principles be used in location and design of facilities and that development meet, to the satisfaction of the District Manager, the criteria of the visual resource management class determined applicable to the lease area.

4. Residual Impacts

Geothermal development will convert a predominantly natural environment to one of industrial development. The guidelines provided as mitigation should reduce the significance and the magnitude of the impact. However, in VRM Class II lands, geothermal development cannot be adequately mitigated to meet requirements of the class. Development in that area would significantly impact landscape values.

I. Educational and Scientific Values

1. Existing Environment

Archaeological/Historical

In pre-European times the areas under consideration were occupied by the Northern Pomo Indians. Large populations lived in the Ukiah Valley and on the shores of Clear Lake. Ethnographic materials indicate that the primary utilization and importance of the Cow Mountain region was as a passage for trade between Clear Lake and the Ukiah Valley. No major habitation sites are identified by ethnographers. Undoubtedly there was hunting and food gathering conducted on the unit lands, but survey results indicate such uses were light.

An archaeological reconnaissance survey of the Cow Mountain area was conducted in June 1975. The area was sampled on the basis of high probability areas and characteristic landscape types. The survey report was submitted to the State Historic Preservation Officer. A copy of his comments is included in Appendix H.

Three archaeological sites were located by the survey, one of which (CA-Lak-464) is located on lands under consideration for lease north of Highway 20. The site consisted of a sparse chert scatter. It probably functioned as a chipping station/hunting camp. No diagnostic artifacts were located, so the period of utilization is unknown.

There are no known historical structures or other features of historical significance on the land under consideration for leasing.

Botanical

The Inventory of California Natural Areas and the Inventory of Rare and Endangered Vascular Plants of California were consulted regarding botanical interests. No unique, rare or endangered plant species are identified relative to this study area. Since surveyed areas are not listed in the inventories it is impossible to determine whether or not the Witter Springs area has been examined.

2. Impacts

Archaeological, Historical

Surface disturbance associated with geothermal development could disturb and destroy archaeological and historical sites. Also, if road development results in increased public access there is potential risk of damage from artifact hunters.

Botanical

Surface disturbance and steam plant emissions may destroy unique plant life. However, without additional knowledge of unique plant communities, or exact siting of development facilities, the magnitude of such impacts cannot be determined.

3. Mitigating Measures

Prior to any surface disturbance the lessee shall have a qualified professional archaeologist conduct an intensive field reconnaissance to locate, describe and evaluate all cultural resources located within the lease area. A case report shall be submitted by the archaeologist to the lessee and BLM describing cultural resources, the potential impact upon them, and recommended mitigation procedures.

If avoidance of impact is not feasible, then the lessee shall carry out recommended mitigation. Such mitigation is normally a two-phase procedure. First, surface collection and test excavation of sites shall be conducted. If testing indicates that it is warranted, salvage excavation with resultant analysis of material and publication of findings shall be carried out. All archaeological work must be conducted by a qualified archaeologist.

In consultation with the State Historic Preservation Officer, all cultural resources located must be evaluated against criteria established for determining eligibility for the National Register of Historic Places. A copy of the case report must be submitted to the State Historic Preservation Officer for comment and review. If resources of National Register caliber are discovered, the Advisory Council on Historic Preservation must be consulted in conformance with 36 CFR 800 for concurrence on findings of eligibility, impact, and mitigation.

In regard to CA-Lak-464, the site discovered in the reconnaissance survey, if avoidance is not feasible then the following two-phase mitigation will be carried out:

Phase One

A) An intensive mapping and/or collecting of flakes will be done using a two meter (6.56 feet) grid over the entire site.

B) Three units, one meter (3.28 feet) square in size, will be excavated to determine whether or not the site has a subsurface archaeological deposit.

C) Up to ten auger holes will be bored using an intuitive sampling method to establish site boundaries.

On the basis of material recovered from a phase one investigation, phase two recommendations could range from, 1) full scale excavation techniques using contemporary sampling methods, to 2) no further excavation.

If the site proves to contain important resources, it will be salvaged. All mitigation measures will be determined in coordination with the State Historic Preservation Officer.

Botanical

Prior to any surface disturbance the lessee will have a qualified botanist survey the proposed area for unique botanical resources. If significant resources are found the project will be modified to avoid impact, or if avoidance is not feasible, mitigation measures will be taken. Mitigation steps will be developed by the botanist conducting the survey.

4. Residual Impacts

Archaeological/Historical

If avoidance of impact of cultural sites is infeasible, mitigation usually takes the form of salvage of the artifacts present. This in itself can be considered partial destruction in that the archaeological site is destroyed making it unavailable for future study by more advanced scientific methods.

Botanical

As with cultural resources, the usual mitigation is salvage, i.e., plant collection. The destruction of the habitat in which a unique plant is located removes it from any future study.

J. Other Land Uses

Ownership - General

1. Existing Environment

The lands in the Witter Springs Study Area lie in Mendocino and Lake Counties. Breakdown of acreages is as follows:

Land Ownership within the Witter Springs
Geothermal Study Area

Area	NRL	Pvt	Mineral Reserve
Mendocino County			
T. 15 N., R. 11 W.	160.00	1,557.79	94.88
T. 15 N., R. 10 W.	502.99	1,085.55	--
T. 16 N., R. 11 W.	3,130.71	7,969.33	2,401.13
	3,793.70	10,612.67	2,496.01
Lake County			
T. 15 N., R. 10 W.	5,651.87	10,357.06	520.00
T. 15 N., R. 11 W.	611.35	1,631.84	--
T. 16 N., R. 10 W.	1,379.69	3,080.16	--
T. 16 N., R. 11 W.	--	443.94	--
	7,642.91	15,513.00	520.00
Totals - acres	11,436.61	26,125.67	3,016.01

Total acres in Study Area = 37,562.28

No lands within the study area are known to be in state or county ownership other than those lands in use for the existing road system.

For the most part, the land is either under federal ownership or privately owned as large ranch units.

The general rough topography of the area has dictated land use and settlement patterns. As a rule, the privately held lands are in the valley bottoms and more level mountain meadows. The rough-broken chaparral-covered hillsides are largely national resource lands.

1) National Resource Lands

There are three primary existing uses of national resource lands in the study area. These are grazing, recreation and mining.

a. Grazing: There is one grazing lease on NRL in the Witter Springs study area. Known as the Furman Allotment Management Plan, some 1760 acres of NRL are under lease to Duane Furman. The lease provides for

290 AUM's (animal unit months)* of grazing in the Griner Peak area. Season of use is from March 1 through July 31, with grazing use divided between the two pasture units involved. Of the 1760 acres in the total lease, a drift fence renders 360 acres in the southern portion unusable to the lessee.

b. Recreation: Very little of the NRL in the study area is available for general recreation purposes due to lack of public access. Most of the NRL is isolated by private land holdings.

Recreation use in the area by members of the general public is considered to be minimal if not non-existent even though there is physical access (foot, not vehicle access) to a small portion of the NRL. Major recreation use on NRL in the area comes from private hunting clubs who obtain access across private lands adjacent to the NRL.

Recreation activity other than hunting and some off-road-vehicle use is not known to occur in the study area.

Several parcels of NRL are visible from Highway 20, Scotts Valley Road and the Mendo-Rock Road offering pleasing aesthetic values to sightseers and the general motoring public. (See Aesthetics portion of this report.)

c. Mining: All of the NRL within the study area is open to the location of mining claims and the filing of applications for leasable minerals. Up to this time, several geothermal lease applications have been filed in the Witter Springs area. (See Map 1 of this report.)

There are no known mining claims in the study area.

2) Private Lands

The primary uses of privately owned lands within the study area boundaries are livestock grazing, rural residential, recreation and intensive farming. A portion of the land is used for utility systems.

a. Livestock Grazing: A major use of private lands in the area is livestock grazing. Several large ranch operations are located in the hilly portion of the study area. A BLM grazing lease has been granted to one of the livestock operators in the Griner Peak area.

b. Rural Residential: Many residences are found in the valley bottoms, particularly along Highway 20, Scotts Valley Road, and in the Witter Springs, Saratoga Springs area. These "ranchette" type developments vary in size from a portion of an acre to 40 and 80 acre parcels. Most of the residents on these "ranchettes" are either retired persons or workers who commute to the Ukiah or Lakeport areas.

The Witter Springs community consists of a post office-store-gas station combination and a few residences.

* One AUM is a measure of the forage required to feed 1 cow for 1 month.

c. Recreation: Commercial recreation developments are numerous in the Blue Lakes area along Highway 20. These resort-type developments offer swimming, picnicking, camping, fishing and boating activities. Peak period of use is from May to September. Motel facilities associated with several of the resorts are open all year.

Private hunting clubs have contracted with several of the ranches in the area to provide deer and wild pig hunting. This provides recreation opportunity for a limited segment of the public. In many cases, the only recreation use of the national resource lands in the study area is by members of these private clubs, as access to the NRL is controlled by the ranchers.

Access to Blue Lakes is restricted by private land holdings. This limits the opportunity for fishing, boating, and swimming activity.

The hot mineral spring at Saratoga Springs is in private ownership and is not open to the public. This also limits recreation opportunity.

Intensive Farming: Several small vineyards and orchards are found within the study area. Other forms of intensive farming found in the area include some irrigated pasture lands used in conjunction with dairy operations and some hay and grain production.

Utility Systems: A power transmission line crosses the northern portion of the study area. The main electric transmission corridor is shown on Map 12. Other smaller lines provide electricity and telephone service to nearly all residences in the study area.

3) State and County Lands

A small portion of the study area is in state and county ownership dedicated to road use. Highway 20 is under control of the State of California with all other public roads in the study area under the control of Lake and Mendocino Counties.

2. Impacts

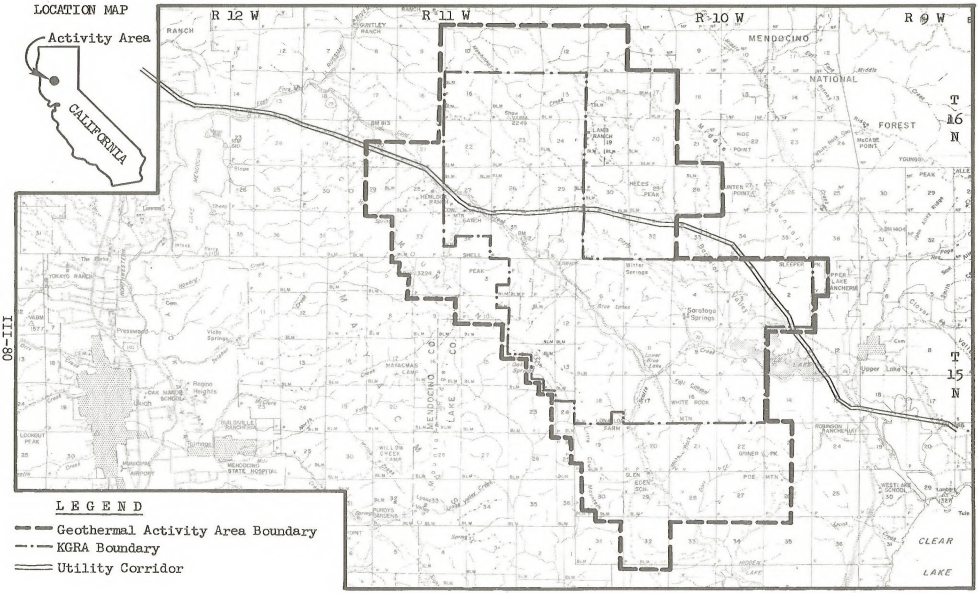
a. Preliminary Exploration

1) National Resource Lands

a) Grazing would not be affected by activities of preliminary exploration other than possible disturbance caused by the intrusion of man and machines. A possibility of mixing of livestock herds exists in the event gates are left open by exploration crews.

A positive impact could occur if drill crews were to hit quantities of fresh water that could be used for livestock watering purposes.

b) There would be no impact on recreation other than the possible disturbance of wildlife resulting from the movements of men and machines in the area. Hunting could be impacted by increased activity on NRL.



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STATUS LEGEND
P - Patented Lands
V - National Resource Lands
Withdrawals
NF - National Forest
BLM - Bureau of Land Management

SCALE: 1/2" = 1 MILE
MT. DIABLO MERIDIAN

WITTER SPRINGS
GEOTHERMAL ACTIVITY AREA
Transmission Corridor

MAP 12

c) Mining would possibly benefit from preliminary exploration on NRL if the well log information were made available to the mining industry. Favorable indications from the preliminary investigations could result in greater activity in the geothermal leasing program.

2) Private Lands

a) Impacts to grazing from preliminary exploration activities on private lands would be similar to those on NRL.

b) Rural residential areas would not be significantly impacted by preliminary exploration activities. There would be a minor, temporary increase in vehicular traffic on roads in the study area.

c) Impacts to recreation on private lands would be similar to those for NRL. The resorts (motels) in the Blue Lakes area may experience some additional business generated by the existence of exploration crews in the area.

d) Portions of the study area being used for intensive farming would not be significantly affected by preliminary exploration activities unless it was necessary to cross planted fields and vineyards with truck mounted drilling equipment.

e) Utility systems would not be affected by preliminary exploration activities.

3) State and County Lands

The roads in the area would experience a very minor increase in vehicular traffic.

b. Exploration Drilling

1) National Resource Lands

a) There would be an increase in noise and human and vehicle activity that may cause disturbance of livestock in the area. Mixing of livestock herds may occur due to increased traffic and greater likelihood of gates being left open. Road and pad construction would possibly take grazing land out of production. With the increased human and vehicular traffic there is an increased possibility of rustling of livestock.

b) Recreation could benefit by activities associated with exploration drilling as many isolated blocks of NRL could be opened to public access. Negative impacts of exploration drilling on NRL would be a temporary decrease in hunting value due to the initial movement of wildlife from the area. Increased human and vehicular traffic would probably result in an increase of poaching of wildlife in the area.

Some visual values would be lost by surface disturbance. See Aesthetics portion of this report.

c) Mining would possibly benefit from exploration drilling on NRL if well log information were made available to the mining industry. Favorable results from exploration drilling will lead to more drilling and a greater interest in geothermal leasing of the area.

2) Private Lands

a) Impacts to grazing from exploration drilling activities on private lands would be similar to those on NRL.

b) Exploration drilling would impact the rural residential portions of the study area and some adjacent areas. Residents of the area would be subjected to increased amounts of dust, noise, traffic and the partial loss of the "rural" feeling that many of these people are seeking. The drilling of exploratory wells will result in the introduction of hydrogen sulphide (H_2S) into the atmosphere. Resultant odors will be considered obnoxious by some local residents. (See Air Quality portion of this report.) There could be an increase in business at local commercial facilities. Also, if commercial quantities of steam are found through exploration drilling, there will be an increase of land values which may result in transfer of land ownership or mineral rights.

c) Recreation on private lands would be impacted by the drilling of exploratory wells. Hunting values would be enhanced by increased access into some presently unroaded areas.

Hunting values would be decreased due to wildlife movements caused by the increased activities of men and machines. Increased human intrusion into the area may result in increased poaching of wildlife. Visual values would be lost by surface disturbance of road and pad building. (See Aesthetics portion of this report.)

The resorts in the area may experience an increase in visitation due to increased number of persons in the area. If H_2S drifts into the resort area, the resorts may lose customers who object to the odor.

d) Intensive agricultural operations in the study area would not be affected unless it becomes necessary to cross planted fields and vineyards with drilling equipment.

e) Utility systems would not be affected by exploration drilling.

3) State and County Lands

The roads in the area would experience an increase in vehicular traffic.

c. Field Development

Impacts affecting other land uses in the event that field development should occur would be similar to those impacts of exploration drilling. Magnitude of the impacts would be greater. The additional discrete operations of power plant construction, pipeline construction, and electric transmission line construction would add to total land committed for geothermal development. These three types of construction would also add visual impact. (See Aesthetics portion of this report.)

d. Production of Steam & Electricity

Impacts affecting other land uses in the event production of steam and electricity should occur would be similar to those impacts for exploration drilling and field development.

Grazing and recreation on both NRL and private lands would benefit from the revegetation efforts on roadsides and drill pads. Some increase in tourist income could occur from sightseers to the area if visitation by the publi is allowed.

e. Total Closeout of Operations

The impacts involved with this stage of development would depend largely on the degree of restoration of the area to pre-lease conditions.

For grazing use on both NRL and private lands, it is possible that closeout of operations would result in a significant increase in acres available for grazing (areas converted by reseeded grasses).

Recreation use of the NRL could be increased if certain permanent easements were allowed to continue to allow for public access. Wildlife based recreation should increase as a result of brush conversions and "edge effect" created by road and drill pad restoration.

Assuming no new industrial development, the area would probably revert to a rural residential character with the closeout of operations. Traffic volumes would be greatly decreased.

County and state roads would experience a decline in traffic flow. It is possible that cost of maintenance of the road system would remain at a high level if all roads were not restored to vegetation.

3. Mitigating Measures

a. National Resource Land

1) Grazing: Impacts to the grazing program on NRL will be mitigated by requiring cattleguards to be installed as opposed to gates to prevent the mixing of livestock herds. After drilling operations are completed and the equipment removed, all pad areas and road-sides will be

revegetated to palatable species to replace vegetation removed in development operations. Livestock in the area will soon become accustomed to the increased human and vehicular traffic and the noise associated with geothermal development.

2) Mining efforts would benefit if well logs were made available to the industry.

b. Private Lands

1) Mitigation measures for grazing on private lands would be similar to those for NRL.

2) There would be no way to mitigate the small loss of agricultural production of portions if portions of intensively farmed lands were used for geothermal access.

3) Mitigation of visual and air quality impacts is discussed elsewhere in this report.

4. Residual Impacts

Residual impacts on both NRL and private lands would be similar. There would be no way that possible livestock rustling and wildlife poaching could be totally prevented. The increased traffic and opening up of new areas to the public will result in these types of losses no matter what degree of law enforcement is committed to an area.

Visual impacts and air quality impacts would remain. These are discussed in their respective portions of this report.

The loss of rural-residential character would be experienced until such time as there was a total closeout of the operation.

The possible loss of agricultural lands if such were used for geothermal access could not be replaced until such time as there was a total closeout of the operation.

K. Regional Economic and Social Characteristics

1. Existing Environment

a. Lake County

Lake County is sparsely populated especially north, east and southeast of Clear Lake. Its 1970 population was 19,700, which represents a 42% increase over the 1960 population of 13,900. Since 1960, the population of the county has grown faster than the state (1960-1970, county growth = 41.7%; state = 26.2%), resulting from immigration and not natural growth These are mostly people who previously have been recreation homeowners (part-time residents) but who now have retired in Lake County.

Table 17

Population Increases

	Lake County	U.S.
1940-1950	Gain of 42.3%	Gain of 14.5%
1950-1960	Gain of 20.1%	Gain of 18.5%
1960-1970	Gain of 41.7%	Gain of 10.2%

The County relies heavily on agriculture, recreation and geothermal energy production as major industries. There is very little manufacturing but many service type businesses.

Agriculture is the number one contributor to the overall economic activity of Lake County. Fruit and nut orchards, wine grape vineyards and forage crops are major agricultural land uses.

Geothermal energy production is considered a major industrial and real estate activity with approximately 100,000 acres of County land now under geothermal lease. Major oil companies, including Union Oil and Gas Company, Burmah Oil and Gas Company, and Shell Oil and Gas Company all applied for geothermal drilling permits in Lake County during the year 1975 with six permits issued after extensive public hearings. Burmah Oil has completed drilling 14 steam wells and Union Oil completed one with a permit for one more. However, as of now, there is not a geothermal energy plant. The County hopes a plant may be completed by 1977 or 1978.

The focal point of a large tourist and recreation industry is Clear Lake, a 41,000 acre water body offering excellent fishing, boating and swimming opportunities.

Of all the northern counties in the BLM Ukiah District, Lake is the only one that has substantial increase in employment since 1960. From 1960 to 1968 its employment increased 1376, from 1618 to 2994. This was almost

an 85% increase. Lake County's primary recreation-tourism income, however, is seasonal, resulting in an unusually high unemployment rate in the off season. Along with the seasonal resort workers, the pear and crop season and allied harvesting practices contributed to an annual average of 11.6% unemployment for 1974.

Lake County has the lowest per capita personal income of any northern coastal county. During inflation, purchasing power of residents should decrease because many now live on fixed incomes. Gross county-wide figures do not reveal the impact of this situation because one sector of personal income - farm income - is up 46% in 1973 over 1972. Thus, while a small number of people have significantly larger personal income, the majority's is static, skewing the statistic. Lake County has a much lower proportion of personal income in wages and salaries than similar north coast counties and a much higher proportion of transfer payments. (Transfer payments include welfare and Social Security; in Lake County, 84% is Social Security.)

The care of the aged, social security, and welfare are pressing county problems. Furthermore, there are housing, transportation, and health care problems. An economic stimulus is also lacking. The young move from the county to seek jobs elsewhere and the county cannot attract labor intensive employment. The county simply does not have the attributes to attract industry. For example, there are limited highways into the county, no railway transportation, and a limited technically oriented labor force. However, despite these problems most of the residents enjoy life in Lake County.

Several environmental studies have sampled public opinion in various parts of the county. It was discovered that most people come to the county for peace and quiet, retirement, the attractive environment and employment opportunities (esp. in rural areas). In regard to community services, most residents feel they need improving (esp. police protection, medical care, recreation, schools, transportation).

When asked if geothermal development will broaden the tax base and increase economic opportunities, 81% of the respondents felt that it would, and 49% felt that true economic benefits are more important than any environmental costs. However, 42% felt that the economic benefits from geothermal development are not more important than environmental costs.

Respondents were divided and unsure about potential direct impacts from noise, odor, and aesthetics. An environmental analysis by Ecoview sheds further light on this question. A study of the Cobb Mountain area, and Anderson Springs - Middletown area indicates that the perceived effect of environmental impacts is related to distance from geothermal wells. Those within a 5-mile radius indicate that they feel environmental impacts (noise, odor, aesthetics) more than those at a greater distance. Respondents more than 10 miles away did not report feeling any impact. In regard to Lake County, as geothermal development continues and comes closer to residences, more impacts will be perceived. This will probably change many residents' attitudes on geothermal development.

b. Mendocino County

Mendocino County ranks 34th in population among the 58 counties in California, with .3 percent of the total population. The 1970 census indicates that the population of Mendocino County at 51,101 remained nearly unchanged from the 1960 count, with an increase of only .1 percent. This is in marked contrast with the state as a whole, which experienced a 27.0 percent increase in population.

Mendocino County has traditionally pursued lumbering as an economic activity, and even today lumber and wood products related industry remain the largest employers within the county. However, with the harvesting of the remaining old-growth timber stands within the county, the lumber industry is expected to curtail their activities during the next 10-20 years.

Agriculture, farming and tourism also generate employment opportunities, but they too are seasonal thus resulting in high unemployment rates during the off season. The average yearly unemployment rate within the county is 11.5% which is higher than the state average, and this trend will continue in future years, especially when the lumber industry vacates.

Light industry, recreation, and second home subdivision have begun to increase income to a small degree. However, unless some major changes occur in one of these areas, they will remain just as supplemental income in comparison to the wood products' current income.

Per capita income is about $800 below the state average and this is expected to continue during future years.

Attitudes and expectations of county residents toward social well-being within Mendocino County are documented in a report prepared by North Coast Opportunities, Inc. The study sampled public opinion within the Ukiah area. Three hundred and one representative households were contacted and asked a variety of social planning questions. The results indicate that the needs of Ukiah Residents are many:

1) 52% (of the households feel a need) for (greater) income
2) 49.5% for consumer protection
3) 46.3% for recreation
4) 40.0% for utilities
5) 38.7% for education/training
6) 38.3% for employment
7) 26.3% for housing
8) 25.3% for transportation
9) 24.3% for health care

Although the study only sampled public opinion within the Ukiah area, it can be expected that the county as a whole feels similar needs for social services, although a different priority might be indicated.

Public opinion relative to geothermal development has not been surveyed in the county.

2. Impacts

It should be understood that there is very little direct impact on humans from geothermal leasing. Most impacts result from exploration and development activities which follow leasing. Since these activities are relatively poorly defined at this time in terms of area involved, timing, and technical detail, assessment of impacts on humans is imprecise.

This analysis will address the impacts of leasing a single 2,560-acre model lease and the entire 11,400 acres of NRL. This will permit assessment of the marginal impacts from leasing less than the entire area.

This two-leveled analysis presents the potential impacts. The probable impacts are quite speculative and depend upon the resource actually discovered, the economic conditions of the nation in general, and the energy market in particular.

Impact of Model Lease Development

This section describes the local human impact from development of a single 2,560-acre lease. Assuming normal operation of one drill rig per lease at any one time, 30 people will be employed in drilling wells at peak periods. The number of employees would probably decrease during winter slowdown periods. Past experience has indicated that drilling costs increase during the winter months.

During power plant, pipeline, and transmission line construction, 150 people would be employed at peak operating periods. The work would be somewhat seasonal with winter layoffs.

During the production phase, 20 people would be employed annually in the maintenance and operation of the field and power plant. This would be a sharp decrease from the development phase.

Employment in the exploration phase would be negligible due to its short duration.

Almost all of the employment provided by this industry can be expected to go to people outside of the present Lake County and Mendocino County labor markets. This is caused by the special skills needed and the structure of the labor unions. The local people would derive employment from provision of services. There would be an initial increase in local construction employment as housing facilities are built for the influx of workers. This would then taper off to probably 10 service jobs in the community.

The development of one lease in this community would probably stimulate an increase in available temporary housing. This would take the form of trailer spaces in trailer courts and apartment space in the existing motel and hotel structures. There could be construction of 5 new single family homes. None of this would require enlarged sewer or water facilities in

in the city. The additional school age children could be accommodated within the existing capacity of the school system. Local businesses would benefit from construction and operations payrolls and purchase of material and equipment.

The greatest negative impact in the community would be felt by low income people who would face increased competition for housing. There would be generally higher rents for housing and trailer space for the duration of the development stage. If two or more leases developed in this manner simultaneously, the housing market could be subject to stress. There would be many applications to locate mobile homes in the counties.

Increased costs to the cities of Ukiah and Lakeport, the counties of Lake and Mendocino and local school districts would be quite small from the development of one geothermal lease. Perhaps one or two additional school teachers, an additional police patrol, and an additional sheriff's patrol would be needed. More permit actions would have to be processed through the appropriate administrative offices. The increased demand for medical services probably would not exceed the capacity of the area's facilities. Some county roads would have to be reconstructed and maintained at more frequent intervals.

Revenues to the government from property tax on the geothermal development would lag one or two years behind the incurred costs. There would probably be some minimal revenue from possessory interest taxation on federal competitive and non-competitive leases. Taxes would be levied on equipment on the site. Some additional taxes would be collected from the improved or new housing. Mobile homes, however, would probably escape local taxation. Their sites would be taxable but would have much less value than the mobile homes. Until such time as enough successful wells are sunk to support a power plant, very little additional revenue will accrue to the local governments. None of the bonus bid from competitive leasing is returned directly to the county.

A fully developed lease (200 MW) would add 14.2 million dollars to the tax base (assessed value). 1/ Yield from a lease to the annual property tax revenue would be $1,065,000 if in Lake County or $1,420,000 if in Mendocino County. 2/

The influx of construction and operations personnel and their families would have very little affect on community attitudes and lifestyles in larger towns, such as Ukiah and Lakeport. Daily construction traffic and industrialization of lands in or near rural areas, such as Bachelor or Scotts Valley, could have an adverse affect on attitudes and lifestyles. Rural residents normally identify with traditional, as opposed to dynamic social structure, and they may resent the intrusion. The development of a single lease would probably result in conflict with tradition but not complete destruction of it.

1/ Assessed value 25% of fair market value; assumed fair market value of $284,000 per MW.
2/ Tax rate of $7.50 per $100 assessed value in Lake County and $10.00 per $100 in Mendocino County.

Impact of Full Development

The 11,400 acres of national resource lands in the study area could be divided into 5 leases, each approximately 2,560 acres. Each lease might support two 100-megawatt power plants as described in the Description of Proposed Action chapter. The leases would potentially result in about 10 of these 100 megawatt powerplants. This would be 1,000 megawatts of power generation capacity, or about one half the field potential presently predicted at The Geysers north of San Francisco.

If the area was developed over a 10-year period, there would be about 90 people employed on 5 drilling rigs. In addition, another 225 people would be employed in the construction of pipelines and transmission lines. There would be considerable overlap between the drilling and plant construction periods. During the production phase, 100 people would be employed in maintenance and operations. In total, the peak employment would occur during the field development phase with about 300 people employed.

It is likely that if development on this scale is warranted there will be development on the adjacent non-federal lands.

It is fairly certain that the labor market in the area cannot supply the needed skills in the necessary quantities. Therefore, most of this labor would be in-migration to the area. This could create stresses on the area's infrastructure systems (housing, transportation, etc.). The population increase could be 600 to 1000 people. This would be a "boom and bust" situation because most of the employment would occur in the field development phase, simultaneously with the construction of facilities to service the rapidly increased population.

Five fully developed leases would add 71 million dollars to the tax base (Assessed value). The annual property tax revenue from this development on federal leases would be roughly $2,300,000 in Mendocino County and $3,600,000 in Lake County. 1/

In the absence of federal leasing, development on private lands would proceed and probably have as great a potential as the federal lands.

IV. ANALYSIS OF ALTERNATIVES

Environmental Analysis Alternative No. 1 - Lease a Portion of the Area

Alternative No. 1 is a combination of the proposal to "Lease for Geothermal Steam Development" and Alternative No. 2 "Do Not Lease". As such, the environmental analysis of Alternative No. 1 is generally the same as previously discussed. The purpose for Alternative No. 1 is to permit the continued development of the Federal geothermal resources in areas where the environmental impacts of the action are not significant and public controversy is not a factor. If there appear to be serious residual environmental impacts or controversy in specific areas, then further environmental studies will be recommended for those areas before a decision on geothermal leasing is made.

1/ Revenue share based on proportion of BLM land in each County.

Impact Analysis Matrix Rating System

For each of the environmental concerns noted on the following matrix, page, a rating of one to five was assigned. The ratings display residual impacts by section and have been assigned by the BLM resource professionals participating in this study. The ratings are a combination of actual on-site observations and studies, extrapolation from similar conditions which occur on adjacent or nearby sites, and the expertise of the resource professionals assigning the rating. The criteria for rating are as follows:

Slope Class: Rated on the basis of average percent slope for the parcel.

Slope Stability: Rated as unknown at present, however a detailed slope stability study is in the final stages of completion, and will be available at the time a leasing decision is made.

Slope Susceptibility: Rated as a combination of existing slope conditions and soil types.

Water Quality: A rating of five was assigned based on expected incremental increases of the JTU (Jackson Turbidity Units) regardless of mitigation.

Vegetation, Wildlife, and Fisheries: Impacts on vegetative communities are going to be progressively more severe from low to more highly structured and complex vegetation. Similarly, animal groupings in terms of population levels and species composition within the different habitat types will be affected.

The following vegetative communities are classed as to increasing structural complexity and sensitivity to change,

Class	
I	Grassland-Agriculture
II	Chaparral
III	Chaparral/Pine-Fir-Chaparral
IV	Hardwood-Woodland Grass
V	Conifer Forest
VI	Riparian

Impacts of geothermal development on the above classes and associated wildlife species are rated according to changes in population levels and species composition as follows:

	% of Change
1. Little or no impact	5 %
2. Light to moderate impact	5-10 %
3. Moderate impact	10-25 %
4. Moderate to high impact	25-40 %
5. High to extreme impact	45+ %

Aesthetics: Rating Assigned using the following system:

V.R.M. Class	Matrix Rating
All Class IV	1
Predominantly Class IV with some Class III	2
Predominantly Class IV with some Class II	3
All Class III	4
Predominantly Class III with some Class II	4
All or predominantly Class II	5

Educational-Scientific: An Unknown rating (X) was assigned due to the possibility of a rare plant community being inadvertently destroyed during development. No rare or endangered plants have been identified within the study area.

Other Land Uses: Rating considers the relative impact on adjoining land uses, which vary from site to site.

The noncompetitive lease applications, based solely on the above matrix system, can be ranked in order of increasing impacts on portions of the application:

1. CA-1166
2. CA-1429, CA-1430
3. CA-1164

IMPACT ANALYSIS MATRIX

Block	Geology (Landslides)	Soils (Erosion (Susceptibility)	Water (Quality)	Wildlife Vegetation	Fisheries	Aesthetics	Educational Scientific Values	Other Land Uses
T15N,R10W,MDM								
Sec. 5*	X	5	5	3	1	2	X	2
6*	X	5	5	3	2	5	X	2
7*	X	5	5	4	2	5	X	3
8*	X	5	5	3	1	5	X	5
15*	X	5	5	3	1	3	X	1
17*	X	5	5	4	1	4	X	2
18*	X	5	5	4	1	2	X	2
1	X	X	5	5	1	4	X	1
19	X	5	5	4	1	2	X	2
20	X	5	5	4	1	4	X	5
21 (CA-1429)	X	5	5	3	1	4	X	3
22 (CA-1429)	X	5	5	3	1	4	X	3
23	X	5	5	4	1	2	X	3
26 (CA-1429)	X	5	5	3	1	4	X	2
27 (CA-1429)	X	5	5	3	1	4	X	5
28	X	5	5	5	1	4	X	2
29	X	5	5	3	1	1	X	2
30	X	5	5	3	1	1	X	1
32	X	5	5	4	1	2	X	2
T16N,R10W,MDM								
Sec. 7 (CA-1166)	X	3	5	5	1	1	X	1
17	X	3	5	5	1	1	X	2
18 (CA-1166)	X	3	5	5	1	1	X	2
19	X	3	5	4	1	1	X	3
20	X	3	5	5	1	1	X	2
28 (CA-1164)	X	4	5	4	1	4	X	2
29 (CA-1164)	X	5	5	4	1	2	X	1
30	X	5	5	4	1	1	X	5
31 (CA-1430)	X	5	5	3	1	3	X	2

Impact Analysis Matrix (Continued)

Block	Geology (Landslides)	Soils (Erosion (Susceptibility)	Water (Quality)	Wildlife Vegetation	Fisheries	Aesthetics	Educational Scientific Values	Other Land Uses
T15N,R11W,MDM								
Sec. 2*	X	5	5	5	1	1	X	1
3*	X	3	5	5	1	1	X	5
10*	X	4	5	5	1	1	X	1
11*	X	4	5	4	1	2	X	2
12*	X	5	5	4	1	5	X	1
13*	X	5	5	4	3	4	X	2
14*	X	4	5	5	1	4	X	2
24*	X	5	5	5	3	2	X	1
T16N,R11W,MDM								
Sec. 10	X	X	5	4	1	X	X	5
11	X	X	5	4	1	X	X	5
12	X	X	5	5	1	X	X	5
13*	X	4	5	5	5	1	X	1
14*	X	5	5	5	5	1	X	5
15*	X	5	5	5	1	3	X	5
20	X	X	5	3	1	5	X	5
22*	X	5	5	5	1	5	X	1
23*	X	5	5	5	2	1	X	2
24*	X	5	5	4	3	1	X	2
25*	X	5	5	5	1	1	X	5
26*	X	5	5	4	1	5	X	5
27*	X	5	5	4	1	5	X	5
28	X	4	5	5	1	5	X	5
29	X	3	5	4	1	1	X	1
33	X	5	5	5	1	3	X	2
34*	X	5	5	4	1	3	X	5
35*	X	5	5	4	1	5	X	5

* Known Geothermal Resource Area (KGRA)

Alternative No. 2 - Decline to Lease

The national resource lands are a small part of the total area. Exploration drilling has not yet started on the adjacent private lands. If a commercial geothermal resource is found, the private lands will be developed subject to State and local laws. Air quality and some of the unknown impacts of the non-condensible gases will affect the adjacent national resource lands. It is very likely that roads would be constructed across national resource lands to gain acccess to drilling sites on private inholdings. The tendency of geothermal development to adversely impact other land uses will affect the nearby national resource lands. Public recreation on the national resource land would be impacted, an increase in man-caused wildfires might occur, and other Bureau of Land Management programs could be affected (Watershed Management, Grazing Management, Wildlife Habitat Development, etc.).

Also, efficient use of the geothermal reservoir would be difficult if the intermingled national resource lands were not developed.

V. THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

For the purpose of this analysis, short term means the time during which the steam wells and lines, and the power plants and lines, are in operation, even though this may be hundreds of years.

As previously discussed, committing an area to power generation from steam means committing a portion of the earth's surface to that use. Incompatible uses would be precluded or reduced to some extent. The nature of this commitment and its potential environmental impacts have been discussed in some detail in previous sections of this analysis. Some additional general comments on the effect of the impacts on productivity are appropriate here.

The Steam Resource: By using up the steam (if in fact current production methods do use it up) it will not be available for future generations to use. It is possible, although highly speculative to predict, that some more productive use might be found, or that it might be used more efficiently for power generation as technology improves. Additionally, improved technology might better be able to eliminate or mitigate environmental impacts if development were to be delayed.

The Surface: If the buildings, steam lines and power lines are ever no longer needed, it is possible to remove them and, except in steep areas, to reshape the land surface to a reasonable approximation of the original contours. Since steep topography is avoided as much as possible to reduce both environmental and economic costs, most of the land could be rehabilitated. Native vegetation and fauna will move into the area, either naturally or with man's assistance. Other surface uses, primarily recreation, which were reduced or eliminated by the action would again be possible. In the long run, therefore, the action appears to have little permanent effect on the productivity of the land surface. Areas such as rocky cuts which could not be rehabilitated would constitute a very small percent of the developed areas.

There are some indications that geothermal development in The Geysers KGRA is reducing the capability of the streams in the area to support steelhead and trout. How much of the observed reductions in populations is due to geothermal development, how much of the reduction could have been prevented by more careful operations and whether the reduction or any part of it is permanent are not clear. However, a long-term effect on productivity is certainly possible.

Off Site Effects: To the extent that power is derived from steam it does not need to be generated from some other source. These other sources now include oil or coal plants, atomic power or hydroelectric. (Other power sources may be developed during the life of this project.) Each kind of power generation has its own peculiar environmental impacts and consequent effect on productivity. A commitment to steam development means that the impacts associated with the alternate sources of power would not occur. It is also possible that conservation and waste reduction measures may eliminate the need for power from steam from national resource lands. The matter is too complex to determine what would happen if the national resource lands were not leased for steam development. Therefore, it is not possible to say what effect different alternatives would have on commitment of resources; whether steam, oil, coal, gas or land and water would be depleted with a specific effect on long-range productivity.

VI. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The loss of soil through erosion from exposed surface areas represents an essentially irrerrievable commitment of the resource. While soil formation is a continuing process, the time periods involved are so long that the loss can be considered essentially irreversible. The quantity of soil loss would be dependent upon the effectiveness of the mitigation measures discussed above.

If vegetative conversion results in replacement of native vegetation by introduced (exotic) species and these species are able to maintain themselves in a persistent sub-climax or climax community, the change will be irreversible.

Permanent increases in stream sedimentation can result in a decrease in water quality that will ultimately affect the productivity of the aquatic ecosystem. The loss in productivity may be irreversible.

The utilization of the steam resources constitutes an irreversible commitment. Once used, it is gone. Although in theory the field may recharge itself, the time required is probably too long to consider in human terms.

On the other hand if steam is not committed to power generation, some other source must be used in its place. Therefore, a decision to generate power is, in itself, a commitment of some resource.

VII. CONSULTATION AND COORDINATION WITH OTHERS

A. Consultation and Coordination in the Development of the Proposal and in the Preparation of the Environmental Analysis Record

Initial efforts to obtain information about the study area began in July 1975. A letter was prepared that identified the areas of interest and requested assistance in making the environmental analysis. The letter was mailed to government agencies that had knowledge of the area and an interest in its development. Additionally, letters were mailed to special interest groups and individuals that either used or had knowledge of the areas or nearby areas.

In July 1975 a news release was prepared that also announced the new study area. The release was sent to newspapers and radio stations within the affected counties.

A series of public meetings was held to obtain comments and input into a management plan for 60,000 acres of NRL. Suggestions, information, and written comments have been obtained, and have been considered by resource specialists in making their recommendations.

Geothermal development is affecting the plans, programs and policies of local governments. The two involved counties (Lake and Mendocino) have indicated their acceptance of the industry by issuing geothermal drilling permits. They have developed procedures to control and direct geothermal development on private lands. County regulations and procedures for supervision and monitoring of development and production are in various stages of completion and implementation. A controlled and environmentally sound geothermal development program is not contrary to the two counties' long range plans.

In the early 1960's public interest in the geothermal development at The Geysers was mild. However, after a few mishaps on private development sites (three uncontrollable wells, sump failures, etc.), and a report by the California Department of Fish and Game that the Big Sulphur Creek steelhead fishery was badly damaged, if not destroyed, by the field development, the interest intensified. Opposition increased as the field expanded from its location in a very isolated and remote section of Sonoma County toward recreational subdivisions and resorts in Lake County. In Lake County the communities of Anderson Springs and Whispering Pines are directly affected by the developing field. Residents of the areas organized and formed action committees. Several conservation groups, particularly the Sierra Club, have been active in support of the residents.

Most development to date has been in Sonoma and Lake Counties. The Lake County public interest is described above. In Mendocino County, three exploratory drilling permits have been issued. There was strong opposition to permitting the exploratory wells on private lands in the Pieta Creek Area. In addition to conservation groups, the California Department of

Fish and Game and the Fish and Wildlife Service, are very concerned about any possible residual adverse impacts on the steelhead fisheries.

B. Comments On The Environmental Analysis Record (EAR)

This section to be completed for final version.

VIII. PARTICIPATING STAFF

The following personnel participated in the preparation of this Environmental Analysis Record:

Bureau of Land Management

Ukiah District Office

Averill, D. E. - Forester
Bellon, A. L. - Chief, Division of Resource Management
Clausen, M. D. - District Manager
French, N. - Archaeologist
Gheen, E. C. - Wildlife Biologist
Graham, J. - Clerk Typist
Johnson, R. L. - Fishery Biologist
Keesling, H. - Archaeologist
Kirby, M. J. - Realty Specialist
Madison, W. - Chief, Division of Operation
McKee, J. S. - Geologist
Moritz, H. W. - Mining Engineer
Niebuhr, D. H. - Technical Illustrator
Saunders, R. D. - Environmental/Plannning Coordinator
Whitmarsh, S. R. - Recreation Planner
Wickstrom, D. E. - Mendocino Resource Area Manager

California State Office

Bays, D. E. - Economist
Grobman, S. - Technical Writer/Editor
Kleinsmith, D. - Natural Resource Specialist
Olsen, W. H. - Archaeologist

U. S. Geological Survey

Reed, Marshall - Office of the Geothermal Supervisor

APPENDIX A

Legal Description

T. 16 N., R. 10 W., M.D.M.

N.R.L.

Sec. 7:	$SE\frac{1}{4}$;	160.00 ac.
17:	$SE\frac{1}{4}NW\frac{1}{4}$, $SW\frac{1}{4}SE\frac{1}{4}$;	80.00 ac.
18:	$E\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$;	160.00 ac.
19:	Lots 3, 4, 5, 6; $NE\frac{1}{4}$, $E\frac{1}{2}NW\frac{1}{4}$;	378.31 ac.
20:	$W\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$, $E\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, $NE\frac{1}{4}SE\frac{1}{4}$;	360.00 ac.
28:	$N\frac{1}{2}NE\frac{1}{4}$, $NE\frac{1}{4}NW\frac{1}{4}$;	120.00 ac.
29:	$SW\frac{1}{4}$;	160.00 ac.
30:	Lots 9, 11, 12, 16;	147.20 ac.
31:	Lots 5, 10, 11, 12, 13, 14, 15, 16.	317.17 ac.

U.S. Mineral Reserve Lands

Sec. 30:	Lots 13, 14;	67.08 ac.
31:	Lot 4.	29.71 ac.

T. 16 N., R. 11 W., M.D.M.

N.R.L.

Sec. 13:	$SW\frac{1}{4}$, $SW\frac{1}{4}SE\frac{1}{4}$;	200.00 ac.
14:	$S\frac{1}{2}N\frac{1}{2}$, $N\frac{1}{2}S\frac{1}{2}$, $SE\frac{1}{4}SW\frac{1}{4}$, $S\frac{1}{2}SE\frac{1}{4}$;	440.00 ac.
15:	$NW\frac{1}{4}NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$, $W\frac{1}{2}SE\frac{1}{4}$;	240.00 ac.
22:	$SE\frac{1}{4}NW\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$, $S\frac{1}{2}SW\frac{1}{4}$: $SE\frac{1}{4}$:	320.00 ac.
23:	$NE\frac{1}{4}$, $S\frac{1}{2}SW\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$, $SW\frac{1}{4}SE\frac{1}{4}$;	360.00 ac.
24:	Lots 3, 4, $W\frac{1}{2}NE\frac{1}{4}$, $NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$, $W\frac{1}{2}SE\frac{1}{4}$;	466.12 ac.
25:	Lots 1, 2;	65.97 ac.
26:	$N\frac{1}{2}NW\frac{1}{4}$;	80.00 ac.
27:	$NE\frac{1}{4}NE\frac{1}{4}$, $NW\frac{1}{4}NW\frac{1}{4}$;	80.00 ac.
28:	$SW\frac{1}{4}NW\frac{1}{4}$, $W\frac{1}{2}SW\frac{1}{4}$;	120.00 ac.
29:	$SE\frac{1}{4}NE\frac{1}{4}$	40.00 ac.
33:	Lots 2, 3, 4, $N\frac{1}{2}$, $N\frac{1}{2}S\frac{1}{2}$	598.62 ac.
34:	$W\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$.	160.00 ac.

U. S. Mineral Reserve Lands

Sec. 10:	$SE\frac{1}{4}NE\frac{1}{4}$, $S\frac{1}{2}SE\frac{1}{4}$;	120.00 ac.
11:	$SW\frac{1}{4}NW\frac{1}{4}$, $SW\frac{1}{4}SW\frac{1}{4}$;	80.00 ac.
12:	$SW\frac{1}{4}NE\frac{1}{4}$, $E\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$;	160.00 ac.

APPENDIX B

Earthquakes Greater Than 1.0 Richter
For Period 1947 to 1972

Date	Latitude North	Longitude West	Richter Magnitude
6-17-72	38° 53.1'	122° 56.0'	3.2
3-21-72	39° 18'	122° 41'	3.0
3-5-72	39° 19'	122° 43'	3.5
1-12-72	39° 10'	122° 34'	3.1
10-30-71	39° 31.7'	123° 09.0'	3.1
10-28-71	39° 24.6'	123° 23.1'	3.1
12-20-70	39° 31'	123° 03'	3.0
12-7-70	38° 39.9'	123° 04'	3.2
12-3-70	39° 11.9'	122° 31.3'	2.8
11-4-70	38° 50'	122° 45'	2.9
8-3-70	38.9°	122.5°	2.7
10-2-69	38.46°	122.69 °	5.7
6-2-69	39° 21.4'	123° 14.7'	3.1
11-24-67	39° 26.7'	122° 30.7'	3.6
6-26-67	39.3°	123.3°	3.5
1-8-67	39° 35.8'	122° 54.7'	2.9
12-23-66	38° 51.1'	123° 9.9'	3.5
8-3-66	39.5°	123.2°	3.4
9-18-65	38.6°	122.7°	3.0
1-27-64	39° 28'	123° 11'	3.0
12-30-63	38° 53.4'	122° 31.2'	3.9
12-30-63	38° 57.1'	122° 42'	3.0
9-25-63	39° 26'	112° 28.4'	3.1
2-2-63	38° 54.5'	122° 43.4'	2.9
2-2-63	38° 51.7'	122° 48.2'	3.1
7-7-63	39° 20'	123° 20'	2.8
7-1-63	38° 53.9'	123° 14.7'	3.4
6-6-62	39° 4.1'	123° 18.6'	5.2

Date	Latitude North	Longitude West	Richter Magnitude
1-1-62	38° 53'	123° 24'	4.1
1-1-62	38° 54'	123° 08'	2.5
10-14-61	39.0°	122.7°	2.7
10-14-61	39° 30'	122° 44'	3.5
4-14-61	38° 55'	122° 35'	2.3
12-8-60	39°	123.2°	3.1
7-24-60	39.2°	123.5°	2.9
7-23-60	38.7°	112.0°	2.7
2-15-60	39.5°	123.3°	2.9
11-11-59	39.3°	123.3°	3.2
10-5-59	39.1°	122.7°	2.8
9-24-59	39.4°	123°	3.6
9-16-59	39.3°	123°	3.5
9-6-59	39° 34'	123°	3.0
6-28-59	38.7°	122.7°	3.4
6-20-59	38.9°	122.8°	3.0
5-18-59	39° 42'	122° 56'	2.9
4-6-59	39.3°	123.2°	3.6
11-16-58	39° 05'	123° 01'	2.8
9-1-58	39° 28'	122° 48'	2.1
9-1-58	39° 28'	122° 48'	3.8
1-22-57	39.1°	122.9°	2.9
1-22-57	39.1°	122.9°	2.8
8-23-56	38.9°	122.8°	2.3
11-6-55	38.9°	122.6°	3.0
5-7-55	38° 56'	122° 52'	4.6
4-29-55	38° 57'	122° 46'	3.6
11-10-54	39° 04'	123° 02'	4.4
1-25-54	39.3°	122.8°	2.9
1-1-54	39.0°	123.2°	3.4
12-28-53	39.4°	122.7°	3.1

Date	Latitude North	Longitude West	Richter Magnitude
12-21-53	39.4°	123.1°	3.1
5-25-53	39.3°	112.3°	3.2
1-24-53	39.5°	123.0°	3.9
8-14-52	39° 18'	122° 53'	4.0
5-5-52	39.3°	122.9°	3.1
2-9-52	38.7°	122.7°	2.4
9-28-51	38° 48'	122° 35'	2.5
2-21-51	39.0°	122.5°	2.9
2-19-50	38° 45'	123° 03'	2.5
11-8-49	38.50°	122.70°	2.5

Bolt and Miller, 1975

APPENDIX C

Modified Mercalli Intensity Scale

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favourably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Stationary automobiles rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken, Knick-knacks, books etc., fall off shelves. Pictures fall off walls. Furniture moved or overturned. Weak plaster cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).

VII. Difficult to stand. Noticed by drivers of automobiles. Hanging objects quiver. Furniture broken. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Waves on ponds: water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of automobiles affected. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken off trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
Alder	Alnus ruba	I	Deer browse on resprouts; cover. Buds, catkins and seeds of value to song birds.
Birchleaf Mahogany	Cerococarpus betuloides	III	Preferred deer browse
Blackberry	Rubus ursinus	I, VII	Berries-Quail and bear; cover; some browsing by deer.
Black Huckleberry	Vaccinium ovatum	I, VII	Berries-Quail and bear; cover.
Black Oak	Quercus kellogii	II	Acorns-Deer, squirrels, bird nesting; pigeon roosting.
Blue Oak	Quercus kellogii	II	Acorns-Deer, squirrels, bird nesting; pigeon roosting.
Blue Elderberry	Sambucus caeurlea	I	Berries-Pigeon, bear, some song birds
Bur Clover	Medicago hispida	II, III, IV	Deer forage, important for quail food
California Buckeye	Aesculus californica	II, V, VII	Squirrel food - Deer use on resprouts
California Hazel	Corylus cornuta	V, VII	Nuts important for rodents; catkins for grouse; some deer browsing

*I-Riparian, II-Woodland-grass, III-Chaparral, IV-Habitat Improvement Areas, V-Pine-Fire-Chaparral VI-Cultivated Lands, VII-Conifer Forest

Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
California Laurel	Umbellalaria californica	I, II, VII	Deer browse on resprouts; cover
Chamise	Adenostema fasciculatum	III, IV, V	Staple deer browse on "available" plants; cover for all wildlife.
Chaparral Pea	Pickeringia montana	III	Deer browse
Christmas Berry	Photinia arbutifolia	I, III, V	Berries - Pigeons, songbirds
Coast Blueblossom Ceanothus	Ceanothus thyrsiflorus	V, VII	Preferred deer browse
Coast Buckwheat	Eriogonum latifolium	V, VII	Foliage-blue grouse, deer. Seeds flowerheads-small mammals and birds
Coffeeberry (California Buckthorn)	Rhamnus californica	VII, V	Fruit-pigeons, woodpecker; browsed by deer, use by small mammals
Coyote bush	Baccharis pilularis	VII	Browsed by deer; cover.
Deer Brush	Ceanothus integerrimus	III, V	Preferred deer browse
Douglas-fir	Pseudotsuga menziesii	V, VII	Cover; seedlings browsed by deer Seds-squirrels; foliage and staminate cones-blue grouse
Digger Pine	Pinus sabiniana	III, V	Seeds important for a variety of nongame birds; pigeons, quail, small mammals.

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Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
Filaree	Erodium sp.	II, III, V	Seeds-songbirds, quail, small mammals. Important forage for deer.
Golden Chinaquapin	Castanopsis chrysophylla	V	Some value for small mammals through seed use.
Gooseberry	Ribes roezlii	I	Fruit-songbirds, small mammals, black bear, deer.
Harding grass	Phalaris tuberosa	IV	Preferred deer forage when green.
Incense Cedar	Liboredrus	VII	Seeds - Small mammals .
Interior Live Oak	Queras wislizenii	II	Acorns-deer, pig, squirrels; bird nesting. Deer us on resprouts.
Knobcone Pine	Pinus attenuata	III, V	Seeds valuable for nongame birds, pigeons, quail, small mammals.
Leather Oak	Quercus durata	II, III, V	See interior live oak
Lupine	Lupinus sp.	I	Seeds-quail, songbirds, turkey. Some deer forage use.
Mountain Mahogany	Cercocarpus betuloides	III, V	Preferred deer browse

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Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
Madrone	Arbutus menziesii	III, V, VII	Cover - use of fruit by birds, small mammals.
Manzanita	Arctostaphylos manzanita	III, V, VII	Cover; use on berries by bears, birds, and predators such as coyote.
Pacific Dogwood	Cornus nuttallii	II, I	Fruit-wood duck, blue grouse, turkey, songbirds. Some deer browse use
Poison Oak	Rhus diversiloba	I, II, VII	Deer browse; cover
Ponderosa pine	Pinus ponderosa	V	Turkey roost trees; seeds valuable to birds, small mammals.
Red Alder	Alnus rubra	I	Deer browse on resprouts, cover
Redberry	Rhamnus crocea	VII, V	See coffeeberry
Red Brome	Bromus rubens	II, III, V	Deer forage during greenup; seeds valuable for all seed-eating species. Including upland game birds, songbirds, small mammals.
Ripgut brome	Bromus rigidus	II, III, V	Same as Red brome
Rose clover	Trifolium hirtum	II	Foliage use by deer and all upland game; quail use on seeds.

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Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
Rush	Juncus sp.	I	Green forage for deer, mammals. Cover and food for waterfowl, wild pig and birds.
Scrub oak	Quercus dumosa	III, V	Deer browse and acorn use; cover. Food for many species.
Sedge	Carex sp.	I, VII	Same as rush
Silk Tassel	Garrya sp.	III	Preferred deer browse
Smilo	Oryzopsis miliacea	II, III, V	See Red brome
Soft chess	Bromus malus	II, III, V	See Red brome
Sugar pine	Pinus lambertiana	VII, V	See Ponderosa pine
Tanoak	Lithocarpus sensiflora	III, V	Deer browse; cover
Toyon	Photinia arbutifolia	III, V	Cover; berries used by upland game and bear.
Varnish leaf	Ceanothus velutinus	VII, V	Preferred deer browse.
Vine maple	Acer circinatum	I	Buds, twigs, seeds-grouse, quail turkey, other birds, porcupine. Some browse use by deer.
Wedgeleaf Ceanothus	Ceanothus cuneatus	III, V	Preferred deer browse

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Appendix D Summary of the Major Vegetative Species and Related Wildlife Use by Habitat Type for the Witter Springs Area

VEGETATION SPECIES COMMON NAME	SCIENTIFIC NAME	WILDLIFE HABITAT TYPE*	USE BY WILDLIFE
Wavyleaf Ceanothus	Ceanothus foliosus	III	Preferred deer browse
Western Chokecherry	Aronia	I, VII	Minor fruit importance to birds; bear
White fir	Abies concolor	VII, V	See Douglas-fir
White oak	Quercus lobata	II	See Black oak
Whitethorn	Ceanothus incanus	VII	Preferred deer browse
Wild grape	Vitis californica	I	Fruit valuable for upland game birds, cover.
Wild oats	Avena barbata	II, III, V	See Red brome
Wild raspberry	Rubus idaeus	I	See Blackberry
Wild rose	Rosa sp.	I	See Blackberry
Willow	Salix sp.	I	Important deer browse; cover, buds valuable to blue grouse, songbirds - foliage and bark used by small mammals.
Yerba santa	Eriodictyon californicum	III, V	Deer browse on resprouts; cover

*I-Riparian, II-Woodland-grass, III-Chaparral, IV-Habitat Improvement Areas, V-Pine-Fire-Chaparral VI-Cultivated Lands, VII-Conifer Forest

Appendix E
Summary of Wildlife Species Found
Within the Witter Springs Area, by
Population Status* and Habitat Use

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Opossum Didelphis marsupialis	X	X	X	X	X
Towbridge Shrew Sorex trowbridgei		X			
Vagrant Shrew Sorex vagrans	X	X		X	
Pacific Shrew Sorex pacificus	X	X			
Shrew-mole Neurotrichus gibbsi	X	X			
Pacific mole Scapanus orarius			X	X	
California mole (Broad-handed) Scapanus latimanus		C		C	
Little Brown Myotis Myotis lucifugus	X	X			
Yuma myotis Myotis yumanensis			X	X	X
Long-eared myotis Myotis evotis			X	X	
Fringed myotis Myotis thysanodes			X	X	
Long-legged myotis Myotis volans		X			X

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.
California myotis Myotis californicus		X	X	X
Silver-haired bat Lasionycteris noctivagans		X		
Big brown bat Eptesicus fuscus	X	X	X	X
Red bat Lasiurus borealis		X	X	
Hoary bat Lasiurus cinereus		X	X	
Western big-eared bat Plecotus townsendi		X	X	
Pallid bat Antrozous pallidus			X	X
Mexican Freetail bat Tadarida brasilensis			X	X
Black bear Ursus americanus	U	U	U	U
Raccoon Procyon lotor	C		C	
Ringtail Bassariscus astutus	X	X		
Fisher Martes pennanti	X	X	X	

*Key to Symbols

X - Species present, further status undetermined
C - Common, regular or resident
U - Uncommon
R - Rare
V - Visitant, vagrant or migrant
SV - Summer migrant or visitant
WV - Winter migrant or visitant
D - Decreasing
S - Stable
I - Increasing

Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Shorttail weasel Mustela erminea	X	X	X		
Longtail weasel Mustela frenata	X		X	X	X
Mink Mustela vison	X				
Badger Taxidea taxus			X	X	
Spotted skunk Spilogale putorius	C				C
Striped skunk Mephitis mephitis	C		C		C
Coyote Canis latrans	C	C	C	C	C
Gray fox Urocyon cinereoargenteus	C	C	C	C	C
Mountain lion Felis concolor	U	U			
Bobcat Lynx rufus	C	C	C		C
Feral pigs Sus scrofa	X		X	X	X
California ground squirrel Citellus beecheyi			C	C	

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Townsend chipmunk Eutamias townsendi		C			C
Sonoma chipmunk Eutamias sonomae	C	C			C
Western gray squirrel Sciurus griseus		C	C		
Valley pocket gopher Thomomys bottae			C	C	
Heermann kangaroo rat Dipodomys heermanni					X
Western harvest mouse Reithrodontomys megalotis	C	C	C	C	C
Deer mouse Peromyscus maniculatus	C	C	C	C	C
Brush mouse Peromyscus boylei		X	X		
Pinon mouse Peromyscus truei		C			X
Dusky-footed woodrat Neotoma fuscipes		C			C
Tree phenacomys Phenaromys longicaudus		C			
Calif. redback vole Clethrionomys occidentalis		X			

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SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
California vole Microtus californicus	C			C	
Norway rat Rattus norvegicus					X
House mouse Musa musculus			C	C	
Pacific jumping mouse Zapus trinotatus	C		C	C	
Porcupine Erethizon dorsatum		U			
Blacktail jackrabbit Lepus californicus	C	C	C	C	C
Brush rabbit Sylvilagus bachmani	C	C	C	C	C
Black-tailed deer Odocoileus hemionus columbianus	C	C	C	C	C
Western pipistrelle Pipistrellus hesperus	X				X
Wild house cat Felis domestica	X	X	X	X	X

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral

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X - Species present, further status undetermined
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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Common Loon Gavia immer	R WV				
Eared grebe Podiceps caspicus	U WV				
Western grebe Aechmophorus occidentalis	C				
Pied-Billed grebe Podilymbus podiceps	C				
White pelican Pelecanus erythrorhynchos	C WV				
Double-crested cormorant Phalacrocerax auritus	C				
Great Blue heron Ardea herodias	C				
Green heron Butorides virescens	C				
Black-crowned night heron Nyctícorax nycticorax	U				
American bittern Botaurus lentiginosus	R				
Whistling swan Olor columbianus	U WV				
Canada goose Branta canadensis	U V				
Snow goose Chen hyperborea	R WV				
Fulvous tree duck Dendrocygna bicolor	V				
Mallard Anas platyrhynchos	C				
Gadwall Anas strepera	R				
Pintail Anas acuta	C WV				
Green-winged teal Anas carolinensis	C WV				
Blue-winged teal Anas discors	R WV				
Cinnamon teal Anas cyanoptera	C SV				
American widgeon Mareca americana	C WV				
Shoveler Spatula clypeata	C WV				
Wood duck Aix sponsa	C				
Redhead Aythya americana	U WV				

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R - Rare
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SV - Summer migrant or visitant
WV - Winter migrant or visitant
D - Decreasing
S - Stable
I - Increasing

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Ring-necked duck Aythya collaris	U WV				
Canvasback Aythya valisineria	U WV				
Greater scaup Aythya marila	U WV				
Lesser scaup Aythya affinis	C WV				
Common goldeneye Bucephala clangula	U WV				
Barrow's goldeneye Bucephala islandica	R				
Bufflehead Bucephala albeola	C WV				
White-winged scoter Melanitta deglandi	R WV				
Ruddy duck Oxyura jamaicensis	C C				
Common merganser Mergus merganser	C				
Marsh hawk Circus cyaneus	R WV			R WV	
Osprey Pandion haliaetus	U SV				
Turkey vulture Cathartes aura	C SV	C SV	C SV	C SV	C SV
White-tailed kite Elanus leucurus	C		C	C	
Goshawk Accipiter gentilis	R	R	R	R	R
Sharp-shinned hawk Accipiter striatus		U	U		U
Cooper's hawk Accipiter cooperii	C		C	C	
Red-tailed hawk Buteo lineatus	C	C	C	C	C
Red-shouldered hawk Buteo lineatus	D		C	C	
Swainson's hawk Buteo swainsoni	U V	U V	U V	U V	U V
Rough-legged hawk Buteo lagopus	R WV		R WV		R WV
Ferruginous hawk Buteo regalis	U WV	U WV	U WV		
Golden eagle Aquila chrysaetos	C	C	C	C	C
Bald eagle Haliaeetus leucocephalus	R				
Prairie falcon Falco mexicanus		R	R	R	R

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SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Peregrine falcon Falco peregrinus		R	R	R	R
Pigeon hawk (Merlin) Falco columbarius	R WV	R WV	R WV	R WV	R WV
Sparrow hawk Falco sparverius	C	C	C	C	C
California quail Lophortyx californicus	C	C	C	C	C
Mountain quail Oreortyx pictus	C	C	C		
Ring-necked pheasant Phasianus colchicus	U		U	U	
Virginia rail Rallus limicola	R				
Sora Porzana carolina	U				
Common gallinule Gallinula chloropus	R				
American coot Fulica americana	C				
Killdeer Charadrius vociferus	C			C	
Common snipe Capella gallinago	C WV			C WV	

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Spotted sandpiper Actitis macularia	U			U	
Solitary sandpiper Tringa solitaria	R V				
Greater yellowlegs Totanus melanoleucus	U V			U V	
Lesser yellowlegs Totanus flavipes	U				
Least sandpiper Erolia minutilla	U V				
Short-billed dowitcher Limnodromus griseus	R V				
Long-billed dowitcher Limnodromus scolopaceus	R V				
Western sandpiper Ereunetes mauri	CV WV				
Marbled godwit Limosa fedoa	CV				
Sanderling Crocethia alba	CV WV				
Northern phalarope Lobipes lobatus	CV				
Glaucous-winged gull Larus glaucescens	C WV				

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Caspian tern Hydroprogne caspia	C SV				
Herring gull Larus argentatus	C WV				
California gull Larus californicus	C WV				
Ring-billed gull Larus delewarensis	C				
Band-tailed pigeon Columba fasciata	C	C	C	C	C
Rock dove Columba livia			C	C	
Mourning dove Zenaidura macroura	C	C	C	C	C
Roadrunner Geococcyx californianus			R		R
Barn owl Tyto alba			C	C	
Screech owl Otus asio	C	C	C	C	C
Flammulated owl Otus flammeolus		R			
Great horned owl Bubo virginianus	C	C	C	C	C

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Pygmy owl Glaucidium gnoma		C	C		
Burrowing owl Speotyto cunicularia			U	U	
Spotted owl Strix occidentalis		R			
Great gray owl Strix nebulosa		U			
Poor-will Phalaenoptilus nuttallii		U SV	U SV		U SV
Common nighthawk Chordeiles minor	U SV	U SV	U SV	U SV	U SV
Vaux's swift Chaetura vauxi		C SV	C SV	C SV	
White-throated swift Aeronautes saxatalis		R V		R V	
Black-chinned hummingbird Archilochus alexandri	R	R	R	R	R
Anna's hummingbird Calypte anna	C	C	C	C	C
Rufous hummingbird Selasphorus rufus	C SV	C SV	C SV	C SV	C SV
Allen's hummingbird Selasphorus sasin	C SV	C SV	C SV	C SV	C SV

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-March	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Calliope hummingbird Stellula calliope		R SV	R SV		
Belted kingfisher Megaceryle alcyon	C				
Yellow-shafted flicker Colaptes auratus	U WV	U WV	U WV	U WV	U WV
Red-shafted flicker Colaptes cafer	C	C	C	C	C
Pileated woodpecker Dryocopus pileatus		U	U		
Acorn woodpecker Melanerpes formicivorus	C	C	C	C	C
Lewis' woodpecker Asyndesmus lewis	R	R	R	R	R
Yellow-bellied sapsucker Sphyrapicus varius	C WV	C WV	C WV		
Red-breasted sapsucker Sphyrapicus varius	C	C	C		
Hairy woodpecker Dendrocopos villosus	C	C	C		
Downy woodpecker Dendrocopos pubescens	C		C		
Nuttall's woodpecker Dendrocopos nuttallii	C		C		

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-March	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
White-headed woodpecker Dendrocopos albolarvatus	U				
Eastern kingbird Tyrannus tyrannus		U	U	U	
Western kingbird Tyrannus verticalis			C SV	C SV	
Ash-throated flycatcher Myiarchus cinerascens		C SV	C SV		C SV
Black phoebe Sayornis nigricans	C		C V	C	
Say's phoebe Sayornis saya			U WV	U WV	
Traill's flycatcher Empidonax traillii	C SV		C SV		
Hammond's flycatcher Empidonax hammondii		C SV	C SV		
Dusky flycatcher Empidonax oberholseri		C SV			C SV
Western flycatcher Empidonax difficilis	C SV	C SV	C SV		
Western wood pewee Contopus sordidulus	C SV	C SV	C SV		
Olive-sided flycatcher Nuttallornis borealis		C SV			

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Horned lark Eremophila alpestris		R WV	R WV		R WV
Violet-green swallow Tachycineta thalassina		C SV	C SV	C SV	
Tree swallow Iridoprocne bicolor	C SV		C SV		
Bank swallow Riparia riparia	R SV			R SV	
Rough-winged swallow Stelgidopteryx ruficollis	C SV			C SV	
Barn swallow Hirundo rustica	C SV		C SV	C SV	
Cliff swallow Petrochelidon pyrrhonota	C SV		C SV	C SV	C SV
Purple martin Progne subis		U SV	U SV	U SV	
Steller's jay Cyanocitta stelleri		C			
Scrub jay Aphelocoma coerulescens	C		C		C
Common raven Corvus corax		C	C		C
Common crow corvus brachyrhynchos	C	C	C	C	C

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Mountain Chickadee Parus gambeli	C WV	C WV			
Chestnut-backed chickadee Parus rufescens		WV	WV		
Plain titmouse Parus inornatus	C		C		
White-breasted nuthatch Sitta carolinensis	C	C	C		
Red-breasted nuthatch Sitta canadensis		C WV	C WV		
Pygmy nuthatch Sitta pygmaea		C			
Brown creeper Certhia familiaris	C	C	C		
Wrentit Chamaea fasciata			C		C
Dipper Cinclus mexicanus	C	C			
House wren Troglodytes aedon			C SV	C SV	
Winter wren Troglodytes troglodytes		C WV	C WV		
Bewick's wren Thryomanes bewickii	C		C		C

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Long-billed marsh wren Telmatodytes palustris	X				
Canon wren Catherpes mexicanus			R		R
Rock wren Catherpes mexicanus		U SV			U SV
Mockingbird Minus polyglottos			U WV	U WV	U WV
California thrasher Toxostoma redivivum			C		C
Sage thrasher Oreoscoptes montanus				U	U
Robin Turdus migratorius	C	C	C	C	C
Varied thrush Ixoreus naevius		C WV	C WV		C WV
Hermit thrush Hylocichla guttata		C WV	C WV		C WV
Swainson's thrush Hylocichla ustulata	C SV	C SV	C SV		
Western bluebird Sialia mexicana	C	C	C	C	
Mountain bluebird Sialia currucoides		R WV		R WV	

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Townsend's solitaire Myadestes townsendi		R			
Blue-gray gnatcatcher Polioptila caerulea	C SV		C SV		C SV
Golden-crowned kinglet Regulus satrapa		C WV			
Ruby-crowned kinglet Regulus calendula	C WV	C WV	C WV	C WV	C WV
Water pipit American pipit	C WV	C WV	C WV	C WV	C WV
Cedar waxwing Bombycilla cedrorum	C WV	C WV	C WV	C WV	C WV
Loggerhead shrike Lanius ludovicianus	U				U
Starling Sturnus vulgaris	C	C	C	C	C
Hutton's vireo Vireo huttoni	C	C	C	C	C
Bell's vireo Vireo bellii	R				R
Solitary vireo Vireo solitarius		C SV	C SV		
Warbling vireo Vireo gilvus	C SV	C SV	C SV	C SV	C SV

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Orange-crowned warbler	C	C	C	C	C
Vermivora celata	SV	SV	SV	SV	SV
Nashville warbler		CV	CV		
Vermivora ruficapilla		SV	SV		
Yellow warbler	CV	CV	CV	CV	CV
Denroica petechia	SV	SV	SV	SV	SV
Magnolia warbler		U	U		
Denroica magnolia					
Myrtle warbler	C	C	C		C
Dendroica coronata	WV	WV	WV		WV
Black-throated gray warbler	CV	CV	CV	CV	CV
Dendroica nigrescens	SV	SV	SV	SV	SV
Townsend's warbler	CV	CV	CV	CV	CV
Denroica townsendi	WV	WV	WV	WV	WV
Hermit warbler		CV			
Denroica occidentalis					
Audubon's warbler	C	C	C	C	C
Dendroica audyboni	WV	WV	WV	WV	WV
MacGillivray's warbler	U	U	U	U	U
Oporornis tolmiei	V	V	V	V	V
Yellowthroat	U			U	
Geothlypis trichas	SV			SV	
Yellow-breasted chat	C	C	C	C	C
Icteria virens	SV	SV	SV	SV	SV

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Wilson's warbler	C	C	C	C	C
Wilsonia pusilla	SV	SV	SV	SV	SV
House sparrow	C		C	C	C
Passer domesticus					
Western meadowlark	C		C	C	
Sturnella neglecta					
Yellow-headed blackbird	C			C	
Xanthocephalus xanthocephalus					
Red-winged blackbird	C				
Agelaius phoenicus					
Tricolored blackbird	R			R	
Agelaius tricolor					
Billock's oriole	C		C		
Icterus bullockii	SV		SV		
Brewer's blackbird	C	C	C	C	C
Euphagus cyanocephalus					
Brown-headed cowbird	C	C	C	C	C
Molothrus ater	SV	SV	SV	SV	SV
Western tanager		CV	CV		
Piranga ludoviciana					
Black-headed grosbeak	C	C	C	C	C
Pheucticus melanocephalus	SV	SV	SV	SV	SV
Lazuli bunting	C				C
Passerina amoena	SV				SV

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SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Evening grosbeak Hesperiphona vespertina		U WV			
Purple finch Carpodacus purpureus		C	C		
House finch Carpodacus mexicanus			C	C	C
Pine siskin Spinus pinus		C	C		
American goldfinch Spinus tristis	C SV		C SV		
Lesser goldfinch Spinus psaltria	C		C	C	C
Lawrence's goldfinch Spinus lawrencei	U SV		U SV		U SV
Red crossbill Loxia curvirostra		R WV			
Green-tailed towhee Chlorura chlorura		U SV			U SV
Rufous-sided towhee Pipilo erythrophthalmus	C	C	C	C	C
Brown towhee Pipilo fuscus	C	C	C	C	C
Savannah sparrow Passerculus sandwichensis	V			V	
Grasshopper sparrow Ammodramus savannarum				R	R
Vesper sparrow Poocetes gramineus				RV	RV
Lark sparrow Chondestes grammacus				C	C
Rufous-crowned sparrow Aimophila ruficeps		R	R	R	
Sage sparrow Amphispiza belli				C	C
Slate-colored junco Junco hyemalis	R WV	R WV	R WV	R WV	R WV
Oregon junco Junco oreganus	C	C	C	C	C
Chipping sparrow Spizella passerina	C SV	C SV	C SV	C SV	C SV
Black- chinned sparrow Spizella atrogularis					R
Harris' sparrow Zonotrichia querula		R WV	R WV		R WV
White-crowned sparrow Zonotrichia leucophrys	C WV	C WV	C WV	C WV	C WV
Golden-crowned sparrow Zonotrichia atricapilla	C WV	C WV	C WV	C WV	C WV

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SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
White-throated sparrow Zonotrichia albicollis			R WV		R WV
Fox sparrow Passerella iliaca	C WV	C SV	C WV	C WV	C WV
Lincoln's sparrow Melospiza lincolnii	WV	SV	WV	WV	WV
Song sparrow Melospiza melodia	C		C	C	C
Snow bunting Plectrophenax hivalis		U WV	U WV		
Cassin's finch Carpodacus cassinii		C			
Common egret Casmesodius albus	U				
Long-eared owl Asio otus	X	X	X		
Common bushtit Psaltriparus minimus	X				X

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Appendix E (cont.)

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Pacific mud turtle (Western pond turtle) Clemmys marmorata	X	X	X	X	X
Western Fence lizard Sceloporus occidentalis	C	C	C	C	C
Western skink Eumeces skiltonianus	X	X	X		
Southern alligator lizard Gerrhonotus multicarinatus	X	X	X	X	X
Western whiptail Cnemidophorus tigris	X	X	X		
Northern alligator lizard Gerrhonotus coeruleus		X			
Sagebrush lizard Sceloporus graciosus	X	X			X
Ring-necked snake Diadophis punctatus	X	X	X	X	X
Sharp-tailed snake Contia tenuis	X	X	X	X	X
Racer Coluber constrictor	X	X	X	X	X
Calif. Striped whipsnake Masticophis lateralis	X	X	X		X
Common king snake Lampropeltis getulus	X	X	X	X	X

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Common garternsake Thamnophis sirtalis	X	X	X	X	X
Western rattlesnake Crotalus viridis	X	X	X	X	X
Rubber boa Charina bottae	X	X	X	X	X
Gopher snake Pituophis melanoleucus	X	X	X	X	X
California mtn. kingsnake Lampropeltis zonata	X	X	X	X	X
Long-nosed snake Rhinocheilus lecontei				X	X
Western terr. garternsake Thamnophis elegans	X	X	X	X	
Western aquatic gartersnake Thamnophis couchi	X	X	X	X	X
Western ring-necked snake Diadophis amabilis	X	X	X	X	X

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SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Pacific giant salamander Dicamptodon ensatus	X	X			
Rough-skinned newt Taricha granulosa	X	X	X		
Red-bellied newt Taricha rivularis	X	X			
Ensatina Ensatina eschscholtzii	X	X	X		
California newt Taricha torosa	X	X	X		X
Cal. slender salamander Batrachoseps attenuatus	X	X	X	X	
Black salamander Aneides flavipunctatus	X	X	X		
Clouded salamander Aneides ferreus		X			
Aboreal salamander Aneides lugubris		X X	X X		
Northwestern salamander Ambystoma gracile	X		X	X	
Olympic salamander Rhyacotriton olympicus	X	X			
Western toad Bufo boreas	X	X	X	X	X

SPECIES BY COMMON & SCIENTIFIC NAME	Riparian-Marsh	Conifer-Forest	Woodland-Grass	Grass-Meadow-Agr.	Chaparral
Pacific tree frog Hyla regilla	X	X	X	X	X
Red-legged frog Rana aurora	X		X	X	
Foothill yellow-legged frog Rana boylei	X	X	X		
Bullfrog Rana catesbeiana	X	X	X	X	X
Tailed frog Ascaphus truei	X	X			

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9/9/74 Mechanical failure of the fiberglass disposal line from Unit 5 & 6 settling pond discharged ~4,500 gallons of condensate into Big Sulphur Creek. A fish kill and excessive siltation was noted. (ref: Union 76 letter 9/19/74 to CRWQCB. CRWQCB files).

9/16/74 A unit 5 & 6 settling pond overflow on 9/15/74 discharged ~45,000 gallons of condensate to Big Sulphur Creek. Improper procedures in water transfer blamed. No fish kill noted, however, parametrix noted a higher than average ammonia and sulfate level present in Big Sulphur Creek. (ref: same as above).

1/6/75 Approximately 50 gallons of No. 2 diesel oil was spilled during routine fueling operations at the Ottoboni state well no. 20. The diesel was contained within a berm built for that purpose. Heavy rains overflowed the berm and released the diesel to Squaw Creek. (ref: Union 76 letter explaining the delay in reporting the spill to CRWQCB 1/15/75. CRWQCB files).

2/25/75 A water spill @ Horner state well #1 in Lake Co. released approximately 8,000 gallons condensed steam which had been used for drilling water was pumped onto the ground by accident. The water percolated into the ground and there was no visable signs of contamination noted immediately after the accident. Mr. Pardini noted suds in High Valley Creek. (ref: Union 76 letter 3/17/75 to CRWQCB, attn: J. Robertson, RWQCB files).

3/31/75 Blow-out of Union Oil Co. Well No. GDC 65-28. Hillsides near well covered with greenish dust which washed into stream tributary to Big Sulphur Creek.

4/9/75 Construction efforts to control blow-out of Union Oil Co. Well No. GDC 65-28 result in high turbidity and sedimentation of Big Sulphur Creek and tributary (reportedly a continuing problem).

5/9/75 Discharge of cooling tower water from PG&E Unit #11 into Squaw Creek.

6/4/75 A flange broke at Unit 11 spilling an estimated 20,000 gallons of condensate to the ground. Of the amount spilled, most was contained in a basin but 10% was reported to have reached Squaw Creek. The flange is of the same type as installed at other units. (ref: PG&E letter 6/4/75 to CRWQCB, attn: Mr. Snetsinger; Interoffice memo 6/5/75 to B. Tancreto, B. Kor, & D. Snetsinger from D. Salisbury. CRWQCB files).

6/6/75 A spill of ~10,000 gallons from Unit 3 consisted of steam condensate and water from a tributary of Big Sulphur Creek. A vitrified clay pipe broke, and drained the water ½ mile down the hill carrying mud into the creek. Duration of the spill was approximately 4 hours. The clay pipe is being replaced with glass lined carbon steel pipe. (ref: PG&E letter 6/10/75 to CRWQCB, attn: Mr. Snetsinger. CRWQCB files).

APPENDIX G

R E V E G E T A T I O N

Proper seed species for:

Drill pads, hillsides, roads - cuts, fills, borrow areas.

Several Species Beneficial
to Wildlife Include:

GRASSES	SHRUBS	TREES
Brome Grass (Bromus)	Wild Cherry (Prunus)	Pines (Pinaceae)
Bluegrass (Poa)	Wild Blackberry (Rubus)	Firs (Abies)
Fescue Grass (Festuca)	Service Berry (Amelanchier)	Alders (Alnus)
	Buckbrush (Ceanothus)	

FORBS

Filarees (Erodium)
Clovers (Trifolium)
Deervetches (Lotus)
Wildrose (Rosa sp.)

Proper plantings and seedings for:

Sumps and Drainage Areas.

Shrubs

Willow (Sulix sp.)
Wild Rose (Rosa sp.)
Wild Blackberry (Rubus)

Grasslike

Rushes (Juncus sp.)
Sedges (Cuvex sp.)

Forbs

Clovers (Trifolium)
Cattail (Typha)
Dandelion (Taraxacum)
Vetch (vicia sp.)

STATE OF CALIFORNIA—THE RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 2390
SACRAMENTO 95811
(916)445-2358

October 26, 1975

Mr. Melvin D. Clausen
District Manager
Bureau of Land Management
555 Leslie Street
Ukiah, California 95482

Dear Mr. Clausen:

I appreciate the opportunity to comment on the "Preliminary Archeological Survey of the Archeological Resources in the Cow Mountain Planning Unit" per your letter of October 3, 1975: reference #3200-CM.

The survey report is an excellent document and I feel that the archeologist's recommendations are appropriate and should be considered. My staff and I are concerned about the potential for historic structures and properties existing in this area and look forward to getting documentation on these cultural items.

I would remind you of your obligations under Executive Order 11593 and 36 CFR Part 800 regarding any proposed procedures to be implemented by lessee in this undertaking. We recommend that the Bureau document and nominate the Norris Trail to the National Register of Historic Places pursuant to Executive Order 11593, section 2.a. 36 CFR Part 800 further stipulates those steps which must be taken prior to any Federal Agency's decision on an undertaking, including a decision as to appropriate mitigation.

If my staff or I can be of further assistance, please do not hesitate to contact us.

Sincerely,

Herbert Rhodes
State Historic Preservation Officer

P-2/821

APPENDIX I

References

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